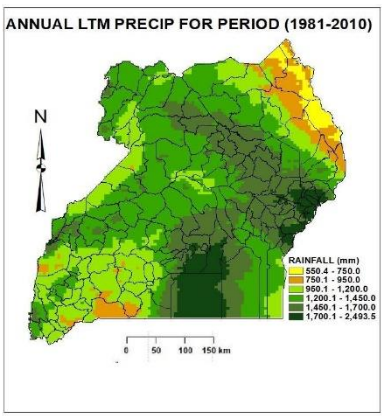
REPUBLIC OF UGANDA

Uganda's Third National Communication to the United Nations Framework Convention on Climate Change



MINISTRY OF WATER AND ENVIRONMENT

JULY 2022

Uganda's Third National Communication to the United Nations Framework Convention on Climate Change

FOREWORD

The challenge of climate change poses the greatest development threat, not only to Uganda, but the entire globe. There is no longer any doubt that the global climate system is changing. The latest scientific information given by the Fifth Assessment Report of the Intergovernmental Panel on Climate Change indicates that global warming poses serious development and environmental problems with far-reaching social and economic consequences.

Uganda faces numerous events associated with the adverse impacts of climate change. Record breaking occurrences of floods, devastating and frequent droughts and erratic rainfall patterns have been experienced. Severe impacts including landslides, loss of biodiversity, land degradation and increased incidences of diseases, pest and vector infestations in both humans and livestock have followed. The recurrent floods in River Nyamwamba in Kasese District on the slopes of The Rwenzori Mountains, and long droughts across the cattle-keeping belt of Uganda are always pointers to the magnitude of the menace.

Coincidentally, these events affect those with least resilience and adaptive capacity. Indeed, the country struggles to cope with the demand for support, especially from the rural communities. Thus, attainment of the country's socio-economic development aspirations as spelt out in the Third National Development Plan and Vision 2040 may be seriously curtailed.

In recognition of the problem, Uganda was one of the first countries to sign and ratify the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and has continued her commitment to the UNFCCC, the Kyoto Protocol and to the Paris Agreement. In accordance with her capacity and capabilities and with the generous support from the wider UN and the specific UNFCCC organs, Uganda has put in place the necessary policy, regulatory and institutional mechanisms to guide and propel the country's climate change response and actions. Uganda has operationalized a National Climate Change Policy and is enacting a Climate Change Bill.

On behalf of Uganda, I therefore have the honour and privilege to present Uganda's Third National Communication to the Conference of the Parties to the United Nations Framework Convention on Climate Change. The document has been prepared in accordance with Article 4, paragraph 1, and Article 12, paragraph 1, of the UNFCCC.

Hon. Sam Cheptoris
MINISTER OF WATER AND ENVIRONMENT
Republic of Uganda

ACKNOWLEDGEMENTS

The importance of strengthening the institutional, scientific, technical, and human capacity of a country cannot be over-emphasized as it forms the centrality for the effective implementation of the United Nations Framework Convention on Climate Change (UNFCCC). Support to the country towards meeting its obligations under the Convention is therefore most welcome.

Uganda's Third National Communication (TNC) under the UNFCCC has been prepared based on a series of studies, research and modelling by a multi-disciplinary Task Force of experts appointed by the Ministry of Water and Environment and executed under the direct supervision of the Climate Change Department (CCD). The preparation of this Communication has been made possible with funding from the Global Environmental Facility (GEF) through the UN Environment as the implementing entity. In this respect, the Government of Uganda, through the Ministry of Water and Environment (MWE), expresses gratitude to these agencies. The support received from GEF, UNEP and the Global Support Programme is highly appreciated.

In preparing this report, Uganda used experts in the area of Greenhouse Gas Inventory (2), Mitigation Assessment (1), Vulnerability and Adaptation (3), Socio-economy (1) and Gender (1). A Project Management Unit (PMU) was established under the direct leadership of the Commissioner, CCD. The PMU provided technical back-up, harmonization and guidance towards the overall project implementation within the agreed timeline. I therefore thank the Task Force Leader and Members of the Task Force, the PMU, the Commissioner CCD, the staff of MWE, the NCCAC and the Parliament of Uganda.

My Ministry is also highly indebted to the various Government Ministries, Departments and Agencies as well as the Civil Society Organizations (CSO) and individuals that made the work of preparing Uganda's Third National Communication possible. I am particularly appreciative of the support provided by the Minister of Water and Environment, Hon. Sam Cheptoris and the State Ministers in the Sector.

Alfred Okot Okidi
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AFOLU	Agriculture, forestry, and other land uses
AfrII	Africa Innovations Institute
Agric	Agriculture
AIC	Agro Insurance Consortium
ASL	above sea level (ASL)
AU	African Union
AWS	Automatic Weather Stations
BAU	Business as Usual
BoU	Bank of Uganda
BTVET	Business, Technical, Vocational Education and Training
CAA	Civil Aviation Authority
CAADP	Comprehensive Africa Agriculture Development Program
CBIT	Capacity-building Initiative for Transparency
CBOs	Community-based organizations
CBR	Central Bank Rate
CBSD	Cassava Brown Streak Disease
CCD	Climate Change Department
CCET	climate change education and training
CDM	Clean Development Mechanism
CEDAW	Convention on Elimination of all forms of discrimination Against Women
CFC	Chlorofluorocarbon
CH_4	Methane
CI	Conservation International
CMPs	Catchment Management Plans
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2eq	Carbon dioxide equivalent
COP	Conferences of Parties
CSOs	Civil Society Organizations
DBH	Diameter at Breast Height
DDPs	District Development Plans
DHI	Dissemination of Health Information
DP	Democratic Party
DRC	Democratic Republic of Congo
DRMS	Domestic Revenue Mobilization Strategy
EFU	Energy, Fuel and Utilities

EMEP/EEA	European Monitoring and Evaluation Program/ European Environment Agency
ENR	Environment and Natural Resources
ERM	Emergency response mechanisms
EU	European Union
FBO	Faith-based organization
FBUR	First Biennial Update Report
FDC	Forum for Democratic Change
FGD	Focus Group Discussion
FMNR	Farmer Managed Natural Regeneration
FSSD	Forestry Sector Support Department
FY	Financial year
GACMO	Greenhouse Gas Abatement Cost Model
GAD	Gender and Development Approach
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEWE	Gender Equality and Women's Empowerment
Gg	Gigagrams
GGGI	Global Green Growth Institute
GHG	Greenhouse Gas
GHGI	Greenhouse gas Inventory
GIS	Geographical Information System
GMES	Global Monitoring for Environment and Security
GNP	Gross National Product
GoU	Government of Uganda
GPG	Good Practice Guidance
GWP	Global warming potentials
Ha	Hectare
HCFC	Hydrochlorofluorocarbon
HE	Higher education
HMIS	Health Management Information Systems
HSDPs	Health Sector Development Plans
HSSIP	Health Sector Strategic and Investment Plan
ICPAC	IGAD Climate Prediction and Application Centre
ICPD	International Conference on Population and Development
ICT	Information, Communication and Technology
IGAD	Inter-governmental Authority on Desertification
IITCP	Inter-institutional technical Climate change Focal Person
INRM	Integrated Natural Resource Management
IPCC	Intergovernmental Panel on Climate Change

IPPU	Industry processes and product use
IWRM	Integrated Water Resource Management
JICA	Japan International Cooperation Agency
KCCA	Kampala Capital City Authority
LDCF	Least Developed Countries Fund
LDCs	Least Developed Countries
LEAP	Low Emissions Analysis Platform
LED	Light emitting diode
LULUCF	Land Use, land use change and forestry (LULUCF)
M & E	Monitoring and Evaluation
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
Mak	Makerere University
MBOs	Member-based organizations
MDAs	Ministries, Departments, and Agencies
MEAs	Multilateral Environmental Agreements
MEMD	Ministry of Energy and Mineral development
MGR	meter gauge railway
MoFPED	Ministry of Finance, Planning and Economic Development
MoGLSD	Ministry of Gender, Labour and Social Development
MoH	Ministry of Health
MoLG	Ministry of Local Government
MOSTI	Ministry of Science, Technology and Innovation
MoWT	Ministry of Works and Transport
MRV	Measuring, Reporting and Verification
MT	metric tonnes
MUCCRI	Makerere University Centre for Climate Change Research and Innovation
MW	Megawatts
MWE	Ministry of Water and Environment
N_2O	Nitrous oxide
NaCRRI	National Crops Resources Research Institute
NAMAs	National Appropriate Mitigation Actions
NAPA	National Adaptation Programme of Action
NAPs	National Adaptation Plans
NARIS	National Agricultural Research Institute
NARO	National Agricultural Research Organization
NATWG	National Adaptation Technical Working Group
NCCAC	National Climate Change Advisory Committee

NCCP	National Climate Change Policy
NCCPC	National Climate Change Policy Committee
NDCs	Nationally Determined Contributions
NDP	National Development Plan
NDVI	Normalised Difference Vegetation Index
NELSAP	Nile Uganda Equatorial Lakes Subsidiary Action Program
NEMA	National Environment Management Authority
NFA	National Forestry Authority
NGO	Non-Government Organization
NGO	Non-governmental organization
NMT	Non-motorised traffic
NMVOCs	Non-methane organic volatile compounds
NOX	nitrogen oxides
NPA	National Planning Authority
NRM	National Resistance Movement
NTF	National Task Force
NUP	National Unity Platform
NWSC	National Water and Sewerage Corporation
OPM	Office of the Prime Minister
OPM	Office of the Prime Minister
PA	Paris Agreement
PCE	Policy Committee on Environment
PE	Primary education
PFCC	Parliamentary Forum on Climate Change
PhD	Doctor of Philosophy
PoA	Programme of activities
RCMRD	Regional Centre for Mapping of Resources for Development
REDD+	Reducing emissions from deforestation and forest degradation
SCCC	Standing Committee on Climate Change
SDGs	Sustainable Development Goals
SE	Secondary education
SGR	standard gauge railway
SLM	Sustainable land management
SNC	Second National Communication
SO_2	Sulphur dioxide
SWOT	Strengthens, Weaknesses, opportunities and threats
TAP	Technology Action Plan (TAP).

tCO_2e/ yr	tons of carbon dioxide equivalent per year
TFR	Total Fertility Rate
TNA	Technology Needs Assessment
TNC	Third National Communication
TWG	Technical Working Group
UAIS	Uganda Agriculture Insurance Scheme
UAV	Unmanned Aerial Vehicle
UBOS	Uganda Bureau of Statistics
UCC	Uganda Communications Commission
UGGDS	Uganda Green Growth Development Strategy
UGP	Uganda Gender Policy
UGX	Uganda Shillings
UNCCP	Uganda National Climate Change Policy
UNCST	Uganda National Council for Science and Technology
UNDP	United Nations Development Programme
UNEA	UN Environment Assembly
UNFCCC	United Nations Framework Convention on Climate Change
U-NIEWS	Uganda Inter- Ministerial / Agencies Monthly National Integrated Multi-Hazard Early Warning
UNMA	Uganda National Meteorological Authority
UPC	Uganda People's Congress
URC	Uganda Railways Corporation
USD	United States dollar
UShs	Uganda Shillings
V&A	Vulnerability and Adaptation
WID	Women in Development
WMO	World Meteorological Organization
WMZs	Water Management Zones

EXECUTIVE SUMMARY

Introduction

Uganda signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and has continued to meet the commitments under the convention. In accordance with Article 4, paragraph 1, and Article 12, paragraph 1, of the UNFCCC. This document presents Uganda's Third National Communication to the Conference of the Parties.

ES 1: National Circumstances and Institutional Arrangements

Geographically, Uganda is a land-locked country in East Africa that lies in the middle of the African Continent; astride the equator between 4°N and 1°S and stretching from 29.5°W to 35°W. Uganda has a warm tropical climate with average temperatures falling in the 25–29°C (77–84°F) range. The observed annual rainfall totals vary from 500 mm to 2800 mm. Uganda repeatedly experiences extreme climate-related events in form of droughts and floods and associated natural disasters. With the country heavily reliant on natural resources, the level of vulnerability is therefore quite high, especially from the effects of climate change.

Uganda's endowment of natural resources such as land, water, forests and biodiversity constitute the primary source and foundation of livelihood for the majority of the people. The country's economy depends heavily on exploitation of these resources. However, natural resource degradation as well as overexploitation is a direct threat to sustainable development. It is estimated that 97% of Uganda's land area is suffering from some form of human-induced land degradation. The key problems include soil erosion and declining soil fertility, deforestation, pollution of land, water and air resources, loss of biodiversity and over-harvesting of forests, fisheries and water resources.

Uganda's population has grown annually at a rate of about 3% between 2002 and 2014. Uganda has a population density of 222 per km^2. In 2019, about three-quarters of the population of Uganda lived in the rural areas. The bulk of Uganda's population is less than 14 years old.

On the economic front, Uganda's economy has been growing rapidly and consistently. In 2018, GDP per capita was at around US$2,458 (PPP); well below the sub-Saharan Africa average of US$4,096 (PPP). Unemployment remains a major development challenge. In 2017, the working population was 15 million persons but with total employment estimated at 9.1 million.

Uganda has embraced the principles of green growth and sustainable development in its economic development efforts. Various legal, policy, planning and institutional frameworks have been put in place in the recent years. In its development efforts, Uganda aspires to transform itself from a predominantly peasant country to a modern and prosperous country by 2040. These are articulated in its Uganda Vision 2040 Framework rolled out through five-year National Development Plans (NDPs); currently at the third.

Agriculture is a core sector of Uganda's economy and the largest employer. Over 80 per cent of rural population are employed in the sector. It contributes about 75 percent of agricultural production. In 2019, agriculture contributed around 21.92 percent to the GDP, 46 percent of its export earnings while 68 percent of total employment and all food requirements. Unfortunately, the sector suffers from ow levels of government expenditure and over-reliance of climate.

Uganda’s targets tourism potential to be harnessed and hence play a major role in the economy and contributor to GDP by 2040. In 2017, the direct contribution of tourism to GDP was UGX 2,699.1bn (2.9% of GDP) while the total contribution was UGX 6,888.5bn in 2017 (7.3% of GDP), up from UGX6, 171.5bn in 2015.

Uganda’s transport sector relies heavily on high-emission vehicles for road transport, 14-passenger commuter taxis and motor cycles. It is not diversified as there is limited use of rail and wide inland water potential. Over 90% of cargo freight and passengers move by road. Transport costs in Uganda thus remain high compared to those of other countries in the East African region.

Uganda’s Information and Communications Technology (ICT) Sector is dynamic and vibrant; registering double digit growth over the last few years.

On the energy front, Uganda like many sub-Saharan Africa countries, relies heavily on biomass. It accounts for 94% of the total energy consumption. This is despite abundant energy resources such as hydropower and solar which are fairly distributed throughout the country.

Uganda possesses a wide variety of mineral deposits, including both high value minerals (such as gold, uranium, iron ore, wolfram, copper, cobalt) and low value minerals. The mining industry is considered to be key in contributing to the Uganda Vision 2040. However, only cement is the most established mining industry in Uganda. The oil and gas reserves, that are targeted for exploitation in the coming years, has the potential to transform Uganda’s economy since the oil and gas industry will continue to be a driver of economic development and poverty reduction in developing countries in the future.

Manufacturing is limited in Uganda although it occupies a central position in Uganda’s economic development and social transformation objectives, strategies, and policy actions. The Sector’s contribution to GDP has grown from 18.9 percent in 2001/02 to 27.1 percent in 2018/19. The sector is dominated by agro-processing, food and beverages, household products, construction materials, and fast-moving consumer goods. Most firms are small and medium enterprises concentrated in Kampala and Central region.

Looking to the future, Uganda has some country-specific features that constrain the country's economic development. These include; being land-locked, proximity to areas of conflict and the ravages of weather and climate.

From a governance point of view, Uganda is an independent State and a Republic. It is governed by a constitution which is the supreme law. The main organs of central and local Government are the legislature, the executive and the judiciary. There are periodic elections that are by universal and adult suffrage; and held by secret vote. Uganda has a decentralized system of governance that involves lower local governments. In Uganda, people's rights and freedoms are respected, and promoted by all organs of Government and by all persons.

Uganda continues to demonstrate willingness, readiness and commitment to address climate change as a responsible member of the wider global community. With respect to the obligation to regularly prepare, publish, report and update its national communications to the UNFCCC, Uganda has so far submitted two national communications to the Conferences of Parties (COP) of the UNFCCC, has prepared and submitted the First Biennial Update Report (BUR1) and has submitted the Nationally Determined Contribution (NDC).

Uganda's institutional arrangements for coordinating Uganda's response to climate change has been developing over the years. At the national level, the National Climate Change Policy (approved in 2015) as well the international regime, distinguishes and defines several key institutional functions: coordination, finance and implementation. Coordination is assigned to the Climate Change Department under the supervision of the Ministry of Water and Environment. Leadership for climate finance is assigned to the Ministry of Finance, Planning and Economic Development (MoFPED) which is Uganda's National Designated Authority (NDA). The implementation is distributed among several sectors. Mitigation is concentrated in the IPCC sectors of agriculture, forestry, energy, transport, waste and industrial processes. Adaptation is the focus of the sectors of water, wetlands, health, and disaster risk management. There are also sectors that cut across such as lands and urban development and transport.

ES 2: National Greenhouse Gas (GHG) Inventory

Uganda's Greenhouse Gas Inventory (GHGI) has evolved tremendously from the first GHI for the first National Communication that covered the year 1993/94 to that of the Second National Communication (SNC) that covered the period 1995 to 2000, for First Biennial Update Report (FBUR) that covered the period 2000 to 2015. The Greenhouse Gas Inventory for the Third National Communication (TNC) covers the period 1995 – 2017 and was prepared in accordance with the 2006 IPCC Guidelines for National GHG Inventories, using IPCC 2006 Inventory Software Version 2.691. It is also informed by the revised 1996 IPCC Guidelines, 2000 Good Practice Guidance and Uncertainty Management (GPG2000), and Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF).

The Climate Change Department (CCD) has supported capacity building programmes for key institutions involved in GHG inventory. Improvements in coordination and basic GHGI infrastructure was supported the Low Carbon Emission Project under UNDP project in 2011 including Software and a Database to hold data from all the sectors are now hosted at Climate Change Department (CCD). The CCD initiated the institutionalization of various components of climate change mainly GHG compilation by mandated Ministries Department and Agencies (MDAs). Personnel in these MDAs received training in data GHG computation and compilation.

The GHGI covers the four main sectors: (1) Energy, (2) Industrial Processes and Product Use and (3) Agriculture Forestry and other Land use (AFOLU), (4) Waste. Key greenhouse gases are CO_2, CH_4 and N_2O. Mainly due to data limitations, Tier 1 has been widely used. Estimation of CO_2 equivalents is based on the Second Assessment Report (SAR) 100-year time horizon global warming potentials (GWP) relative to CO_2.

ES 2.1: Energy Sector Emissions

The energy sector applies both the reference approach (or top down approach), which is derived from fuel imports versus exports and the sectoral approach which is based on the amount fuel consumed per activity in each sector. Both the reference approach and the sectoral approach show that total emissions have been increasing since 1995. Emissions from imported fuels, increased from 968 Gg in 1995 to 5,010 Gg in 2017.

CO2 is the major GHG in the energy sector estimated at 4,743 Gg in 2017. This is followed by CH4 and N2O at 2,591 Gg CO2 eq and 627.1 Gg CO2 Eq respectively. NMVOC is the most significant indirect gas in the energy sector estimated at 2,747Gg in 2017. This is followed by CO, NOx and SO2 at 1,822 Gg, 50 Gg and 7 Gg, respectively.

The transport sector was the main source of energy sector emissions (Figure ES 2.1). CO2 from the transport sector alone was estimated at 3,168.4 Gg CO2 eq. The Commercial / Institutions and residential subsectors combined were the main source of CH4, N2O, CO and SO2 in 2017 estimated at 2,297 CO2 eq Gg, 425 CO2 eq Gg, 1,308 Gg and 4 Gg in 2017, respectively.

In addition to the aforementioned GHGs, the energy sector is the major source of precursor gases namely; CO, NWVOC, NOx and SO2. Biomass combustion is the main source of precursor gases with CO as the most significant. CO emissions increased from 770 Gg in 1995 to 1,438 Gg in 2017. NMVOC increased from 141.34 Gg. in 1995 to 327.33 Gg 2017.

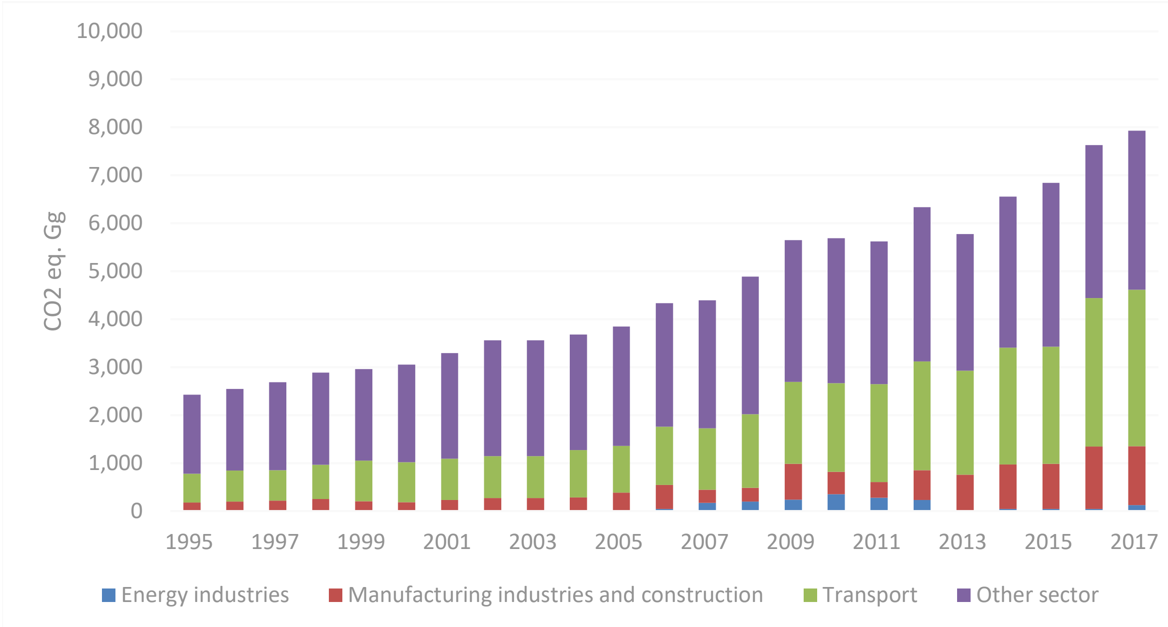
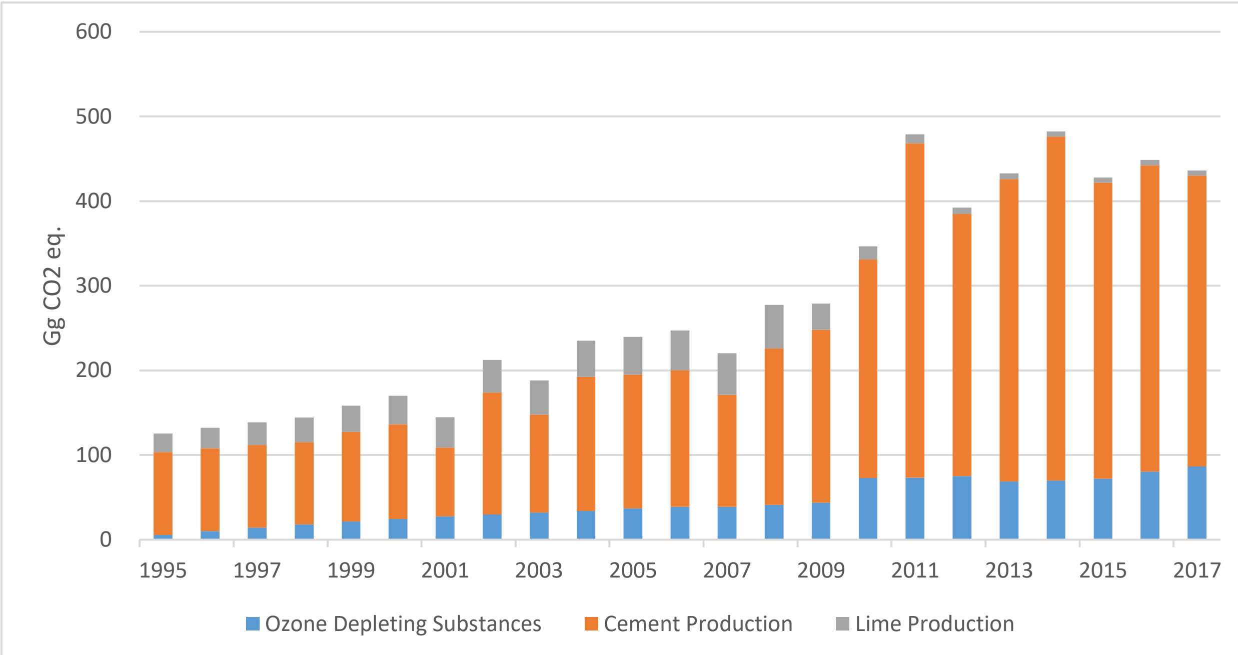


Figure ES 2.1: The overall emissions from the energy sector 1995 to 2017

ES 2.2: IPPU Emissions

Uganda industrial sector is undergoing transformation. Uganda produces most of the cement to meet national demand. Cement production is on increase following demand in the construction sector. Within the last 10 years, cement factories have increased from two factories to five cement factories and this has a bearing on emissions from the industrial sector. Some of the factories have installed modern clicker furnace and may thus not lead to substantial increase in emissions. From 1995 to 2017, the emission from production of cement increased from 98 Gg CO2eq to 343.4 Gg CO2eq while those of lime production in creased from 22 Gg CO2eq to 51.5 Gg CO2eq in 2008, thereafter there was drastic reduction to 6.3 Gg CO2eq that was because the government abounded the use of lime in road construction in favour of cement and stones aggregates.

There have been increasing imports of HFC-134a which is used in the refrigeration and air conditioning, and fire protection. The emission from ODS increased from 5.4 to 86.5 Gg CO2 eq. in 1995 to 86.5 GgCO2 eq in 2017. The main source of emission is from mobile air conditioners.



ES 2.3: Waste Emissions

There is a growing rate of waste generation especially in the urban areas due to population increase, urbanization and industrial development and thus an increase in GHG emissions from the waste sector. From 1995 to 2017 the amount of waste generated (in cities) more than doubled increasing from 3,273.2 Gg on 1995 to 7,596.2 Gg.

Uganda industrial sector has been developing over the last three decades and thus increase in emission from industrial waste water treatment and discharge. The specific water generated (m3) per industrial product (in tons) for beer & malt is 18.15 m3/ton, while for beverages is 4.087 m3/ton. The waste water generated from fish processing and sugar refining is 11.1m3/ton, and 9.2 m3/ton, respectively.

Methane emissions are dominant in the entre waste sector and mostly from the solid waste disposal subcategory. Solid waste is the main sources of emission contributing 70% of the total emission in 1995 and 65% in 2017 (Figure ES 2.2). The contribution of emissions from waste water treatment and discharge increased from 12% in 1995 to 22% in 2017. The emission from the biological treatment of waste decreased from 18% in 1995 to 13 % in 2017, while the emission from burning of solid waste and incineration was less than 1% of the total emissions.

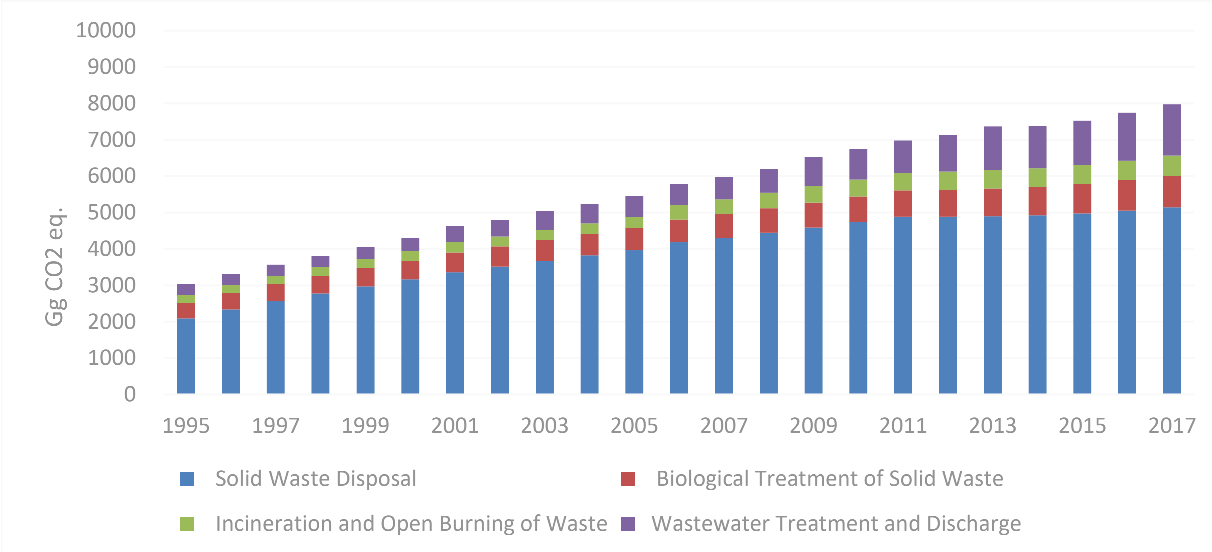


Figure ES 2.2: The trends of emission in the waste sector

ES 2.4: AFOLU Emissions

Emissions from the AFOLU sector are estimated to have risen from about 28.1 thousand Gg from 1995 up to 79.3 thousand Gg CO2 equivalents with land use and forestry accounting for a big portion of the emissions followed by CH4 from enteric fermentation and thereafter direct N2O emissions from managed soils (Figure ES 2.3).

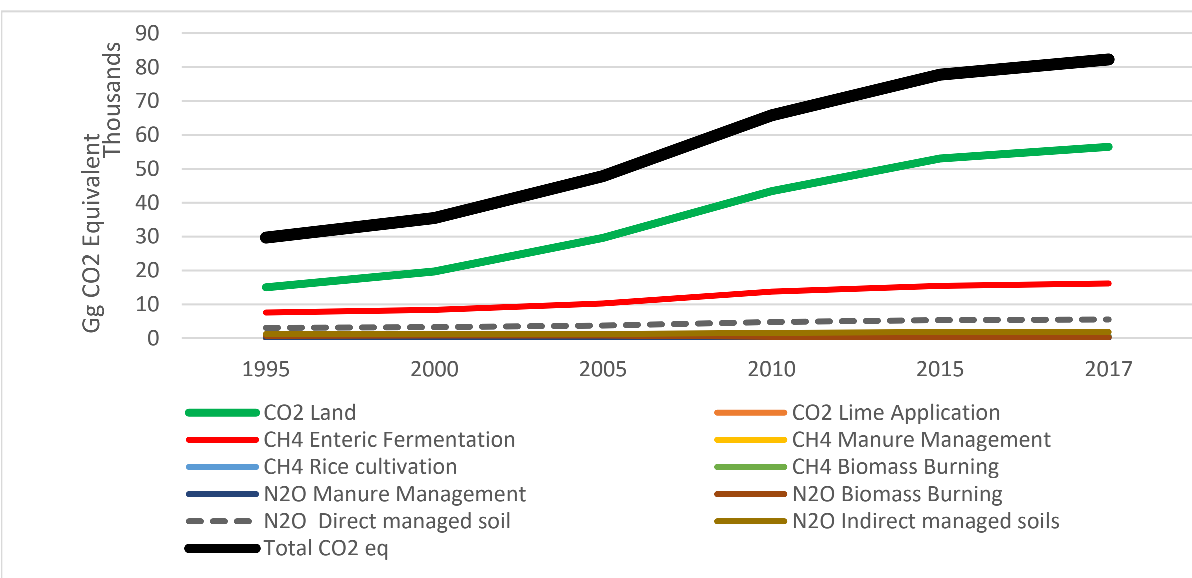


Figure ES 2.3: Total AFOLU Emissions CO2 Equivalents

From 1995 up to 2017 CO_2 was the most significant gas under the AFOLU sector estimated to have rose from 14,978 to 56,430 Gg. CH_4 was the second most significant GHG followed by N_2O. From 1995 to 2017, annual emissions of CH_4 and N_2O rose from 339 Gg (7,110 Gg CO_2 Eq) and 19 Gg (6,027 CO_2 Gg Eq) to 639 Gg (13,415 Gg CO_2 eq) and 31 Gg (9,473 CO_2 eq), respectively.

CH_4 emissions from enteric fermentation have rose at an average of 5% per annum raising from about 270 Gg of CH_4 in 1995 to over 567 Gg of CH_4 in year 2017. Non- dairy cattle contributed most of the CH_4 enteric emissions (74%) mainly because they account for a large share of the livestock population and partly because of relatively heavy body weight at an average of 175 kg. CH_4 emissions from manure management rose at an average of 3% per annum from 13.6 Gg in 1995 to 23.9 Gg in 2017.

CO_2 emissions related to carbon stock changes on land rose at an average or 13% per annum from 14,978 Gg in 1995 to over 56,430 in 2017. Land remaining forest land accounted for the largest share of the emission estimated at 77%. CO_2 removals on land converted to forest (afforestation, reforestation, forest restoration) were estimated to have more than doubled from 155 Gg per annum in 1995 to 392 Gg in 2017.

ES 3: Climate Variability and Change, Climate Change Vulnerability and Adaptation Measures

ES 3.1: Introduction

Climate variability and changes as well as climate change vulnerability and adaptation measures, constitute sizeable part of the process of Uganda's Third National Communication. This underscores adaptation as Uganda's priority in climate change actions (MWE, 2016).

Planning for and understanding adaptation actions calls for availability information on climate of the country and its projections as well as vulnerabilities across sectors. Hence vulnerability assessment becomes a key wherewithal for adaptation actions across sectors. Furthermore, understanding adaptation actions, whether direct or indirect as co-benefits, calls for effective national-level institutional arrangements (LEG, 2012) as well as sector-specific capacity, both human resource, and institutional capacity.

ES 3.2: Climate Variability and Change

ES 3.2.1: Climate Summary

Uganda's climate was assessed to understand the trends in mainly rainfall and temperature both in historical period of 1981-2010 and future period from 2031-2060 per decade as 2030s, 2040s and 2050s. Uganda being in the tropics has mainly two rainfall seasons following the apparent movement of the sun north and south of the equator.

These seasons are March to May (MAM) commonly referred to as the 'long rains' and the second season is usually from September to November (SON) commonly referred to as the short rains. However, areas in the northern and north eastern parts are in a unimodal rainfall distribution with one rainfall season that normally starts in April with a small relaxation in June/July up to October or November.

ES 3.2.2: Historical climate

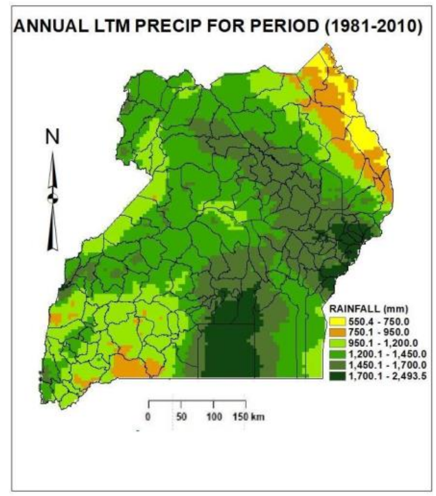


Figure E3.1: Mean annual rainfall climatology of Uganda for the period 1981-2010

Total annual rainfall in the period 1981-2010 varied between 750-2400mm with highest amounts of 1700-2400mm observed around the Lake Victoria and the Mt. Elgon region while the least amounts (750-950mm) are observed in the Karamoja region and some lower districts in the cattle corridor like Isingiro. The details are shown in the map. The MAM season is still a major season in all parts of the country especial the Central, Eastern and Western parts of the country. High amounts of between 450- 1000mm are observed in the Lake Victoria basin as well the Elgon region because of the Land-Lake breeze effects as well as topography in Elgon region. The rest of the country receives a total seasonal rainfall of about 250-450mm apart from the Karamoja area that receives on average seasonal of less than 150mm. The JJA season is mainly a wet season for Northern parts of the country with most places in Western and Southern Uganda receiving less than 150mm for this period.

Mean annual temperatures of between 24.6 and 26.4oC are observed in the Northern parts of country. The lowest mean temperature of between 12.4 and 20 oC is observed on Mt. Elgon, Mt. Rwenzori and the Kigezi highlands in South Western Uganda. The rest of the country recorded an annual mean temperature of between 20.1oC and 24.4oC. In terms of trend annual mean temperatures have been increasing at a rate of 0.23 °C per decade from 1950 to 2018 and the rate of increase is slightly higher at 0.24 °C per decade from 1990 to 2018. In all the years' western Uganda is warming faster than the rest of the regions with a warming rate of 0.62°C per decade for the period 1990 to 2018.

ES 3.2.3: Projected climate

Analysis on future projections was therefore done using the CORDEX grand ensemble that has all the GCM-RCM combinations in the data set for RCP 2.6, RCP 4.5 and RCP 8.5. Under RCP2.6 much of the country rainfall is not expected to change in the climate period 2031-2060 compared to the 1981-2010 average apart from the Masindi, Hoima area as well as Karamoja region where rainfall is projected to decrease by 5 to 10 % relative to the baseline. Under RCP 4.5 no significant changes are also projected across the country with only South Western highlands projected to have an increase in rainfall of between 5 to 10% relative to the baseline. Under RCP 8.5 mean annual rainfall in the 2031-2060 period is expected to decrease by 5 to 15% in most parts of central Uganda, increase by 5 to 10% in South Western Uganda while other parts of the country are projected not to have significant changes in annual rainfall. For the 2040s under RCP 4.5 the Northern region, Western Region and Karamoja area are projected to have an increase in rainfall of 5 to 10% relative to the baseline while other parts will not have any significant changes in annual rainfall. Under RCP 8.5 the central parts of the country are projected to have reduced rainfall of about 5 to 15% while other areas are not expected to have any rainfall changes in this period.

Mean annual Temperature projections at climate level (2031-2060) show projected temperature increases of 1 to 1.5oC under RCP 2.6 and RCP 4.5 for most parts of the country while RCP 8.5 projects an increase in temperature of 1.5 to 2.5 oC relate to the 1981-2010 average. In terms of decadal changes, temperature projections show a similar pattern across the country for the 2030s (2031-2040) under the three RCPs scenarios with annual mean temperatures projected to increase by 0.5 to 1.5 oC relative to the 1981-2010 average. The changes begin manifesting in 2040s (2041-2050) with RCP 8.5 projecting more temperature increases compared to other scenarios and is pronounced in the 2050s (2051-2060) where RCP 8.5 projects temperatures across the country to be in the range of 1.5 to 3 oC relative to the 1981-2010 average.

E3.3 Climate Change Vulnerability in Sectors

Uganda is ranked among the countries with low levels of human development with an index of 0.544 ranked as 159 out of 189 countries on the Human Development Index. However, with this low rank, the country has made some good efforts especially in life expectancy at birth that has increased from 46.2 in 2000 to 63.4 in 2019. The major climate hazards in Uganda include floods, droughts, landslides, earth quakes, heavy storms and epidemics.

ES 3.3.1: Agriculture

The major crops grown in Uganda include; Cereals (Maize, Millet, Sorghum, Rice); Root crops (Cassava, Sweet potatoes, Irish potatoes); Pulses (Beans, Cow peas, Field peas, Pigeon peas); types) and the cash crops include coffee, tea, cotton and tobacco. Crop suitability maps for eight key crops based on spatially-explicit temperature and rainfall data in Uganda using the Eco crop model were produced for both the current climate and expected projected future climate. Analysis shows that Cassava, Maize and Sorghum are grown in almost all parts of the country as seen in high suitability values compared to other crops while Ground nuts are highly suitable in Northern Uganda. In addition, Arabic coffee as expected is highly suitable around Elgon region of Eastern Uganda and the Rwenzori Mountains. The suitability levels for all crops in the future are expected to reduce with negative values expected for beans in Northern Uganda. On the other hand, Sorghum and Cassava are expected to be the most performing crops in the future. For Arabic coffee projections show that about 25% of the land currently suitable will be lost by the year 2050 with also net loss of land suitable for Robusta coffee with a potential to shift in higher altitudes. Suitability levels for Robusta Coffee is expected to reduce in most parts of Northern Uganda while South Western Uganda is projected to be highly suitable.

Climate change impacts on the yield of livestock focus mainly on impacts of droughts and floods. Climate change will affect the quality of feeds and pasture especially during droughts which are expected to increase in frequency in the future.

For fisheries sub-sector increasing temperatures may lead to low oxygen levels in the water leading to death of some plants that serve as feeds for the fish, and this may lead to reduced fish production.

ES 3.3.2: Forestry and wildlife

The annual forest cover loss was 2.2% of the total forest cover over the period 1990 to 2020. Forests on private land reduced from 16% to 4% and protected forests reduced from 8% to 6% of the national land area. Annual forest cover loss was recorded highest on Private Forests (1.9%); 94,747.48ha) and 0.3%; -12,976.74ha) on protected forests. The data indicates that the forests outside protected areas (Pas) reduced from 67% of the total forest cover area in 1990 to 38% in 2017. Climate change-induced changes are likely to affect forests and wildlife in various ways. For example, extreme weather and climatic events such as windstorms and flooding can destroy and kill trees on a massive scale, as observed in Bwindi Impenetrable National Park.

ES 3.3.3: Tourism and Biodiversity

Climate affects a wide range of the environmental resources that are critical attractions for tourism, such as snow conditions, wildlife productivity and biodiversity, water levels and quality. Climate also has an important influence on environmental conditions that can deter tourists, including infectious disease, wildfires, insect or waterborne pests and extreme events such as floods or tropical storms. Projected changes in climate, such as heavy rainfall, increased temperatures, and strong winds will affect the tourism industry through increased infrastructure damage, additional emergency preparedness requirements, higher operating expenses (e.g. insurance,

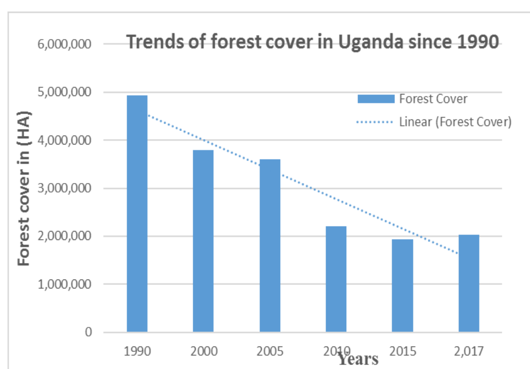


Figure E3.2: Trends of forest cover in Uganda during the period 1990 to 2017.

backup water and power systems, and evacuations), as well as business interruptions when tourists are forced to cancel some of the planned trips because of those changes in climate.

ES 3.3.4: Water

Climate change will result in significant impacts on Uganda's water resources. Some of the effects are already visible now, especially the increasing water stress in many parts of the country caused by prolonged droughts, and the deteriorating quality of water caused by floods and run-off and the future impacts will make the situation more severe. The impacts of climate change on water resources will have cascading effects in various sectors that directly depend on water, such as agriculture and food security, ecosystems and biodiversity, energy supply and electricity generation, navigation, health, hygiene and sanitation among others. Uganda is increasingly facing a major challenge of prolonged droughts and unexpected floods due to climatic change and variability and is predicted to be water stressed by 2025. Climate change is projected to have significant impacts on the hydrology of basins characterized by glaciers, and the annual accumulation and melt of snow peaks. Increased temperature leads to melting of glaciers and glacial retreats.

ES 3.3.5: Wetlands

Wetlands cover approximately 26,600 km2 of Uganda's total area of 241,500 km2, including water bodies. With a coverage of 11 percent of the total land area, wetland resources represent one of the country's vital ecological and economic natural resources. Data from the National Biomass Study Unit of the NFA revealed that, in 2005, Uganda's wetlands cover as a proportion of the total land area had reduced by an estimated 11percent.

ES 3.3.6: Health

Climate change has significant direct and indirect health implications for Ugandans. Several diseases that are currently endemic in Uganda will likely increase in prevalence and distribution due to climate change. There is also potential for diseases that are not yet established in Uganda (in humans) to be introduced because of climate change. Climate change also threatens human health through its effects on food insecurity and malnutrition. Other potential impacts of climate change on health include;

(i) Potential change in distribution of vector- and water-borne diseases
(ii) Expansion of malarial zone to highland areas that had traditionally been free from mosquitoes
(iii) Increased risk of respiratory diseases and infections due to prolonged dry spells
(iv) Increased risk of food insecurity and malnutrition through decreased agricultural productivity

ES 3.3.7: Transport

Some of Uganda's transport systems and infrastructures are built with inadequate consideration of changing climate. This results into climate-related damage on vital infrastructure such as roads, bridges, and rail networks.

ES 3.3.8: Cities and the Built Environment

Uganda is a fast-urbanizing country, and thus vulnerable to specific climate change risks associated with urban areas. These climate change risks include increasing temperatures owing to the urban heat island effect, and urban flooding owing to increasing rainfall intensities and insufficient capacity of existing urban drainage systems.

E3.4 Climate Change Adaptation in Sectors

ES 3.4.1: The National Adaptation Working Group

The National adaptation technical working group (NATWG) was expanded to include more stakeholders to strengthen the existing adaptation core group under the Climate Change Department. The NATWG executes arrange of roles, including provision of information on adaptation, and undertaking adaptation assessment. The expansion of the members of the NATWG was guided by the NAPs framework under the UNFCCC (LDC, 2012) which identifies technical issues that call for sectoral expertise, as well as other issues of national concern, such as gender, MDAs, and non-state stakeholder representation. To be able to undertake adaptation assessment and provide information on adaptation measures effectively, a range of topics were proposed to strengthen technical capacity of members of NATWG. These topics which include: (i) Fundamentals of climate change science, (ii) predicting climate variability and change, (iii) vulnerability and adaptive capacity assessment, (iv) climate change and disaster risk management, (v) gender and climate change, and (vii) Mind-set, were identified and ranked previously by members of the core team, and published (MWE, 2013).

ES 3.4.2: The National Adaptation Plan

National arrangements for the Formulation, Registration and Implementation of NAPs.

The Agriculture NAP was developed in 2018, as part of the National Adaptation Plan process for Uganda. The Agric-NAP, supports the NAP process by integrating agricultural policies and sustainable development into climate change adaptation and building capacities for the formulation of the country's NAP.

A review of the national arrangements to enable the formulation, registration and implementation of NAPs was undertaken, to establish entry points for Uganda's NAPs, namely: (i) Vision 2040 and the Uganda National Development Plan; (ii) Uganda Green Growth Strategy; (iii) Roadmap for Creating an Enabling Environment for Delivering on SDGs in Uganda; (iv) NDC Review Process; (v) GCF Readiness Funding; and (vi) Agric-NAP.

Various levels of the institutional arrangement in the NCCP, namely, Implementation, Coordination, and their respective components were examined to identify (and where necessary propose new) levels / components, that could fulfil the requirements for formulation, registration and implementation of NAPs.

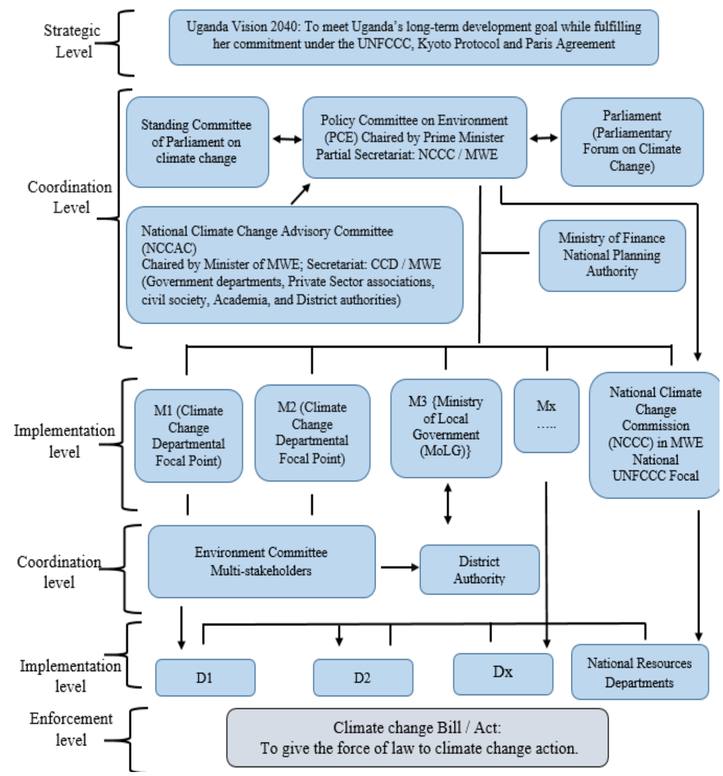


Figure E3.3: Institutional arrangement for climate change action in Uganda as at 2020

National governance structure for the establishment and maintenance of NAPs

Following literature review, the following stages in the establishment and maintenance of Uganda's NAPs were proposed: (a) Stage one: laying the ground and addressing gaps, (b) Stage two: preparatory elements, (c) Stage three: Implementation strategies, and (d) Stage four: Reporting, Monitoring and Review (RM & R) (LDC, 2012). Uganda has initiated the process to formulate a National-level NAP, through various stages, including submission of funding proposal to the Green Climate Fund (GCF), which is the entity mandated by the Paris Agreement to support the development phase of a country's NAP process through its Readiness and Preparatory Support Programme. The Proposed governance structure of Uganda's NAP is envisaged to consist of: a high-level policymaking body, and technical working groups tasked with supporting, coordination and providing technical inputs for the high-level body.

Updating Uganda's NAP

The updating of NAPs emanates from article 7 para 10 & 11, of the Paris Agreement, which call for periodic updating of NAPs. It is proposed that Uganda's NAPs will be updated every after a period of 5 years, as guided by the UNFCCC indicative sequencing of activities at the national level, for implementation of the Convention and Paris agreement. The proposed sources of inputs to the NAP-Updating system include the following: (i) Annual reports from sectors on implementation of adaptation actions; (ii) Monitoring and review report from the CCD of the previous NAP; (iii) Research reports in various dynamics such as weather, climate and climate change, vulnerabilities at regional, sectoral and ecosystems; and (iv) The National MRV system which is under development.

ES 3.4.3: Implementation of adaptation measures across Sectors

Agriculture Sector

The agriculture sector has implemented a range of adaptation actions to climate change impacts at both Policy level, and Technical level. At Policy level, the measures include development of the various policies and plans: (a) National Development Plan for the Agriculture Sector 2018; (b) Guidelines for Mainstreaming Climate Change Adaptation and Mitigation in Agricultural Sector Policies and Plans (MAAIF, 2018d); (c) National Adaptation Plan for the Agriculture Sector (MAAIF, 2018c), and (d) Uganda Climate Smart-Agriculture Country Program 2015-2025 (MAAIF, 2015b). At technical level, the implemented projects and measures include: Establishment of the Uganda Agriculture Insurance Scheme (UAIS) in Financial Year 2018 / 17, from which over 175, 000 farmers benefited.

Water Sector

During the reporting period, the Water sector implemented adaptation measures through resilience projects in the water catchments, trans-boundaries, and dry lands, and supporting individual initiatives towards adapting to climate change, with the aim of maintaining continuous supply of water, and environment management. Catchment Management Plans (CMPs) were developed for investment and management measures, and a various resilient projects were implemented, such as, the "Enhancing Resilience of Communities to Climate Change through Catchment-Based Integrated Management of Water and Related Resources in Uganda" (EURECCCA), which increased the resilience of communities to the risk of floods and landslides of Awoja, Maziba and Aswa Catchments.

Health Sector

Uganda approved a series of five-year national Health Sector Development Plans (HSDPs) and National Health Policies (NHPs) to enhance the health system's ability to prepare for, and cope with rising needs for treating climate-sensitive diseases. The policies and plans include "Second National Health Policy 2010 /11-2019/20", and "the Health Sector Strategic and Investment Plan (HSSIP)" with a Section 2.3.6 titled, "Changing lifestyles and climate change", dedicated to climate change and health concerns (MOH, 2010a, MOH, 2010b). Furthermore, the MoH developed an

Emergency Medical Services (EMS) policy and strategic plan to advance timely pre-hospital and emergency care. Over the period 2015-2020, the Health Sector rolled out Core hybrid (digital and paper) Health Management Information Systems (HMIS) tools which include; DHIS2.3, mTrac and Integrated Human Resource Information System (iHRIS).

Energy Sector

As recommended by the NCCP on adaptation, several modern technologies and fuels are being promoted and deployed by the MEMD through projects and programmes to improve the sustainable utilization of the biomass resource in the country, and to cut significant GHG emissions. These measures such as improved biomass cooking technologies and fuels; and Sustainable charcoal production technology, offer mitigation co-benefits of adaptation measures. There were efforts by Rural Electrification Agency (REA) to phase out wooden electricity poles in favour of the climate-resilient concrete ones in east, north eastern, and northern parts of the country.

Figure E3.4: Pilot project: Climate-resilient concrete poles for electricity transmission erected by REA along Serere Road in Soroti Municipality

Wetlands Sector

Adaptation measures were implemented to mitigate wetland degradation as well as promoting adaptation to impacts of climate change in the wetland sub-sector during the financial year 2019 / 2020. During the reporting period, there was increment in wetland restoration mainly due to establishment of the Regional Technical Support Unit which works with DLG to undertake wetland restoration as well as direct release of fund to the regions and LGs to undertake the tasks, as well as wet lands demarcation, to achieved a cumulative total of 480.39Km of demarcated wetland boundary across the country, up from 226.6km, representing 96.1% of the planned target of 500 Km for 2020. This achievement was reached through projects like "Building resilient communities, wetland ecosystems and associated catchments in Uganda".

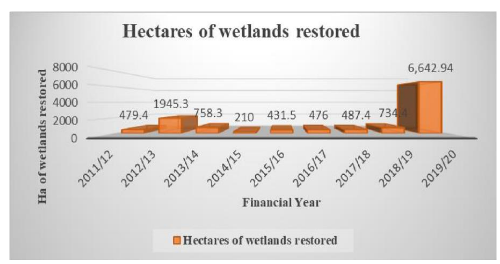


Figure E3.5: Trends in wetland restoration in Uganda during the period 2011 to 2020

Disaster risk management

Various achievements were made by the sector through the project titled "Strengthening community resilience to climate change and disaster risks in Uganda (SCORE project)", such as (i) Establishment of a strengthened and integrated functional climate information, early warning and response system (e.g. Uganda Inter-Ministerial / Agencies Monthly National Integrated Multi-Hazard Early Warning (U-NIEWS) bulletins that are developed and disseminated on the 15th of every month).

Forestry Sector

Over the reporting period, the forestry sector has implemented adaptation actions mainly through research, and resilient projects that conserve forests. Through National Forestry Resources Research Institute (NAFORRI), there was promotion of intensified and sustained forest restoration efforts through biological control agents. In this way, NAFORRI introduced Psyllaephagus bliteus (2017), and Cleruchoidesi nockae (2019), for control of Red gum lerp psyllid (order Hemiptera, family Psyllidae,) and Bronze bug respectively. Furthermore, NaFORRI updated the pests and diseases guideline developed under SPGS II and trained 80 key stakeholders in the forest sector in tree pests and diseases identification, recognition, and management. Furthermore, a total of 1,310,352 assorted tree seedlings were distributed to farmers in selected districts in the 4 catchment areas of Ngenge, Manafwa, Tochi and Mubuku-II covering approximately 1,310 hectares.

Transport Sector

The transport sector has implemented adaptation actions that enhance resilience to the impact of climate change through policies, strategies, plans, guidelines and physical-level investments, which include the following: (i) Through the MoWT, a program called "The Integrated Transport Infrastructure and Services Program" was developed and is under implementation (GoU, 2022). (ii) A Master Plan was established to Shape a More Sustainable Transport Sector in Uganda, 2021–2024, which outlines where and how Uganda's transportation infrastructure and services, including roads, railways, inland waterways, and air transportation, should develop over the next five years.

The physical-level implemented investments include the building of resilient roads and bridge infrastructure to climate change, through a range of projects, such as: the, twenty-four (24) roads which were upgraded to paved bituminous standards, covering a total length of 1,692km; and the KCCA's program entitled "Second Kampala Institutional and Infrastructure Development Program", through which a detailed a detailed design of the rehabilitation and expansion of the Nakivubo Drainage System as a mechanism for managing flood risk damage to city was undertaken

Cities and the Built Environment

The Ministry of Lands, Housing, and Urban Development, working in closely with the urban authorities, developed and implemented a number of policies, strategies, and actions geared to increasing resilience to climate change, namely;

(i) Developed and disseminated the Uganda National Urban Climate Change Profile (2018) for the regional cities of Arua, Fortportal, Gulu, Jinja, Lira, Masaka, Mbale, Mbarara, and Kampala, the capital city;

(ii) Established the UGCities4Resilience Network in partnership with Kampala Capacity Authority (KCCA) in the ten (10) regional and strategic cities of Arua, Gulu, Lira, Soroti, Mbale, Jinja, Masaka, Mbarara, Hoima, and Fort portal. The aim is to adapt cities to climate resilience.

(iii) Established and maintains green spaces in urban areas as part of resilience building in cities like Kampala, Arua, and Fort portal.

E3.5 Constraints and Gaps in the Implementation of Adaptation Actions

Constraints, and gaps were identified in the areas below, causing retardment / barriers to implementation of adaptation actions in Uganda:

(a) Accessing financial and other support: inadequate capacity to write proposals for accessing funding under the different winding of the GCF, and awareness of the latest requirements for GCF funding proposal; ***(b) Climate scenarios, science and translation to local context:*** Limited accessibility to climate data and climate change scenarios to underpin effective adaptation actions; ***(c) Risk and vulnerability assessment and risk management:*** various methodologies and guidelines issues related to vulnerability assessment and risk management. ***(d) Access to and use of technology:*** related to various sectors, ***(e) Linkage with the development agenda:*** Clarity on and understanding of the concept of integrating adaptation into development planning; ***(f) Logistical and infrastructural risks:*** The lack of sufficient storage capacity both at farm level and agricultural produce trading system levels, plus inability to construct durable and weather tight stores; ***(g) Enabling environment:*** The legal environment for the agricultural sector is conducive but implementation of many initiatives has been low. ***(h) Gender-related constraints:*** External resources and technical assistance is in most cases directed towards men, and women are accorded minimal wrights compared to men.

E3.6 Proposed Interventions and Opportunities

a) Capacity building in the following areas: (i) proposal writing to develop human capacity to prepare GCF concept notes and funding proposals. There are already ongoing activities of capacity building on proposal writing. There is an opportunity for up-scaling; (ii) generating, accessing and using climate data to develop climate scenarios; (iii) accessing and using climate change scenarios at the ground level; and (iv) risk and vulnerability screening in development projects, programs and activities.

b) Developing of a mechanism to channel climate finance to local government authorities.

c) Provision of support for the following issues: (i) climate information services and early warning systems projects, and capacity development for risk-informed planning; and (ii) to projects on developing platforms for sharing and accessing information on climate change adaptations. A proposal has been put forward to develop an "Interactive digital platform for identifying and reporting adaptation actions in Uganda".

d) Investigating irrigation and water harvesting technologies to combat climate variability and climate change is critical; as well as putting in place early warning systems (EWS) and emergency response mechanism (ERM) for managing disasters, such as droughts, floods, and outbreak of pests and diseases.

ES 4: Climate Change Mitigation Assessment and Measures

While Uganda's overall emissions at global level are minor, the country plays its part is assessment and implementation of mitigation actions. Uganda's Climate Change Policy, NDC and National Development Plan (NDPIII) all recognize and specify climate change mitigation and adaptation as being critical to the achievement of increased household incomes and improvement of quality of life of the population. Under the NDC, for example, it is anticipated that cumulative implementation of a series of policies and measures in the energy supply, forestry and wetland sectors are projected to result in approximately 22% emission reduction of national greenhouse gas emissions by 2030 compared to business-as-usual.

As part of the preparation of the Third National Communication, mitigation assessment was conducted in selected sectors: transport, AFOLU and waste. An economy wide mitigation assessment was conducted. These used the Greenhouse Gas Abatement Cost Model (GACMO) and the Low Emissions Analysis Platform (LEAP) tools. The mitigation options were premised on the existing as well as the projected legal and institutional framework for implementation of the mitigation measures.

The assessment was conducted in the transport subsector which accounts for close to 66% of the emissions of Uganda's energy sector and is ranked as the fifth key category source in absolute values and as the eighth key category in terms of trends. Key among the actions are the halting of the growth of passenger motor cycle, increase investment if public rapid transit as well as increase use of electric mobility.

Mitigation assessment in the AFOLU sector was driven by emissions from degradation of forests (forest land remaining forest), conversion of (mainly forests) to cropland, and CH4 emissions from enteric fermentation of ruminant animals which were identified as key emitting categories both in absolute terms and trend. The key intervention is forest restoration.

Solid waste management and disposal was assessed as key mitigation measure in the urban areas. The assessment focused on both on-going and planned projects. Key management actions are waste to energy for small scale and large scale farms, waste to energy from industrial waste water and household waste water.

At the economy wide level, iinterventions in terms of emission reduction options covering several sectors were developed and mitigation effect (in terms of tCO2) of each unit computed. These were spread at periodic intervals of; (1) 2015 to 2020, as baseline and future as (2) 2020 to 2025, (3) 20225 to 2030 and (4) 2030 to 2050. Figure ES4.1 and Table ES4.1 present the results.

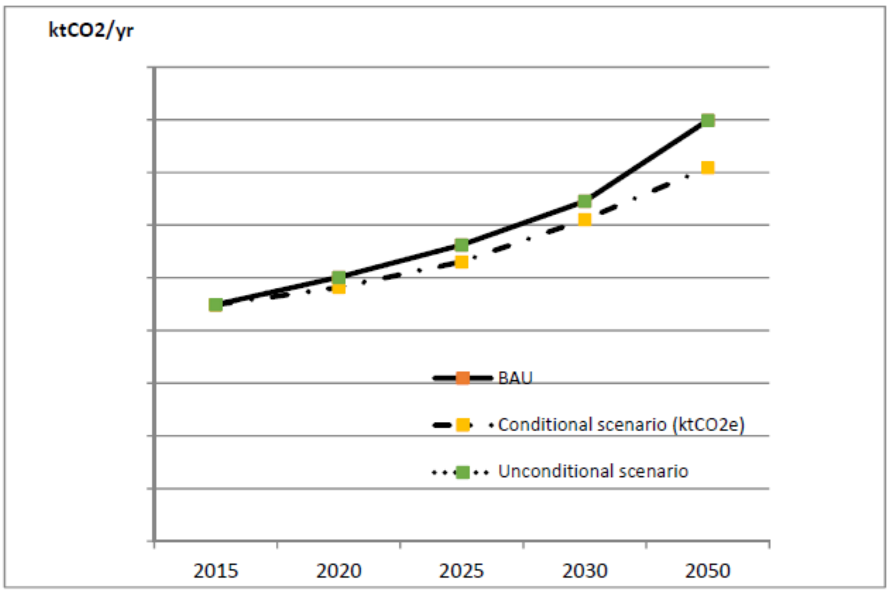


Figure ES 4.1: Conditional Scenario (kt CO_2e) vs baseline emissions for period 2020 to 2050

Table ES 4.1: Economy wide periodic Interventions (reduction options)

Intervention	Period	2025		2030		2050	
Reduction option	Sub-type unit	Units	kt/year	Units	kt/year	Units	kt/year
Efficient lighting with LEDs	1000 Bulbs	5000	388.59384	5000	388.5938	5000	389
Efficient office lighting with LEDs	1000 lights	1000	44.410725	1000	44.41072	1000	44
Reforestation	Reforestation of 1000 ha	500	1833.3333	500	1833.333	500	1,833
Hydro power connected to main grid	1 MW	2000	3846.131	2000	3846.131	2000	3,846
Composting of Municipal Solid Waste	1000 t/day plant					1	4,137
Biogas at rural farms using kerosene	1000 units					1000	1,228
Biogas at big farms	84000 pigs					1	281
Biogas from industrial waste water	1 plant					10	258
Solar house PVs	500 W	5000	1.9935844	5000	1.993584	20000	8
Solar LED lamps	1000 lamps					20000	1,878
Bus Rapid Transit (BRT)	1 km BRT line	3	5.9503849	3	5.950385	200	397
More efficient gasoline cars	1000 cars	100	40.89038	500	204.4519	2000	818
More efficient diesel cars	1000 cars	100	17.972129	500	89.86064	2000	359
Shifting freight transport from road to rail (1000 ton km/day)	1000 ton km/day	1000	241.36461	2000	482.7292	10000	2,414
Composting of Municipal Solid Waste	1000 t/day plant	PAO	106		106		105.9016
Biogas from Municipal Solid Waste	2000 t/year plant				24.37344		24.37344
Landfill gas flaring	1 t/day plant						124.4152
			6,527		7,028		18,144
BAU (Per BAU)		6%	112,561	5%	129,090	11%	159,804

Ongoing mitigation measures are reported include:

a) Construct enabling infrastructure for electricity sector development, including power lines, substations and transmission facilities
b) Achieve at least 3,200 MW renewable electricity generation capacity by 2030, from 729 MW in 2013
c) Sustainable energy solutions in public buildings & Energy efficiency in hospitals
d) Integrated energy solutions for schools in off grid areas-NAMA
e) Promotion and wider uptake of energy efficient cooking stoves or induction cookers
f) Promotion and wider solar uptake of solar energy systems
g) Implement Fuel Efficiency Initiative NAMA
h) Development and implementation of a long-term transport policy accounting for climate change mitigation concerns
i) Development and enforcement of building codes for energy efficient construction and renovation

In the agriculture, land use (change) and forestry:

a) Develop an enabling environment for forestry management
b) Reverse deforestation trend to increase forest cover to 21% in 2030, from approximately 14% in 2013
c) Develop enabling environment for wetlands management
d) Increase wetland coverage to 12% by 2030, from approximately 10.9% in 2014, through demarcation, gazettement and restoration of degraded wetlands
e) Livestock breeding research and manure management practices
f) Climate Smart Agriculture techniques for cropping

In the Waste Sector, the responsibilities framework for waste disposal management are mainly enshrined in the laws that govern municipalities. By nature of the sector, these interventions are mainly urban or peri-urban based. Almost all the projects in the waste sector follow CDM carbon accounting procedures.

ES 5: Constraints, Gaps, Needs and Support Received

ES 5.1 Overview

Uganda's capacity to meet its reporting obligations to UNFCCC has gradually improved since its first national communication in 2002. Capacity has been built in the CCD as the coordinating institution as well as the sectoral MDAs that are involved in the compilation process. Notable improvements are in the basic GHG inventory. Many stakeholders from MDAs, NGOs, academia, CSO, youth representative that are engaged in various climate change activities such advocacy and negotiations have received capacity building support. Other decision making levels in form of National Climate Change Advisory Committee (NCCAC) and the Climate Change Standing Committee at Parliament are active in the process.

Nonetheless, the country faces technical and financial difficulties in implementing climate change activities and preparing national communications. The main training and capacity needs include a wide range of issues in areas of data collection, data collation and archiving, data processing and compilation of GHG plus reporting mechanisms. In addition, decision makers at the senior management level need to be engaged so as to provide adequate support.

The major constraints and financial gaps that Uganda faces include:

1) <u>Difficulty in tracking climate financial inflows:</u> Several organisations in the country receive climate funding from multiple sources that do not pass through the Ministry of Finance. In addition, most of the programmes take place at different levels and unless it is held at the national level, it is difficult to track.
2) <u>Inadequate financial allocation in national budget;</u> Domestic financing of climate change activities is very limited including allocation of funds for the national communication and other national and international reporting arrangements. The COVID-19 pandemic has constrained the situation further by widening the financing gap in almost all sectors and government institutions.
3) <u>Weak institutional coordination;</u> Weak institutional coordination within government and among donors makes it difficult to estimate expenditure on climate change activities in many ways lead to duplication of climate change interventions. A particular gap exists in the structures for the implementation of climate change activities in local governments.
4) <u>Lack of streamlined system and lack information sharing:</u> Several entities especially NGOs, CSOs, academic institutions receive technical assistance support directly from donors as part of the global action which is important in filling the existing gap. This information may not be captured and often leads to duplication of effort.

ES 5.2 Opportunities and Barriers in GHG Inventory

Currently, the Uganda's GHGI compilation processes are conducted and led by national experts working with sector working groups that are drawn from sectoral MDAs. This has been facilitated by capacity building programmes especially related to improvements in coordination and putting in place basic GHGI infrastructure such software and a database. The following needs need to be addressed:

1) Low level of support from decision makers at the senior management. Governance level issues include streamlining GHG data management, institutional arrangements (effectively manage roles and responsibilities) and training in the relevant GHG software. While Uganda has received support from a number of international agencies such RCMRD, UNEP, GEF and the Rainforest Coalition, more is still needed.

2) Improved data collection, collation, archiving and analysis from all sectors. For example, the energy sector needs to reconcile data on fuel imports and exports in comparison with end-use fuel in the various energy sub categories. Under the waste sector, solid waste generation and disposal outside municipalities in not well accounted for.

3) Determination of the methane fraction by waste type and quantity of waste water generated (m^3 per tonne) of industrial products in the beer and beverages industries. Documentation and tracking of use of lubricants and HFC-134a is more important than ever before given that the use of these products is on the increase in the transport sector, refrigeration and air conditioning, and fire protection industries.

4) Estimation of area under rice paddy, nitrogen content major fertilizer types and desegregation or characterization of livestock by breed type and age classes is of great need in the agriculture sector. Given that harvesting and trading of wood products is largely informal and not properly regulated, documentation wood extraction and attribution of where the wood is extracted from remains a big challenge. Efforts initiated by FAO need to be revived or enhanced.

ES 5.3 Opportunities and Barriers in Implementation of Adaptation Measures

The section identifies constraints and gaps of areas that are reflected in the various Articles and Paragraphs of the Paris Agreement which are vital in implementation of adaptation actions. The constraints and gaps are specific to the areas that are barriers for implementation of adaptation actions. These include;

a) Access to financial and other support:

   i. Capacity to write proposals for accessing funding under the different windows of the GCF
   ii. Awareness of the latest requirements for GCF funding proposals

b) Climate scenarios, science and translation to local context

   i. Low resolution of existing climate scenarios that cannot provide details to aid zoomed in decision-making.
   ii. Availability and accessibility of climate data and climate change scenarios to underpin effective adaptation assessment, planning and implementation.
   iii. Methods and tools for translating climate data and climate change scenarios to the local context

c) The area of risk and vulnerability assessment and risk management is crucial in making decision on the adaptation action to implement. The gaps identified include;

   i. Specific methodologies and guidelines for enabling understanding of the baseline and the progression of vulnerability and risk.
   ii. Institutionalization of risk and vulnerability assessment and risk management at all levels of governance and in key sectors
   iii. The absence of area specific local vulnerabilities that affects local adaptation planning
   iv. Ways to build evidence for adaptation additional arguments in funding proposals to the GCF

d) Access to and use of technology

   i. Promotion of technological developments related to climate change adaptation in agriculture and other sectors

e) Linkage with the development agenda

   i. Clarity on and understanding of the concept of integrating adaptation into development planning.
   ii. Capacity to integrate international processes that are relevant to adaptation planning using the appropriate frameworks.

For constraints pertinent to the agriculture sector in the implementation of adaptation actions, the following were identified

1) Logistical and infrastructural risks at farm and produce trading system levels that leads to high post-harvest storage losses
2) Weak enabling environment especially the inadequate institutional arrangements and financial resources to enforce policies
3) Gender related productivity gaps resulting from differentiated impacts of climate change and access to factors of production by men and women.

This section further proposes interventions and identifies existing opportunities to address the identified constraints and barriers as per the categories.

1) Accessing financial and other support through capacity building in proposal writing and mechanisms to channel climate finance to local governments
2) Capacity building on developing climate scenarios and using them at the ground level, support for climate information services and early warning systems
3) Capacity building on screening projects for risk and vulnerability assessment
4) Support to developing platforms for easy access and sharing of information to ease access to and use of technology
5) Assist SHFs to invest in agriculture as a business to enhance promotion of commercialisation of agriculture
6) Building resilience to agricultural production systems through investing in irrigation and water harvesting technologies to combat climate variability and change
7) Create an enabling business environment to attract private investments in the agriculture sector through addressing institutional capacity gaps at the national and district levels

ES 5.4 Opportunities and Barriers in Implementation of Mitigation Measures

Formulation of mitigation action, mobilisation of resources and monitoring of implementation efforts is a major challenge in the area of mitigation measures. While efforts have been made to ease data sharing among government institutions through MoUs, the following constraints and gaps exist:

a) Improvement of establishment and transparency of baselines
b) Collection of the relevant data and monitoring of the scenarios being followed by sectors
c) Development of channels for abating information from private sector players
d) High cost of sustainable data access and management especially by remote mode
e) Development of standardized and subsequent profiling of sources especially solid waste
f) Climate modelling to understand and predict the impact of climate change on sectors followed by mitigation analysis and mitigation scenarios building

ES 5.5: Constraints and Gaps in Technology Transfer

Elements of Uganda's efforts in the enabling environment for transfer of environmentally sound technologies can be found in various sectors of the economy. These include policies and plans is several sectors. For the TNC, two key sectors where efforts in transferring environmentally sound Technologies can be found are agriculture and energy sectors especially agriculture and energy. In agriculture, these are in form of Climate Smart Agriculture (CSA) Technologies while in energy they take the form of Clean Energy Technologies (CET).

Uganda's capacity in the development and transfer of environmentally sound technologies has many gaps and constraints. The lack of an overall policy and legal framework is a major gap.

Current technology transfer efforts in Uganda are wide spread in various sectors of the economy. Many technology transfer elements are captured in the various sector policies.

Uganda joined Technology Needs Assessment (TNA) Phase III project which was launched in 2016 with other 23 countries. The TNA project implementation in Uganda effectively commenced in February 2019 and is expected to be completed in 2021. The TNA is a set of country-driven activities leading to the identification, prioritisation and diffusion of environmentally sound technologies for mitigation and adaptation to climate change. Within the TNA process, Uganda has identified the sectors of agriculture, water, land use, land use change, forestry and energy as the sectors of focus. Specific technology needs have been identified in each.

5.6 Financial Resources and Technical Support for Preparation of National Communication

Uganda has received fincial support from the Global Environmental Facility through the United Nations Environment Programmme to prepare the Initial National Communication, the Second National Communication and the First Biennial Update Report in 2019 as well as this Third National Communications.

5.7 Financial Resources and Technical Support from National and Bilateral/Multilateral Agencies for Activities Related to Climate Change

There has been a lot of support towards meeting the cost of various activities addressing climate change in Uganda mostly through several development aid channels. Data on financial contributions were obtained from the Ugandan Ministry of Finance, as summarised in Table ES.2.

Table ES 5.1: Summary of projects on Climate Action, 2013-2020

Project Name	Implement. Agency	Amount
Strengthening the Adaptive Capacity and Resilience of Communities in Uganda's watersheds	AfDB	USD 9,781,415
Climate Resilient Livelihood Opportunities for Women Economic Empowerment (CRWEE) in Karamoja and West Nile Regions of Uganda	FAO	USD 8,968,448
Global Climate Change Alliance Plus (GCCA+): Scaling up Agriculture Adaptation to Climate Change in Uganda	FAO	USD 9,197,600
Strengthening the Capacity of Institutions in Uganda to Comply with the Transparency Requirements of the Paris Agreement	CI/AFRII	USD 1,100,000
Energy for Rural Transformation Project (Phase III)	World Bank	USD 8,200,000
NAMA on Integrated Waste Management and Biogas in Uganda	UNDP	USD 2,170,030
Food-IAP: Fostering Sustainability and Resilience for Food Security in Karamoja Sub Region	UNDP/FAO	USD 7,139,450

Integrated Landscape Management for Improved Livelihoods and Ecosystem Resilience in Mount Elgon	UNDP	USD 1,620,320
Reducing Vulnerability of Banana Producing Communities to Climate Change Through Banana Value Added Activities - Enhancing Food Security and Employment Generation	UNIDO	USD 2,820,000
Building Resilience to Climate Change in the Water and Sanitation Sector	AfDB	USD 8,370,000
Building Resilient Communities, Wetlands Ecosystems and Associated Catchments in Uganda	UNDP	USD 24,140,000
Enhancing resilience of communities to climate change through catchment-based integrated management of water and related resources in Uganda	OSS	USD 7,751,000
Provision of Improved Water Source for Resettled Internally Displaced Persons in Acholi Sub-Region	JICA	USD 9,730,000
Recovery and Development in Northern Uganda	Danida	USD 9,608, 000
Project for the Restoration of Livelihoods in the Northern Region (PRELNOR)	IFAD	USD 60,200,000 (IFAD loan: USD 50,200,000, Adaptation for Smallholder Agriculture Programme (ASAP) grant: USD 10,000,000)
The Farm Income Enhancement and Forest Conservation Programme – Project 2 (FIEFOC-2)	AfDB	USD 82,300,000 (AfDB loan: USD 76,700,000, Nordic Development Fund (NDF) grant: USD 5,600,000)
Development Initiative for Northern Uganda (DINU)	DFID/TMEA, GIZ, UNCDF, UNCIEF and GoU	USD 150,630,000
Climate Smart Agriculture in Northern Uganda	GIZ	USD 5,671,000
Joint Partnership Fund (JPF) - Basket	Danida	USD 24,280,000
Sector Budget Support for Rural Water Supply	Danida	USD 51,298,000
Climate Resilient Agribusinness for Tomorrow (CRAFT)	SNV	USD 14,600,000
Enhancing adoption of Climate Smart Agriculture (CSA) practices in Uganda's farming systems	UNDP	USD 1,240,000
Enhancing resilience of agricultural landscapes and value chains in eastern Uganda – scaling up Climate Smart Agriculture (CSA) practices	UNDP	USD 1,123,080
Climate Change Resilience and Disaster Risk Reduction for National Transformation.	UNDP	USD 1,952,087
Promotion of Renewable Energy and Energy Efficiency	GIZ	USD 7,525,000
Reform of the urban water and sanitation sector	GIZ	USD 13,899,000
Promotion of mini-grids for rural electrification	GIZ	USD 9,546,000
Support to rural development Uganda	GIZ	USD 10,669,000

NDC Support Programme	UNDP	USD 802,500
NDA Strengthening & Country Programming	GGGI	USD 700,593
Northern Uganda: Transforming the Economy through Climate Smart Agribusiness (NU-TEC)	DFID through Palladium, Mercy Corps , AgDevCo	USD 25,055,600
Promotion of Drought Resilience and Food Security in Karamoja Region	KfW	USD 21,600,000

ES 6: Gender and Climate Change

The Government of the Republic of Uganda recognizes that gender equality, women's empowerment and equity is essential to the success of every development program. To this end therefore, gender mainstreaming was adopted as a key strategy to achieve this, spearheaded by the national machinery for gender equality and women's empowerment. Uganda has a conducive legal and policy framework for addressing gender and equity concerns, and institutional mechanisms including sector specific arrangements to attain it.

Government has adopted comprehensive measures to address gender equality and women's empowerment as a socioeconomic, development and human rights concern at both international and national levels. At the international and regional level, Uganda is signatory to various instruments such as the Convention on Elimination of all forms of discrimination Against Women (CEDAW), The International Conference on Population and Development (ICPD, 1994) and the Beijing Declaration and Platform for Action (1995), The African Union Gender Policy and Strategy (July, 2004), The AU Solemn Declaration on Gender Equality in Africa (2004), The Maputo Protocol, among others.

At the national level, the Constitution (Articles 21 (equality and freedoms from discrimination) and 24 (respect for human dignity and protection from inhuman treatment) articulates gender considerations. The overarching Vision 2040 targets Elimination of Gender Based Violence to give opportunity to every Ugandan to live a life of dignity. The current National Development Plan (NDP III) requires all Sectors and Local Governments to abide to equality and equity principles and elimination of barriers to women's advancement and gender equality as a path to national economic growth targets.

The Uganda Gender Policy UGP 2007 provides the overall framework for gender mainstreaming in all government sectors, and provides the focus areas of intervention. The National Climate Change Policy (NCCP) and its strategy (2015), The Uganda National Irrigation Policy (2018) that promotes balanced growth across regions, Water and Sanitation Gender Strategies of (2010 – 2015) & (2018 – 2022, The Environment and Natural Resources Sub Sector Gender Mainstreaming Strategy (2016 - 2021), The National Strategy and Action Plan for Gender Mainstreaming in the

Oil and Gas Sector 2016; and The Roads sub-sector Gender Policy 2019, which guides the mainstreaming of gender in the Sub Sector

The process of compiling this chapter was informed by a gender analysis of climate change stakeholders. The purpose of the gender analysis was to obtain information and data on the situation of gender equality among the climate change stakeholders in regard to the situation of female staff and the gender responsiveness of institutions within which they work and the people they serve. The analysis used a number of gender-responsive approaches such as purposive sampling, review of relevant literature, key informant and focus group discussions. Qualitative data was collected using a structured questionnaire developed by the TNC team.

The multi- dimensional factors that affect the welfare of women and girls and overall gender responsiveness in climate change were identified. The Water and Environment sector in Uganda has a stronger gender lens compared to other sectors because it has put in place deliberate measures to address the constraints of women in accessing services. The good practice of Affirmative Action for water user committees and Young Water Professional is a case to replicate. The great influence of externally supported interventions for addressing gender and equity concerns in all institutions was also noted.

Key bottlenecks and challenges that undermine gender mainstreaming include informal gender biases which dominate most levels of the government, preventing women's access to needed services. Harmful traditional practices and gender stereotypes also undermine female empowerment. Sectors that have gender - specific policies and strategies lack the resources to implement them while other sectors don't have them at all. Whereas there is an overarching national gender policy, the weakness of domesticating it in various sectors is still visible. In addition, there are no specific budgets to strengthen gender mainstreaming in sectors and the sole responsibility relies on the Gender Focal Point Officer. More so, there are some science - based sectors that do not appreciate the relevance of gender to their mandates, while others lack tangible GEWE indicators to track progress.

The gender analysis recommended the establishment of gender structures in climate change sectors, development of gender indicators, stronger linkages and synergies with the national gender machinery and affirmative action for women in leadership positions. Capacity building on the relevance of gender, gender and equity budgeting as well as media advocacy for gender mainstreaming were also recommended.

ES 7: Other Relevant Information for Reaching Convention Objectives

ES 7.1 Research and Systematic Observation

Since Uganda is particularly vulnerable to the increasing frequency and severity of droughts, floods, and severe storms and their impacts on sectors such as agriculture, fisheries, as well as infrastructure, the country is keen to participate in national and international longterm observation and collection of meteorological, hydrological and climatological data.

The Uganda National Meteorological Authority (UNMA) is the core institution mandated to undertake and coordinate systematic observation of meteorological parameters. It conducts these through and observation network of manned and automatic weather stations (AWS) categorized as Synoptic, Agrometeorological, Hydrometeorological and rainfall stations as well as a weather Radar. Due to insufficient coverage of the country by weather stations and other challenges, various institutions whose operations rely on weather information have resorted to installing their own stations in consultation with UNMA. An operational electronic platform (eStation) has also been established in Uganda, hosted by the National Environment Management Authority (NEMA) to provide free access to remotely sensed data and satellite derived products to support planning and decision making in environmental management.

ES 7.2 Education, Training and Public Awareness

Uganda places access to weather and climate information to the population as one of the major barriers to the flow of the relevant information. The low levels of understanding of and the need for such information need to be addressed through targeted awareness, education and training. Uganda developed a "National strategy and action plan to strengthen human resources and skills to advance green, low-emission and climate-resilient development 2013 – 2022: Uganda's Climate Change Learning Strategy". Various actions are continuing towards climate change education and training in Uganda, at both the policy level and the technical level, across sectors, by both the state (MDAs) and non-state entities, Private sector, Development partners, and member-based organizations (MBOs) (NGOs, FBOs, CSOs and CBOs).

ES 7.3: Capacity Building

Uganda has undertaken several capacity building initiatives in recent years. These have included:

a) Building capacity for LDCs to participate effectively in intergovernmental climate change processes; this aimed at providing technical support to enable Uganda to participate and negotiate more effectively during UNFCCC processes.

b) Capacity-building Initiative for Transparency (CBIT) supported by GEF to implement the Paris Agreement. This helped to establish and strengthen in- house capacity to be able track progress and produce more comprehensive and accurate reports capturing implementation of climate actions in the medium to long-term.

c) Sub-regional and/or regional capacity-building activities for integrating mitigation and adaptation to climate change into medium and long-term planning

ES 7.4: Information and Networking

Uganda plays an active role in addressing the global climate change problem through cooperation with all countries through being a Party to all the Multilateral Environmental Agreements and various other Protocols and Agencies. Through this, the country aims at sharing information, networking and joint actions in preserving the environment within a sustainable development paradigm.

ES 7.5: Summary and Conclusion

The Government of Uganda has made efforts to educate and raise awareness of the entire population about climate change and its impacts on national development. Enhanced attention has been given to decision makers. In addition, substantial progress has been made in the institutional and legal regimes. However, limited progress is evident in transfer of mitigation and adaptation technologies in the country.

Uganda has benefited from the support provided by the United Nations agencies in the critical area of climate change through enhanced education, training, research, capacity building, and information and networking. Specific projects around the National Communications have been particularly supported and these have enhanced the local capacity.

The Government of Uganda will continue to place concerted efforts in developing plans and actions at both local and national level and looks forward to the continued bilateral and multilateral support towards their implementation.

CHAPTER 1

NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

1.1 Introduction

This chapter on the National Circumstances provides information on Uganda which may affect national ability to deal with the mitigation and adaptation challenges to climate change. The chapter presents a description of Uganda including geographical characteristics, climate profile, forests, land use, biodiversity and wetland resources, population, culture and history, governance and political systems. In addition, the chapter describes the economic sectors of the country, including its development objectives and the economic development challenges. The institutional framework relevant to the preparation of this third national communication is also presented in this chapter.

1.2 Geographical Characteristics

Uganda is a land-locked country in East Africa that lies astride the equator between 4°N and 1°S and stretches from 29.5°W to 35°W. It is bordered by Kenya in the East, South Sudan in the North, Tanzania and Rwanda to the South and the Democratic Republic of Congo (DRC) to the West (Figure 1,1). The country has a total surface area of 241,555 km2 of which 44,650 km2 (17.2 %) is occupied by open water and swamps, and 196,904.3 km2 is open land. Uganda's land area stands at an average height of 1,200 meters above sea level (ASL). The minimum altitude is within the Albert Nile at 620 meters above sea level while the maximum altitude is the peak of Mt. Rwenzori which is at 5111 meters. Uganda shares a number of trans-boundary water bodies; namely: Lake Victoria with Kenya and Tanzania and Lakes Albert and Edward with the DRC. The central part of the country is a plateau surrounded by four main mountain ranges; the Rwenzori Mountains (often called the Mountains of the Moon) in Western Uganda forming about eighty kilometres of the border between Uganda and the DRC. In Eastern Uganda, the border with Kenya is marked by a volcanic mountain (Mt. Elgon) at 4,324 metres ASL. In the North East, there is Mt. Moroto with an

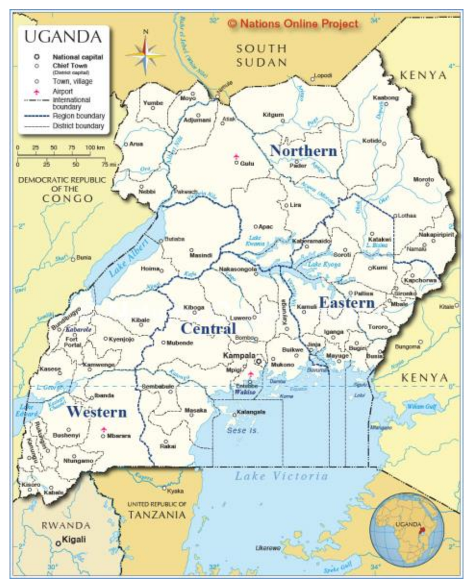


Figure 1.1: Uganda's Geographical Location

altitude of 3,085metres ASL. Further south, there are the Mufumbiro volcanoes with an altitude of 4,132 metres ASL which marks the border with Rwanda and the DRC.

1.3 The Climatic Profile

Three quarters of Uganda is within the tropical belt and hence Uganda’s climate is largely tropical. This means that generally, Uganda has a warm tropical climate with temperatures falling in the 25–29°C (77–84°F) range on an average. The temperatures fall in the 17–18°C (63–64°F) range during the months of December to February as the hottest, but with chilly evenings. Uganda’s average annual near-surface temperatures are around 21°C. The assessment of the annual state of climate revealed that year 2018 was the seventh warmest year on record over Uganda since 1950, falling after the years: 2009, 2017, 2016, 2015, 2011 and 2014. The rate of increase of temperature over the period from 1950 to 2018 was found to be about 0.23 °C/decade, while the period from 1990 to 2018 exhibited a slightly higher rate of about 0.24 °C/decade. The warming level in 2018 was about 0.37°C above the long-term mean value based on period: 1981-2010. In all the years, western Uganda is warming faster than the rest of the regions. It exhibited alarming warming rates of 0.56°C/decade and 0.62°C/decade over the periods: 1950-2018 and 1990-2018, respectively (UNMA, 2019).

In Uganda the observed annual rainfall totals vary from 500 mm to 2800 mm; with an average of 1180 mm between 2000 and 2009. Rainfall has been on average about 8 percent lower than average rainfall between 1920 and 1969. In 2018 Uganda observed extreme rainfall events which led to flooding that affected thousands of people across the country.

It is estimated that 90% of natural disasters are climate change-related. The country has been repeatedly affected by extreme events such as droughts and floods (See Figures 1.2 and 1.3); often with short periods between them.

Figure 1.2: Drought in Mbarara District – 8th August 2020

Figure 1.3: Flooding in Kasese District – 4th November 2020

(Source: http://floodlist.com/africa/uganda-floods-kasese-november-2020)

Climate is Uganda's most valuable natural resource. It is a key determinant of the state of other natural resources as well as sectors such as water resources, forest, agriculture, ecotourism, wildlife, transport and health. While the country is considered well endowed with fresh water resources that provide livelihood to over 40% of her population, climate change is a looming threat. Its effect on the natural resource base will adversely affectUganda's social and economic development.

1.4 Natural Resources Profile

Natural resources constitute the primary source and foundation of livelihood for the majority of the people of Uganda. Natural resource and climate change management underpin the agenda for the country's development framework (NDP III) as they are central for the realisation of the sustainable industrialisation.

Uganda's natural resources cover a wide spectrum and include forests, wetlands, water resources, wildlife and biodiversity, land and soils. These resources are under increased pressure arising from high population growth and environmental degradation. This has concomitant increased emissions and impacts, respectively.

1.4.1 Land

Land is one of the most critical resources of Uganda and is utilized in a wide variety of ways; constituting about half of the value of the asset basket of poor Ugandans. Land area estimates for 2015 by type of cover (Figure 1.4) as updated using the Remote Sensing Survey indicated that agricultural land occupies the largest proportion of land cover area (43.6%), followed by grassland (21.1%) and water bodies by 15.3%. Bushland takes up 8.1% of the total land. The rest of the land is either estimated as wetlands (3%), built-up area (0.6%) or impediments (0.03%).

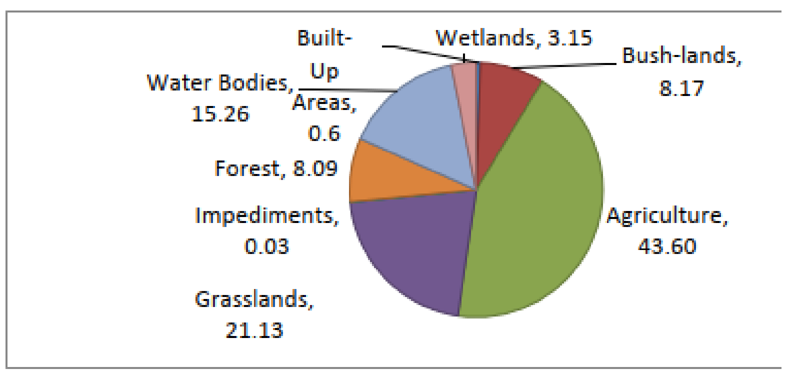


Figure 1.4: Share of Land Cover type, for Uganda 2015 (Sq km) (Source: Uganda Bureau of Statistics)

The proportion of land covered by forests was estimated as 9% in 2015 (MWE, 2016) down from 18.3% in 2005. The latter is attributed to mainly human activities. Changes in land use (Figure 1.5) clearly indicate this.

1.4.2 Water Resources

Uganda is well endowed with water resources; both surface and ground water; with 15.3% of Uganda's area covered by open fresh water sources (rivers, lakes, streams and swamps). Average annual groundwater recharge is also relatively high (19.1 to 39.9 mm). However, Uganda's natural water resources continue to experience both natural and man-induced variability as well as the impact of climate change uncertaintiesas well as pressure from the high population growth rate.

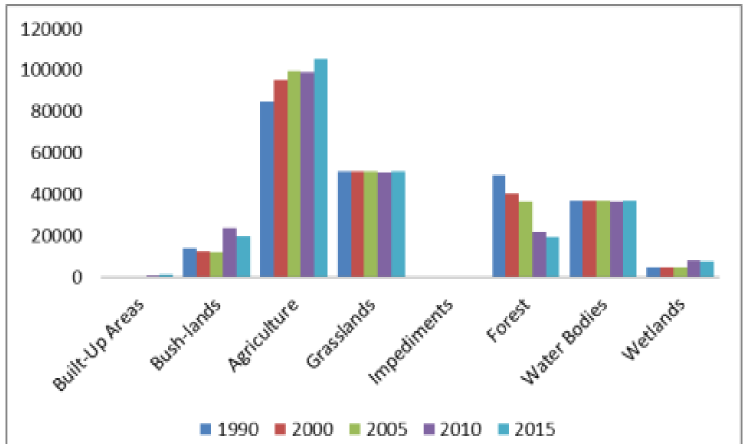


Figure 1.5: Land Cover area by type, 1990-2015 (sqkm)

(Source: Uganda Bureau of Statistics)

1.4.3 Forest Resources

Forestry resources play a significant role in Uganda's national development. Forests provide a range of ecosystem benefits including: watershed protection, biodiversity conservation and control of soil erosion. It is estimated that forests contributed an equivalent of 8.7% of GDP in 2016.

A key characteristic of Uganda's forests is that 70% are privately owned and 30% are in the protected area network including national parks and forests reserves. Substantial decline has occurred over the years driven in part by the increasing demand for energy and agricultural land by the rapidly growing population and partly lack of regulation of forests on private land.

1.4.4 Biodiversity

Biodiversity in Uganda provides a multitude of services such as tourism (including ecotourism), food security, agriculture (including the fishing, livestock and crop industry), cultural uses and ecosystem balance. These services support economic growth, livelihoods and human health and subsequently raising demand for sustainable development and utilization of resources such as forests and wetlands. With a recorded 18,783 globally recognized species of fauna and flora, Uganda ranks among the top ten most bio-diverse countries in the world. Most of the biodiversity is found in natural forests and other natural ecosystems such as mountains, savannahs, wetlands, lakes and rivers.

To conserve this biodiversity, Uganda has gazetted specific areas; including 10 national parks, 12 wildlife reserves, 10 wildlife sanctuaries, 5 community wildlife areas, 506 central forest reserves (1,173,753 ha) and 191 local forest reserves covering 4,957 ha. Uganda also boasts of 12 Ramsar Sites. The protected areas have all been rationalized and regazetted.

Like other natural resources, the rate of biodiversity loss in Uganda is high. With shifts in climate regimes, indeed, there is concern over the downward trend of Uganda's biodiversity, as some niche species may become extinct.

1.4.5 Natural Resources Degradation

Uganda is experiencing natural resource degradation which is a direct threat to sustainable development. It is estimated that up to 97% of Uganda's land area suffers from some form of human-induced land degradation. Such problems include soil erosion and declining soil fertility, deforestation, pollution of land, water and air resources, loss of biodiversity and over-harvesting of forests, fisheries and water resources. This continued liquidation of the country's natural capital undermines long-term economic progress and will aggravate poverty. It is estimated that 4-12 percent of GNP is lost due to environmental degradation; 85 percent of this from soil erosion, nutrient loss and the forced switching of crops to lower value varieties. Halting and reversing degredation and restoring of the natural resource base is one of the country's development priorities within the NDP III.

1.5 Population

Uganda's population has continued to grow over time. Figure 1.6 shows that, the population increased from 9.5 million in 1969 to 34.6 million in 2014 representing an average annual growth rate of 3.0% between 2002 and 2014.

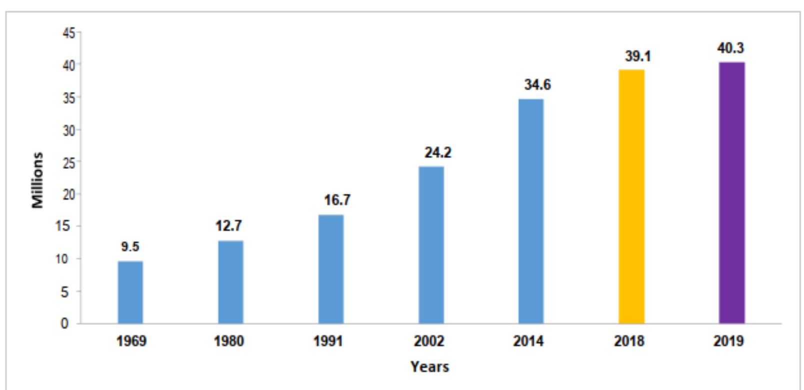


Figure 1.6: Census Population, 1969 - 2014 and Projected Population 2018 and 2019

(Source: Uganda Bureau of Statistics)

The population was placed at 41.6 million by mid-year 2020 (UBOS, 2020). According to UN data, Uganda population is equivalent to 0.57% of the total world population. It ranks number 32 in the list of countries (and dependencies) by population.

With this population, the population density in Uganda is 222 per Km2 (574 people per mi2) with a total land area of 199,810 Km2 (77,147 sq. miles), In addition, the growth rate declined from 3.2 in 2002 to 3.0 in 2014 with an average annual increase of about one million persons. The median age in Uganda is 16.1 years (Worldometers, 2020).

Uganda's urban population has increased rapidly from less than one million persons in 1980 to about 5.0 million persons in 2012 and further increased to 7.4 million in 2014 (Figure 1.7). About 25% of the population is urban (11,135,655 people in 2019).

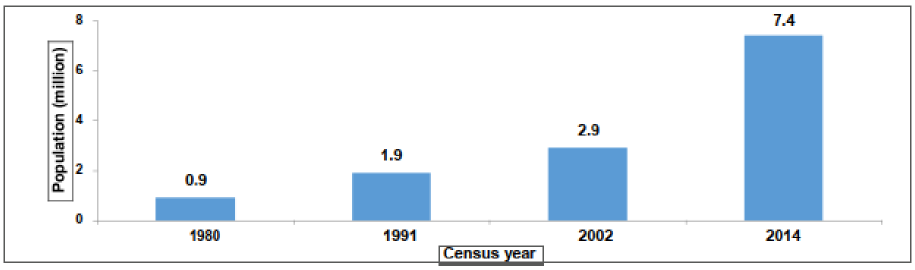


Figure 1.7: Urban Population of Uganda as Determined at Census Year.

(Source: Uganda Bureau of Statistics)

The growth in urban population from 2.9 million in 2002 to 7.4 million in 2014 was driven mainly by formation of new districts and subsequent gazetting of new urban areas (Town Councils and Municipalities) (UBOS, 2020). The other factors contributing to rapid increase in urban population include (2) natural growth, and (4) Rural - Urban Migration (exacerbated by declining agriculture productivity which has continued to discourage rural settlements).

Most people in Uganda live in rural areas and only 25.5 percent of the population in 2019 lived in urban areas. Figure 1.8 shows Uganda urban vs rural population from 1955 to 2020.

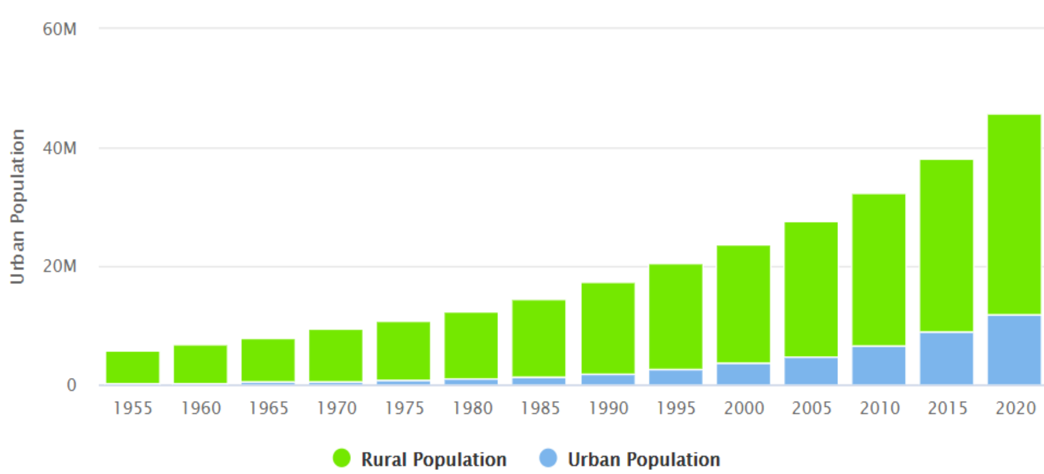


Figure 1.8: Urbanization in Uganda 1955 – 2020

(Source: Uganda Bureau of Statistics)

1.6 Demographics

Uganda's demographics show a decline in Total Fertility Rate (TFR) from 7 children per woman to 5 children per woman between 1995 and 2016 (Figure 1.9). Despite this, it still remains highest in the world. Uganda seems unable to curtail it.

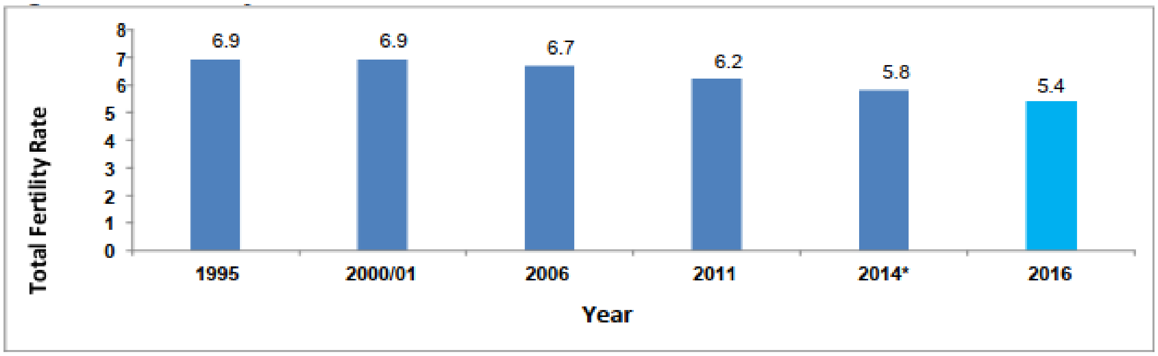


Figure 1.9: Fertility Trends, 1995- 2016

(Source: UDHS Data (1995, 2000/2001, 2006, 2011, 2016)

From available statistics, one may conclude that Uganda has a large population that can be classified as a work force that can be utilized for economic growth of the country. However, the biggest percentage of Uganda's population is young (0-14) years which is a disadvantage in that these young children need to be fed, educated and provided with adequate and qualitative health care. Uganda's Total Fertility Rate (TFR) described as the number of children per woman is one of the highest in the region and stood at 6.9 in the past decade. Currently the TFR is at 6 children per woman. High fertility rates resulted in Uganda having one of the youngest populations in the world, where more than half the population is younger than age 15.

The high child dependency ratio places significant pressures on public provision of social services, and on families, who must spend scarce resources on their children's health and education.

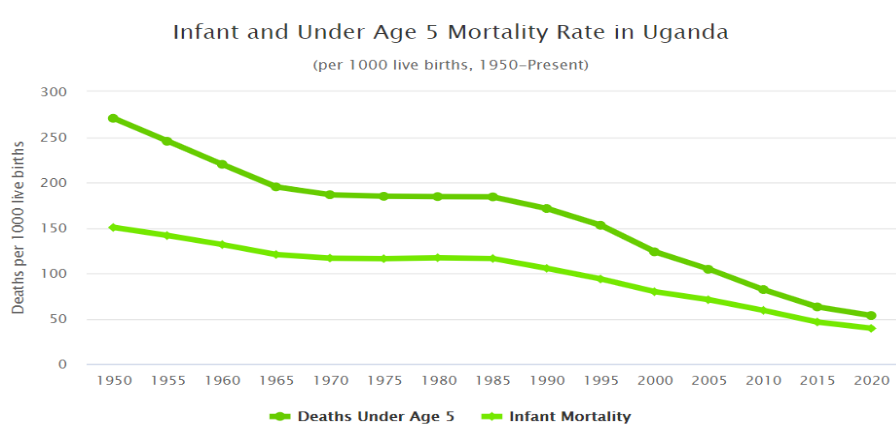


Figure 1.10: Infant Mortality in Uganda, 1955- 2016

(Source: Uganda Bureau of Statistics)

However, a young population also presents an opportunity to take advantage of the 'Demographic Dividend', but it requires a clear strategy for investing in building human capital to prepare the future labour force. Increasing investment in social services, while critical, will be insufficient for harnessing the Demographic Dividend in Uganda. Figure 1.10 shows mortality rate between 1955 and 2016, and Figure 1.11 shows fertility trends between 1955 and 2016 in Uganda.

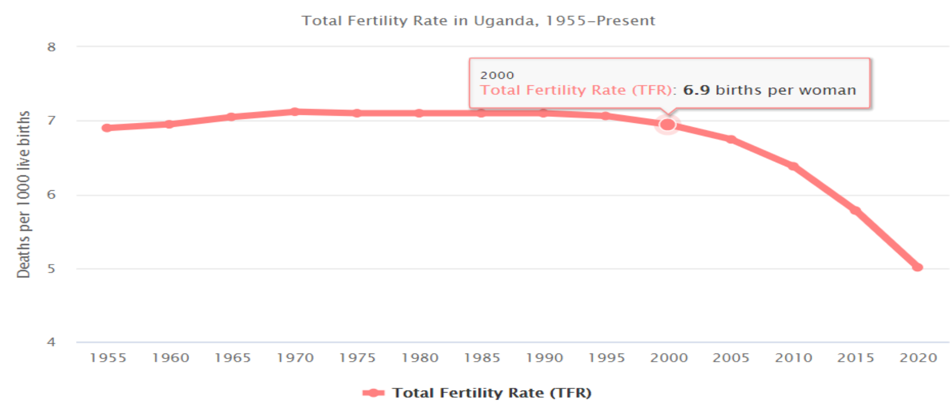


Figure 1.11: Fertility Trends in Uganda, 1955- 2016

(Source: Uganda Bureau of Statistics)

Life Expectancy in Uganda is 64.4 years for both sexes, 66.7 years for the females and 62.0 for the males. The Infant Mortality (IM) is currently 39.2 while deaths under five (5) years is 53.3. Figure 1.12 below shows Uganda's life expectancy from 1955 to 2020.

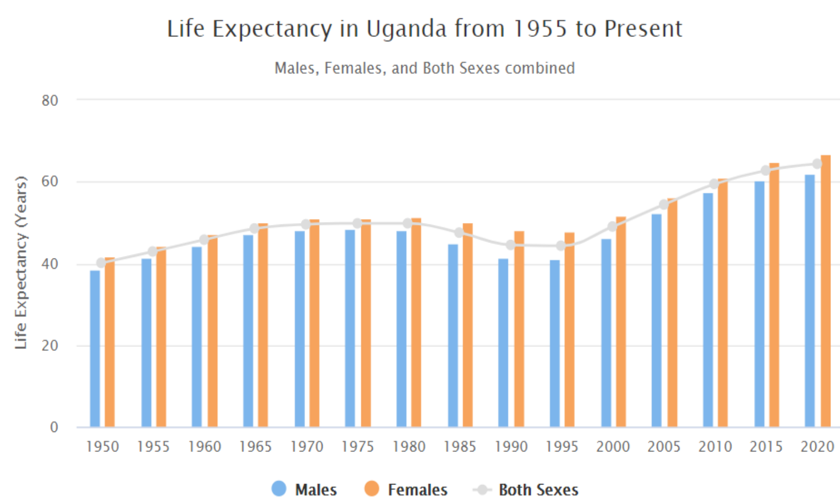


Figure 1.12: Life Expectancy, 1955- 2016

(Source: Uganda Bureau of Statistics)

1.7 Economic Performance

Uganda has diverse natural resources, including fertile soils, regular rainfall, substantial reserves of recoverable oil, and small deposits of copper, gold, and other minerals. The Economic Growth Strategy that underpins the NDP III is built on the need for rapid industrialisation of the Ugandan economy with one of the objectives focusing on exploiting natural resource endowments with environmental protection in mind. In this regard, the economy of Uganda is made up of sectors of agriculture that constitutes 24.2 percent, industry making up 25.5 percent while, the services sector contributes 50.3 per cent. The agriculture sector includes animal industry, fisheries and crop production. The industry sector includes manufacturing, construction and electricity supply sub-sectors. The services sector is made up of wholesale and retail trade, telecommunications, hotels, restaurants, communication, transport and tourism sub-sectors.

Uganda's economy has been growing rapidly and consistently over the past 30 years resulting in the doubling of per-capita income. Indeed, in the first decade of the 2000s, Uganda was one of the fastest growing economies in the world- with annual growth well above the regional average for sub-Saharan Africa as it recovered from the unrest of the 1980s and instability of the 1990s. It peaked at 10.4% in 2008, real growth rates have since slowed significantly; hitting lows of 2.2% in 2012 and 2.3% in 2016 (see Figure 1.13). More recently, growth has recovered to 6.2% and is expected to pick up pace in the coming years. However, GDP per capita, at around US$2,458 (PPP) in 2018, is still some way below the regional average of US$4,096 (PPP) for sub-Saharan Africa - suggesting that reaching upper-middle income status by 2040 will be a challenge (NPC, 2019).

1.7.1 Real GDP Growth

In the 2016/17 financial year, Uganda debased her economy. As per the Budget Framework Paper of 2020/2021, the rebased Gross Domestic Product (GDP) figures show the economy expanded

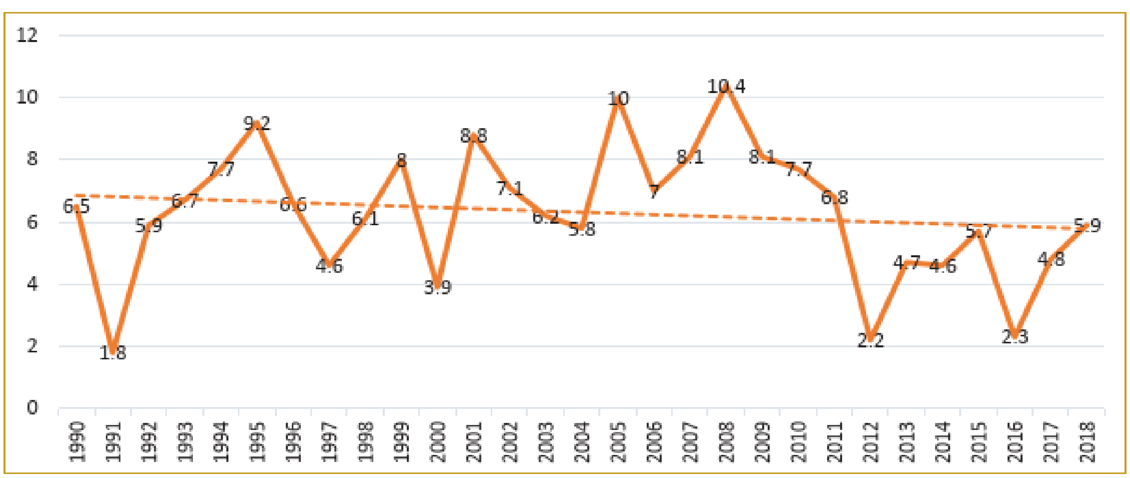


Figure 1.13: Real GDP growth in Uganda 1990-2018 (Annual percent changes)

(Source: IMF World Economic Outlook (April 2018)) by 6.5 percent in real terms during Financial Year (FY) 2018/19 compared to 6.2 percent in FY 2017/18. GDP in constant prices stood at UGX 122,694 billion in 2018/19 as shown in Figure 1.14. The estimated nominal GDP per capita was UGX 3,294,955 equivalent to US Dollars 878. In real terms, GDP per capita was UGX 3,146,097 in 2018/19 equivalent to US Dollars 891 (See figure 1.15)(UBOS, 2020).

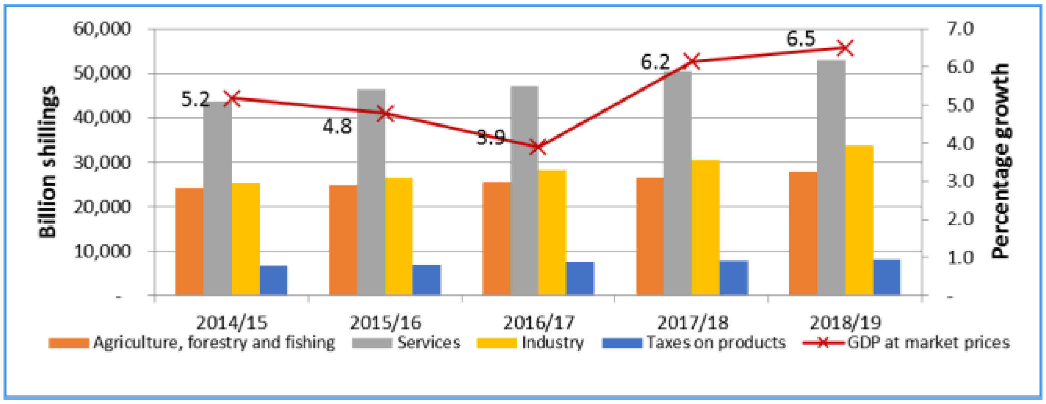


Figure 1.14: GDP in Constant prices and percentage growth rate, 2014/15 – 2018/19

(Source: UBOS statistical abstract, 2019)

The growth realized in 2018/19 resulted from increased private and public sector investments, continued recovery in agriculture, significant growth in manufacturing and services sectors and a relatively stable global economy which supported trade. The growth in the agriculture sector was a result of favourable weather conditions and the benefits of continued Government interventions including provision of quality seedlings, fertilizers, extension services, and pesticides. The recorded Output in the manufacturing sector was as a result and a boost from the newly commissioned factories (food processing, cement production, and iron & steel processing), on the other hand growth, in the services sector was supported by increased trade, finance and insurance activities.

1.7.2 Inflation

The Uganda annual headline inflation averaged at 3.1 percent in FY2018/19 from 3.4 percent that was recorded in the FY2017/18. This was largely on the account of lower food prices and benign global oil prices. In the FY2019/20, annual headline inflation was projected to decline further to 3.0 percent, due to a reduction in core and Energy, Fuel and Utilities (EFU) inflation.

1.7.3 Interest Rates

The Central Bank Rate (CBR) stood at 9.4 percent on average in the FY2017/18 and increased marginally to 9.8 percent in FY2018/19. However, following a low and stable inflation outlook in FY 2019/20, the CBR was reduced to 9.0 percent in October 2019 in order to boost private sector credit growth so as to strengthen the economic growth momentum. As a result of the accommodative monetary policy, lending rates have also declined slightly to 19.8 percent in October 2019 from an average of 20 percent in FY 2018/19. It is however, expected that in the near future interest rates are expected to remain relatively stable supported by accommodative monetary policy as well as low and stable inflation outlook.

1.7.4 Exchange Rate

The Uganda shilling depreciated by 2.1 percent against the US Dollar to an average mid-rate of UShs. 3,736.8 per US Dollar in FY 2018/19 from UShs. 3,658.7 per US Dollar in FY2017/18. The exchange rate is projected to remain relatively stable, depreciating by 0.1 percent to an average rate of UShs. 3,741.6 in FY 2019/20. The stability will be largely driven by improved inflows from coffee exports, tourism receipts, offshore portfolio investors and Foreign Direct Investments especially in the Oil and Gas Sector.

1.7.5 Unemployment

In general, unemployment remains a major development challenge in Uganda. According to the NPA, despite the country's impressive macroeconomic performance over the last 20 years, it has not had a significant impact on the structure of the labour market. Whereas the economy has grown at an average of 5.4% over the last 10 years it has not created enough gainful jobs. The working age population is growing faster than the economic growth. The working age population grew from 16.5 million to 19.1 million between 2012/13 and 2016/17. In FY2016/17, the working population was 15 million persons but with total employment estimated at 9.1 million. Currently a total of 700,000 people enters the labour market every year of which only about 238,000 (34 percent) are absorbed. Moreover, employment has expanded in lower-productivity activities such as subsistence agriculture and petty trade as well as the informal sector (NPA, 2020a). Based on the 2016/17 Uganda National Household Survey (UNHS), Kampala has the highest unemployment rate at 21 percent while West Nile region has the lowest rate at 3 percent. Unemployment is highest among persons aged 15-24 years at 17 percent while the age group 31-64 years had the lowest unemployment rate at 5 percent.

1.7.6 External Trade

Uganda continued to register trade surplus with the East African Community (EAC) in FY 2018/19. However, the trade surplus with EAC slowed down in the FY 2018/19 compared to FY 2017/18 (See Table 1.1).

Table 1.1: Trade Balance with EAC Member States (US$ Million)

Countries	FY 2018/19			FY 2018/19		
	Exports	Imports	Trade Balance	Exports	Imports	Trade Balance
Kenya	842	469	373	487	694	-207
Tanzania	85	126	-41	77	433	-356
Rwanda	253	20	233	167	15	152
Burundi	37	1	36	45	6	39
South Sudan	338	7	331	389	6	383
TOTAL	1,555	623	932	1,165	1154	11

It should be noted that Uganda recorded a higher trade deficit with the rest of the world, because its imports of goods grew faster than exports. In this regard, in comparison with FY 2017/18, the value of imports increased by 22.2 percent to USD 9,604 million, while exports earnings improved by 9.7 percent to USD 5,898 million during FY 2018/19. This led to the widening of the trade deficit by USD 1,222 million (49.2percent) to USD 3,706 million in 2018/19 from USD 2,484 million registered in 2017/18.

Remittances (personal transfers from abroad) remained largely unchanged in FY 2018/19, declining marginally by 0.1 percent to USD 1,244 million from USD 1,245 million in FY 2017/18. On the other hand, Foreign Direct Investment (FDI) inflows rose by 80.6 percent to USD 1,755 million in FY 2018/19 from USD 972 million registered the previous year on account of increased investment in equity and investment fund shares by non-residents.

1.7.7 Domestic Revenue

The Uganda domestic revenue will amount to UShs 21,545 billion in FY 2020/21 and will grow at an average of 0.6 percentage point of GDP over the medium term (MFPED, 2019). This will be supported by implementation of the Domestic Revenue Mobilization Strategy (DRMS) and oil revenue receipts. The DRMS aims to raise Uganda’s revenue effort closer to its potential over the next five years. Of the total domestic resources projected in FY 2020/21, UShs 20,040 billion will be tax revenue and UShs 1,505 billion for Non-tax revenue. This revenue performance will be driven by development and implementation of a comprehensive compliance plan targeting tax evasion and aggressive tax avoidance.

1.7.8 External Borrowing

A total of UShs 6,930 billion is projected as external financing in FY 2020/21. Of this, UShs 6,160 billion is in form of concessional and non-concessional project loans, while UShs 771 billion is budget support loan. The NDP III identifies concessional and non-concessional loans from multilateral creditors to continue being an important source of financing for the country’s development framework, averaging at 1.6% and 2.2% of GDP respectively over the NDP III period.

1.7.9 Domestic Borrowing

The Government of Uganda has projected that it is to borrow from the domestic market UShs 2,570 billion in FY 2020/21, equivalent to 1.6 percent of GDP. However, this is projected to decline to an average of 0.8 percent in the medium-term, in line with Government's policy of maintaining domestic borrowing below one percent of GDP, to avoid crowding out the private sector.

1.7.10 Debt Repayments

Uganda's amortization of external debt is projected to increase from UShs 723 billion in FY 2019/20 to UShs 1,229 billion (equivalent to 0.8 percent of GDP) in FY 2020/21, and will average at 1.1 percent of GDP over the medium term. This is as a result of the recourse to non-concessional loans that are typically characterized by shorter grace periods.

1.8 Economic Development Efforts

Uganda has embraced the principles of green growth and sustainable development in its economic development efforts. This is demonstrated in the various legal and policy, planning and institutional frameworks that have been put in place in the recent years. Sustainable development was provided for in the 1995 Constitution which also provided for public awareness on effective management of the natural resources.

In its development efforts, Uganda aspires to transform itself from a predominantly peasant country to a modern and prosperous country by 2040 as articulated in its Uganda Vision 2040 Framework which has been the basis for the three National Development Plans (NDPs). Uganda acknowledges that this aspiration can only be achieved when the country embraces the green growth approach which is in line with the African Union Vision 2030 and the Sustainable Development Goals (SDGs). To this end, the Government produced the Uganda Green Growth Development Strategy (UGGDS) as one of the steps towards achieving its economic development objectives which are to:

(i) Increase sustainable production, productivity and value addition in key growth opportunities (agriculture, tourism, minerals, oil and gas)
(ii) Increase the stock and quality of strategic infrastructure to accelerate the country's competiveness.
(iii) Enhance human capital development.
(iv) Strengthen mechanisms for quality, effective and efficient service delivery.

While Uganda sustained its economic growth rate of an average of 7 per cent per annum during the period 1990 to early 2000, this has recently slowed since 2016 even as public spending and public debt have grown. The slow down could be due to several factor but may be basically attributed to bad weather, difficulty in credit accessibility by the private sector and the poor implementation of Government projects. There was remarkable improvement in the economy in the latter half of 2017 due growth of information, communication and technology (ICT) services and the favorable weather conditions for Uganda's backbone sector, agriculture.

The economic outlook for 2019 was very positive; thanks to a recovery in the agriculture sector, the sustained growth in services, and the continued huge investment by the Government into public infrastructure. Uganda's budget is dominated by energy and road infrastructure spending, while Uganda relies on donor support for long-term drivers of growth, including agriculture, health, and education. The medium-term growth of the economy is also very positive. The Government had projected the economy to grow by 6.2% in the financial year 2019/20, with agriculture, industry and services projected to grow at 3.8%, 5.6% and 7.8% respectively (MOFPED, 2018). Although the Ugandan economy was on a path of rapid and sustained growth, however, the heavy reliance on the agriculture sector remains a big challenge to Uganda. In this regard, the number of new jobs arising from this growth has been disappointingly low. Sustained growth of the economy was expected to create jobs, drive poverty reduction and make growth more inclusive.

It should also be highlighted that the trade balance has weakened due to the high import bill, resulting in a widening of the current account deficit. Bank of Uganda (BoU) has continued to pursue an accommodative monetary policy stance throughout FY18/19 in a bid to boost private sector credit growth and to strengthen the economic growth momentum. After a record low of UShs 3,897 to the USD, back in September 2018, the Shilling has recovered, and even appreciated since then.

Whereas the economic outlook for 2019 was good, there were still many risks to the economy, external debt is expected to rise as the Government continues to borrow to fund the construction of strategic public infrastructure (MOFPED, 2018). Indeed, Uganda's economy suffered drastically in 2020, because it was hit by the COVID-19 pandemic and locust plagues. The global surge in Covid-19 cases poses a key downside risk, as some regions are bringing back restrictions that could weigh on the external sector. Economics project growth of 4.7% in 2021, which is down 0.2 percentage points from earlier forecast, and 5.6% in 2022 (Focus Economics, 2020).

1.9 Agriculture

Agriculture in Uganda involves growing of crops, rearing of animals on small and large scale and fisheries. Agriculture is a core sector of Uganda's economy and the largest employer. Over 80 per cent of rural population (women and men) are employed in the sector and contribute about 75 per cent of agricultural production. National figures show that in 2019, agriculture contributed around 21.92 percent to the GDP, 46 percent of its export earnings while 68 percent of total employment and all food requirements (UBOS, 2014). The contribution to GDP by different agricultural sub-sectors is as follows crops (67%), livestock (16%); fisheries (12%) and forestry (4%). In addition, agriculture also contributes 100% of all material resources for agro-based industries and food crop production. About 80 percent of Uganda's land is arable and currently only 35 percent is being cultivated. However, despite the importance of the sector, it has grown at only 2% per annum over the last five years. In comparison, other East African countries have had up to 5% annual output growth in agriculture.

While agriculture plays a pivotal role in Uganda's economy especially in addressing poverty reduction and overall economic growth, experts believe that government expenditure in the sector remains too low to meet commitments and the country's requirements. Under the Maputo Declaration of the Comprehensive Africa Agriculture Development Program (CAADP), for example, the share of agriculture sector in the public expenditure (measured as budget allocations to the sector) the country has an obligation to allocate 10 percent of the national budget to their agriculture sector and to have a 6% annual growth of the sector. This would address the negative impacts of climate change.

1.9.1 Crop Agriculture

With the country receiving adequate amounts of rainfall and being blessed with favourable soils, substantial food and cash crop agricutre takes place almost throughout the country. Thes are both home consumption and sale; most people with limited land practice subsistence farming in which crops are grown for home consumption. There are 17 major food crops that are grown in the country. These are grouped into: cereals (maize, millet, sorghum, rice); root crops (cassava, sweet potatoes, Irish potatoes); pulses (beans, cow peas, field peas, pigeon peas); oil crops (groundnuts, soya beans, sim sim), plantain bananas (for food, beer, sweet types) (UBOS, 2010). The main cash crops of Uganda are coffee, tea, cotton and tobacco. Of these cash crops, coffee forms a major source of foreign exchange for the country and dominates exports in terms of value.

From an economic point of view, subsistence farming is a non-monetary sub-sector in agriculture. Similarly, agriculture is exclusively dependent on smallholder farmers who, for example in the central parts of the country, generally intercrop coffee with food crops such as bananas and beans. On the other hand, the monetary subsector of agriculture mainly comprises of additional cash crops (coffee, tea, tobacco and cotton). Coffee is Uganda's main export, which has fortified the formation of different coffee plantation farms and projects all over Uganda.

Uganda's agriculture is heavily risky and highly vulnerable to the vagaries of nature and climate change. National figures indicate that 96% of the farming parcels depend on rain as the main source of water, 3% parcels use swamps/wetlands as their main water source and only 1% use irrigation as the main source of water (UBOS, 2007). Out of the total 3.95 million agricultural households about 7% of are prone to flooding, mostly in the Eastern region (UBOS, 2010). It is striking that 8 out of the 10 most severe floods and droughts in terms of numbers affected since 1900 have occurred within the last 20 years (CRED, 2014). These and more challenges principally are the entry point for agricultural related green growth interventions in the Uganda Green Growth Development Strategy (UNDP, 2017)

1.9.2 Animal Agriculture

As of the year 2020, Uganda had more than 14.2 million cattle, 16 million goats, 4.5 million sheep, 47.6 million poultry and 4.1 million pigs, according to data from the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and the Uganda Bureau of Statistics (UBOS) (UBOS, 2018a). The livestock population growth rates have been estimated to grow at 1.4, 2.5, 4.3 and 3.0 for cattle, sheep, goat and chicken, respectively. In addition, weekly milk production per milked cow to be around 8.5 litres and egg production rates per week at 4 and 5 for exotic layers and indigenous chicken, respectively. These are considered low productivity figures. As for crop production, livestock has continued to be affected by climate and annual weather patterns in addition to other factors like poor husbandry practices including, feeding and nutrition, poor breeding, and animal health. Moreover, the various climate change related factors have led to other scenarios, and these include droughts and floods, that led to death of animals. This is a result of a reduction in quantity and quality of pastures, drinking water, increased diseases and vector prevalence.

1.9.3 Fisheries

Fisheries resources are among the most significant natural endowments of Uganda due to the expansive water resources that support a large and varied fish population. In this regard, fishing is one of the most important sub-sectors in Uganda's agricultural sector; giving an estimated 1.5 million people a source of livelihood with the majority of those employed in the sub-sector are women and youth; who comprise 70 – 87 percept (MAAIF, 2018).

The Ugandan fisheries industry is largely artisanal and is based on activities carried out in open water sources comprising of five major lakes (Victoria, Albert, Kyoga, Edward and George). These five major lakes, and the associated water shed comprising of rivers, swamps and flood plains, cover about 18% (42,000 km^2), and are the critical habitats, breeding and nursery grounds for fish. The Ugandan lakes account for 90% of the total fish catch. Uganda is also the second largest aquaculture producer in Sub-Saharan Africa after Nigeria. Aquaculture production in Uganda increased from just over 800 tonnes (2000) to 117 600 tonnes in 2015. Production was mostly composed of catfishes (51 percent) and Nile tilapia (49 percent) (FAO, 2017). The aquaculture that comprises of fishponds and fish cages, contributes 10% of the total fish catch. Uganda also has over 160 minor lakes and various rivers, flood plains and swamps that partly contribute to fish production (Ikwaput, 2004; Atukunda & Ahmed, 2012).

Fish export has become a major source of foreign earnings for Uganda. It is the second largest export earner for Uganda. It has grown at an average rate of about 48% per year (4,687 tonnes in 1991, 31,681 tonnes in 2007, and 21,552 in 2011) with a peak in 2005 when the country earned about USD 143 million. In 2006, Uganda's total informal fish export to South Sudan, DRC, Rwanda and Kenya was reported to total about USD 33 million (about 14% of all total fish exports).

1.10 Tourism

Uganda's development frameworks, Vision 2040, Green Growth Development Strategy, and National Development Plans, point out the country's tourism potential as one of those core attributes that need to be harnessed and hence play a major role in the economy and contributor to GDP by 2040.

The Government's tourism investments emphasize aggressive marketing, diversification of products and development of tourism supporting infrastructure and services, including airports and roads to tourism areas. Emphasis is further placed on appropriate skills development; increasing the quantity and quality of accommodation facilities; intensifying the provision of security and protection of tourists and tourist attraction sites; combating poaching and eliminating the problem of wildlife dispersal to ensure maximum exploitation of tourist attractions and amenities; tourism management (Regulation and enforcement, grading and classification of hotels and restaurants) and; conservation of tourism sites and wildlife. Promotion of domestic tourism through cultural, regional cluster initiatives and national events; enhancing women entrepreneurship and employment in cultural and creative industry as well as agro-tourism are also emphasized.

The direct contribution of Tourism to GDP in 2017 was UGX 2,699.1bn (2.9% of GDP) while the total contribution including wider effects from investment, the supply chain and induced income impacts, was UGX 6,888.5bn in 2017 (7.3% of GDP), up from UGX6, 171.5bn in 2015.

The Government has increased its expenditure in the Tourism sector through its increased contribution to economic and sustainable development of the country. Several reforms have also been undertaken. Uganda adopted a tourism policy in 2003 and enacted the Tourism Act in 2007. The Uganda Tourist Board was re-branded to create Tourism Uganda in order to market Uganda overseas. Several tourism associations such as the Uganda Tourism Association, Uganda Community Based Tourism Association, Uganda Hotel Owners Association and several conservation organizations have been created and facilitated.

1.11 Transport

The transport sector in Uganda is not diversified in terms of options and currently relies on high-emission vehicles for road transport, marked by the majority 14-passenger commuter taxis and occassionally supplemented by rail, inland water and air transport. These modes operate on networks which collectively comprise the country's transport system. Over 90% of cargo freight and passengers move by road. Air and rail transport modes are limited in utilization and inland water transport is less developed though with enormous potential. This has resulted in transport costs in Uganda to remain high compared to those of other countries in the East African region.

The Green Growth Development Strategy identifies these short comings to foster ineficiencies in economic transformation with negative consequencies for the social and environment aspects. Thus, it recommends the development and provision of sustainable transport options. The NDP III has also prioritized to continue improving the country's competitiveness by investing to reduce transport costs and improve transport interconnectivity. More so, transport infrastructure such as roads and bridges are highly vulnerable to the vagaries of climate change. Thus, the NDP III prioritises climate proofing the already existing transport infrastructure through, for instance, raising bridges and improving drainage systems.

1.11.1 Road Transport

Road transport in Uganda is the most dominant and all the other sectors depend on it either directly or indirectly. In 2019, the country had a total road network of 159,364 km which comprise of 20,854 km of National Roads; 38,603 km of District Roads; 19,959km of Urban Roads and 79,947 km of Community Access Roads. Overall, only 6,107km (3.83%) is paved and for district roads only 106.5 km (0.28%) is paved while for urban roads, 1229.7 km (6.16%) is paved. Overall rating of the paved road network condition has generally improved over the period 2009/10-2015/16. However, the above rates still lag behind many developing countries as network conditions reflect low maintenance expenditures. This inadequate level of road maintenance results in lower travel speeds and higher operating costs. Hence, there is need to increase funding for road maintenance in order to preserve the huge investments being made by government in road development.

In Uganda over 70% use non-motorised traffic (NMT) including the pedestrians, rickshaws, bicycles, handcarts and animals manly use in rural areas. The motorised vehicle stock has increased to 1,355,090 in 2019, from 739,036 in 2012, on average the vehicles are more 15 years. Public passenger transport in Uganda is a mix between private, motorcycles, minibuses and buses.

1.11.2 Water Transport

Uganda's water transport system is still dominated by the "informal Sector" characterized by small motorized and non-motorized boats transporting goods and passengers. The principal lake and river system includes; Lake Victoria, Lake Kyoga, Lake Albert and Lake George, together with River Kagera, the Victoria Nile and the Albert Nile. Transport on Uganda's water comprises mainly: wagon ferry services on Lake Victoria; short distance road vehicle ferries acting as 'road bridges (Figure 1.15); and informal sector operations by individual canoes. The means of propulsion that vessels on inland water vessels use contribute 90% of internal combustion engines and this generates air pollutants and CO_2, as compared to sailboats and paddle propelled boats, thereby affecting energy efficiency and the vessel's environmental impact.

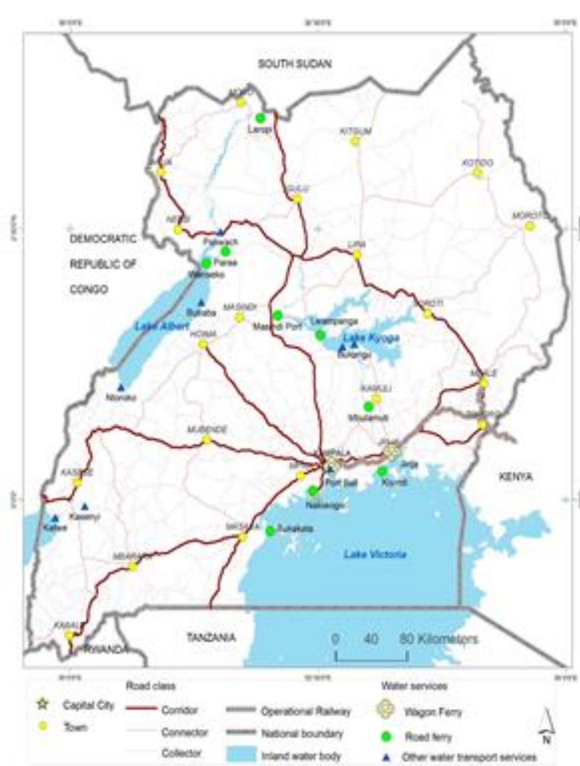


Figure 1.15: Inland Water Transport

1.11.3 Railway Transport

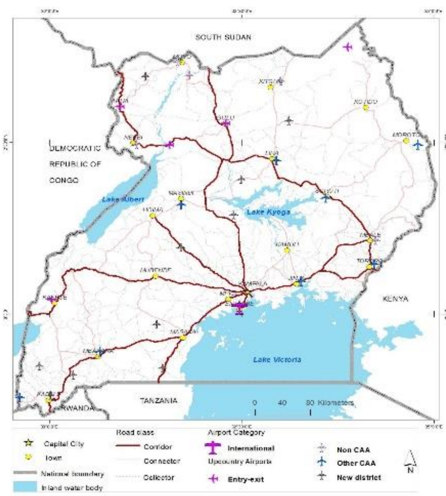


Figure 1.16: Railway Transport network

Uganda's railway network currently comprises of 325km of the meter gauge railway (MGR) that is operational out of the 1,266km (Figure 1.16) representing 25.6% of the rail network. The rest of the rail network is closed largely because of dilapidation. The share of railway transport has declined from 12% to 5% within the last 8 years. The sub-sector is managed by the Uganda Railways Corporation (URC) through an Act of Parliament of 1992. The railway transport sector has been operating below it capacity due to dilapidation of the railway line (only 26% of the railway line is operational), poor state of locomotives, unavailability of MV Umoja, poor state of real estate property and theft of track materials.

It should be noted that the railway sub-sector is undergoing an upgrade from the metre gauge rail (1067mm) to the standard gauge (SGR) (1,435mm).

1.11.4 Air transport

Uganda's air transport sector is managed by the Civil Aviation Authority (CAA) created by an Act of Parliament in 1991. The CAA is an autonomous body reporting to MOWT and capitalized in 2006. The national carrier, Uganda Airlines, which ceased operations decades ago, has been revived under the MoWT/CAA. International traffic dominates flights at Entebbe, up to 97% for passengers and 99% for cargo. International passenger numbers per annum increased during the last 8 years from 781,428 to 1,303,484 in 2016 (MOWT, 2018). The Government of Uganda is building a new international airport at Kabaale, in Hoima district, mainly to service the oil-producing region. There are 30 up-country aerodromes including airports, though 60 are licensed officially. Of these, 19 have regular but unscheduled services, with only 13 being administered by CAA. Runway lengths vary from 1,342 to 3,100m (Gulu). The main international airport is at Entebbe, 40km south of the Capital Kampala. It has two runways of 1300m and another of 3600m. Up to 17 international airlines operate to and from Entebbe. There are thirteen regional aerodromes managed by CAA.

1.12 Information and Communication

Uganda's Information and Communications Technology (ICT) Sector is dynamic and vibrant. The sector has registered double digit growth over the last few years. Sector dynamism is a result of Uganda's good ICT legal and regulatory framework, a stable macroeconomic environment, and economic reforms, pursued since the early 1990s. The telecommunications sub-sector, formerly dominated by a single national operator, has been progressively liberalized over the last 20 years. As in the rest of the continent, this is largely due to the rapid expansion of mobile telephony. According to statistics from UCC, the number of telephone subscribers had reached 10 million in March 2009 — up from more than 8.7 million in December 2008 — which is about one-third of the country's population. Of the 10 million subscriptions, 9.8 million are mobile phone subscribers while around 200,000 are fixed-line owners.

1.13 Energy

Uganda has abundant energy resources which are fairly distributed throughout the country. These include, hydropower, biomass, solar, geothermal, peat, and fossil fuels. According to available statistics, the energy resource potential of the country includes an estimated 2,000 MW of hydro power, 450 MW of geothermal, 1,650 MW of biomass cogeneration, 460 million tons of biomass standing stock with a sustainable annual yield of 50 million tons, an average of 5.1 kWh/m^2 of solar energy, and about 250 Million tons of peat (800 MW). The overall renewable energy power generation potential is estimated to be 5,300 MW and it comprises large hydro of over 2000MW, mini-hydro at 200MW, solar energy at 200MW, biomass at 1,650MW, geothermal at 450MW and peats at 800 MW. Uganda's development targets are generation from different sources as follows: hydropower - 4,500MW; geothermal - 1,500MW; nuclear - 24,000MW; solar - 5,000MW; biomass - 1,700MW; peat - 800MW and thermal - 4,300MW.

The rate of electricity connectivity access is 28% as of June 2019; with total installed generation capacity at 1,182 MW (May 2019) and peak electricity demand approximately 650 MW. Households comprise the largest overall energy consumer group, followed by industry, and transportation (MEMD, 2019).

Biomass is the predominant type of energy used in Uganda, accounting for 94% of the total energy consumption in the country. Charcoal is mainly used in the urban areas while firewood, agro-residues, and wood wastes, are widely used in the rural areas although the sugar cane industry also uses it to produce electricity in a cogeneration process. The total standing biomass stock is stated with 284.1 million tons with a potential sustainable biomass supply of 45 million tons. However, accessible sustainable wood biomass supply stands at 26 million tons. This amount meets 59% of the total demand of 44 million tons per year. As of the year 2019, biomass contributes 88% of the total primary energy consumed through firewood, charcoal, and crop residues; electricity contributes approximately 2%; while fossil fuels (oil products) account for 10% of the national energy mix (MEMD, 2019). Of the oil products, transport consumes 90% whereas the usage of kerosene in households consumes 6%.

Uganda has considerable hydro resource potential estimated to be over 2,000 MW with the largest being along River Nile. A total of 59 mini hydropower sites with a potential of about 210 MW have been identified through different studies. This gives a fair picture of the small and mini hydro potential in the country. Some of the sites can be developed for isolated grids and others as energy supply to the grid.

The average solar radiation is 5.1 kWh/m^2/day and it is the renewable energy resource on the market with the highest adoption rate in Uganda. Existing solar data clearly indicate that the solar energy resource in Uganda is high throughout the year with a variation (max month / min month) of only about maximum 20% (from 4.5 to 5.5 W/m^2), which is due to the location near the equator. The insolation is highest in the dryer area in the north-east and very low in the mountains in the east and south-west.

With respect to wind, most measurements have shown an average wind speed of 3.7m/s indicating that the wind energy resource in Uganda is insufficient for large-scale electricity generation. However, the wind resource may be suitable for special applications, such as water pumping in remote areas and for small-scale electricity generation in mountainous areas.

The exploration for geothermal resources in Uganda estimates its potential to be at 450 MW. So far, three potential areas all situated in western Uganda, in the western branch of the East African Rift Valley have been identified for detailed exploration.

1.14 Mining, Oil and Gas

Uganda has a wide variety of mineral deposits, including both high value minerals (such as gold, limestone, uranium, marble, graphite, gypsum, iron ore, wolfram, nickel, copper, cobalt, tin, rare earth elements) and low value minerals like industrial minerals, construction materials, dimension stones and semi-precious stones. Mining reserves and activities are prevalent in Kabale, Hoima, Buliisa, Kasese, Ntoroko, Masaka, Kabong, Kisoro, Busia, Tororo, Ntungamo, Mubende, Kotido, Bushenyi, Rukungiri, Moroto, Amudat, Kanungu, Bugiri, Gulu, Buhweju, Namutumba and Mayuge districts (See Figure 1.17).

While small-scale and artisanal mining has a long history over the last 100 years, a more formal mining sector has developed recently. Nationally, the mining industry is considered to be key in contributing to the Uganda Vision 2040, the National Development Plan II (2015–2019), and more recently NDPIII. According to “Uganda Vision 2040”, Uganda has the opportunity to build a strong mining industry that can be a source of revenue, employment and socio-economic development (NPA, 2020b).

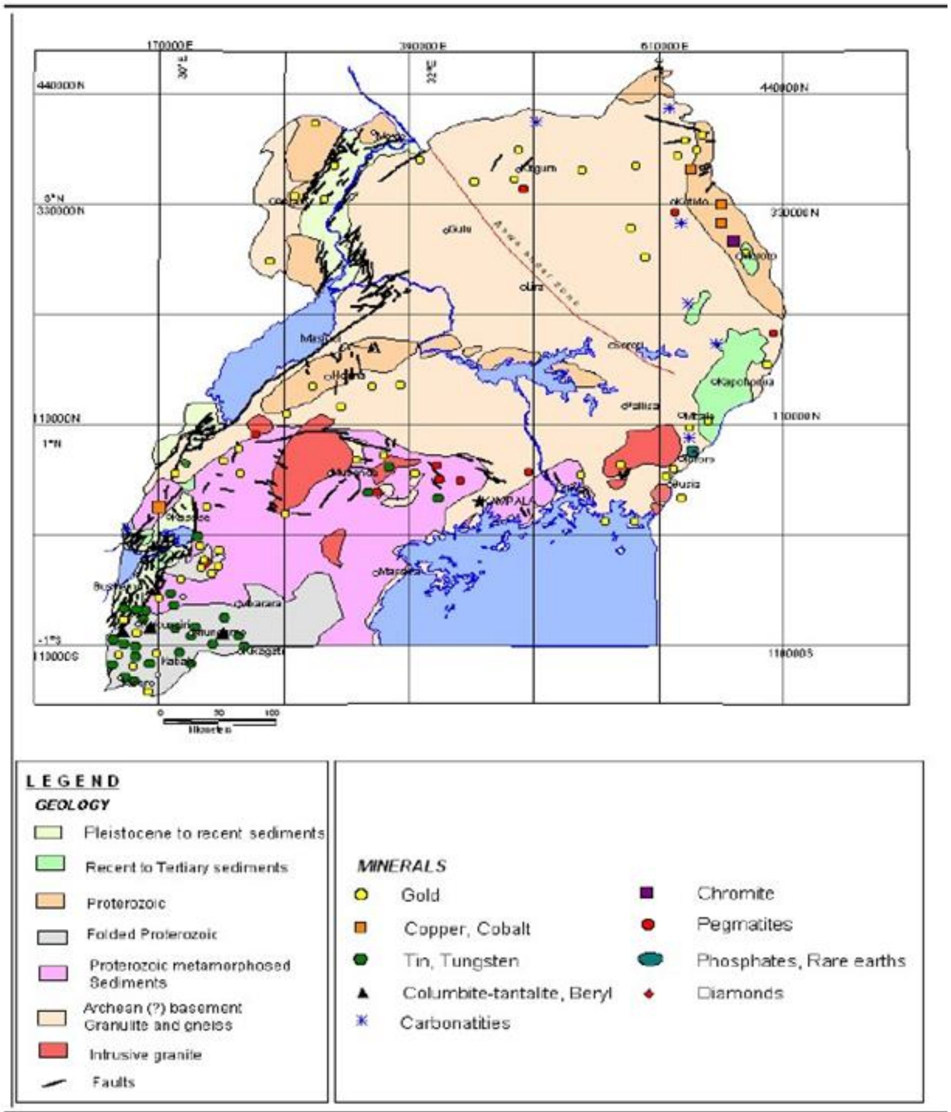


Figure 1.17: Mineral distribution in Uganda

The most established mineral exploitation is that of limestone in form of cement manufacturing. The industry employs over 2,200 people, and another 17,000 people who are directly and indirectly employed by the sub-sector. Cement is one of the leading products in Uganda's manufacturing industry (Table 1.2).

Table 1.2: Cement Production Capacity in Uganda

Ser. No	Company	Installed capacity (million metric tons)	Actual Production capacity (million metric tons)
1	Tororo Cement Ltd	3	2.4
2	Hima Cement Ltd, Kasese	0.9	0.8
3	Hima Cement Ltd, Tororo	1.0	Last stage of commissioning (0.8)
4	Kampala Cement Ltd	1.2	0.33
5	National Cement Ltd	1.0	0.1
	Total	7.1	4.43

With this capacity, Uganda is self-sufficient and has surplus to export to the Democratic Republic of Congo, Rwanda and South Sudan; and even the entire EAC region.

Uganda has exploitable oil and gas resources. It is anticipated that the oil and gas industry will transform Uganda's economy and become central to its development. The country has identified sustainable exploitation of her petroleum resources as important especially these resources are located in an ecologically sentitive biosystem. The country has been developing the institutional framework and plans for the sector; balancing petroleum resources developments with protection and conservation of natural environment; and strategic investment of petroleum revenues to promote equitable socioeconomic and infrastructural transformation of the whole economy.

1.15 Manufacturing

Manufacturing is limited in Uganda; although it occupies a central position in Uganda's economic development and social transformation objectives, strategies, and policy actions. The manufacturing sector in Uganda is dominated by agro-processing, food and beverages, household products, construction materials, and fast-moving consumer goods. Most firms are small and medium enterprises concentrated in Kampala and the Central region. Other industrial activities include: manufacture of textiles and leather products; sawmilling; and processing of chemicals and chemical products.

The Sector's contribution to GDP has grown and is the second largest sector in the economy (See Table 1.3). The sector employs about 9.8% of the total workforce and contributes about 23% of the total merchandise exports. As stated earlier, cement industry is one of the major industries with its domestic consumption estimated at 3 million metric tons, and factory production capacity of about 7 million metric tons rising from 2.83 in the year 2017.

Table 1.3: Contribution of Each Sector to GDP from 2014 to 2019

	2014/15	2015/16	2016/17	2017/18	2018/19
Industry, O/W	25.5	26.4	26.0	26.5	27.1
Mining & quarrying	0.9	1.1	1.2	1.2	1.4
Manufacturing	17.8	16.4	15.5	15.8	15.5
Electricity	1.2	1.2	1.3	1.3	1.4
Water	2.2	2.3	2.4	2.4	2.3
Construction	5.2	5.4	5.6	5.9	6.5

1.16 Waste

The Uganda National Environment Waste Management regulations (1999) defines waste as any matter prescribed to be waste, and any radioactive matter, whether liquid, solid, gaseous or radioactive which is discharged, emitted or deposited into the environment in such volume, composition or manner as to cause an alteration of the environment. In Uganda waste is generated from a number of sources; households, institutions, industries, commercial or business establishments like markets. The household sector is estimated to be the major waste generator accounting for between 52 – 80% of the total weight of waste generated in Uganda (Mwesigye, et al., 2009). Over the years the country has registered growing trends of waste generation per capita in line with the country's economic growth and increased urbanization. Both increased volumes and complexity of waste have occurred with current estimates at 0.5kg/capita/day (NEMA, 2012). In Kampala City, waste generation increased from 0.26 to 0.47 kg/capita/day from 2011 to 2017 with annual waste quantity increasing significantly by 48%. Also projections indicate that annual waste of Kampala City would increase by approximately 60% by 2030 (Aryampa et al., 2019). The national growth rate is mainly attributed to population growth, urbanization, per capita income, economic growth and the overall industrialization. The urban solid waste is mainly composed of vegetable / organic matter (83.6%), waste paper (10.9%), and e-waste. These wastes mainly originate from household, business premises, and offices. Other materials include: wastes plastics (1.2%), waste metals (0.3%), and glass / cullet materials (0.1%) while other miscellaneous materials such as broken pots, enamels, containers other than plastics and metals constitute 3.9 percent.

The waste generated from KCCA and other selected Municipalities across the country in tons, shows that waste collected increased by 2.7 percent from 755,084 tons in 2017 to 776,237 tonnes in 2018. The Western Region had the highest increase (45.8%) followed by the Northern (25.5 %) (UBOS, 2018a).

The major challenges for urban centres are waste collection, transportation, treatment, storage, and disposal, and as such a lot of indiscriminate waste disposal practices have become common among households (Okot-okumu, 2012).

1.17 Development Challenges

Studies undertaken by the Ministry of Finance, Planning and Economic Development (MFPED) in the recent past indicate that Uganda performed very well in achieving the Millennium Development Goal (MDG) of halving poverty by 2015. Uganda also achieved a lot in reducing the proportion of population that suffers from hunger and intensified on efforts to promote gender equality and empowering women in development. According to the Poverty Assessment Report, in 2013, more than one third of the population lived below the poverty line of US$ 1, 90 per day (World Bank, 2016). In addition, it was noted that, the likely hood of one falling back in poverty was still very high by then. This demonstrated a fragile gain which required robust actions by the Government.

The 2016/17 Uganda Household Survey (UBOS, 2018b) estimated that the proportion of Uganda's population that lived below the poverty line rose from 20 per cent in the Financial Year 2013/14 to 21 per cent in the 2017/18 Financial Year. All the regions in Uganda registered an increase in the number of poor persons but this was not case with northern region where which registered a decrease in the number of poor people from 44 per cent to 33 percent in the same period.

However, Uganda has some country-specific features that has affected and can be expected to affect the economic development. It is land-locked, which means that geography imposes a 'tariff' through high transport costs, on both exports and imports. This has implications for Uganda's international competitiveness. Moreover, the geographic location close to violent conflicts for a long time in both South Sudan and the Democratic Republic of Congo contributes to insecurity, and hence investment incentives, also in Uganda. Uganda it's self also had a very troubled past, and the security situation in the northern, and to some extent also the eastern parts of the country was very bad, even though peace and security have been achieved. According to Lundström & Ronnås, (2006), Uganda is also one of the few success stories in Africa when it comes to combating HIV/AIDS. The adult prevalence rate fell from 18 per cent in the early 1980s to 6–7 per cent in 2005. However, the decline has levelled off and there are indications that the infection rate is increasing again.

1.18 Climate Change Impacts

The economic development challenges faced by Uganda are cleary compounded by climate-related impacts. These include, but not limited to, erratic weather patterns being observed. Some of the primary and secondary climate change impacts that are affecting the economic development efforts of Uganda are outlined below. Detailed analysis is provided in Chapter 3.

1.18.1 Droughts

Drought is one of the recurrent natural disasters in Uganda. Evidence suggests that droughts in Uganda are becoming more frequent and more severe; with the western, northern, and north-eastern regions experiencing more frequent and longer-lasting droughts than seen historically (IGAD, 2010). Drought leads to secondary impacts like degraded grazing and cropping lands, and overall environment degradation that result into drying up of water ponds, reduced surface water and river flows, drying up or reduced underground water levels, increased wild fire outbreaks, dust-storms, and increased temperatures; leading to uncomfortable hot and dry air, among others (MAAIF, 2018).

1.18.2 Floods

Flooding in Uganda occurs relatively frequently and is linked with El Niño or La Niña episodes. In addition, the seasonal to inter-annual variability (especially as driven by the ENSO events) is reflected in variations or shifts in the seasonal rainfall, intra-seasonal dry spell occurrence and rainfall intensity, thunderstorms, lightening and hailstones.

Some vivid examples include: in2007, the Teso sub-region in Eastern Uganda and part of Northern Uganda experienced the heaviest rainfall in 35 years (One World, 2008) and in 2014, the flooding of River Nyamwamba in the Mt. Rwenzori region not only resulted in loss of food production and property; leaving people homeless and without food, but also led to serious soil erosion and destroyed irrigation infrastructure, both on the hill slopes and down the valleys.

Flood impacts lead to secondary impacts of landslides, soil erosion, silting of dams and drainage channels, bursting of dams and river barks, water logging in low lying valleys and wetlands, water leaking, displacement, outbreaks of epidemics of animal and crop diseases and pests.

1.18.3 Impact and vulnerability of crop production

Climate change is likely to reduce yields of desirable crops in the long-term. A number of indirect impacts, such as increased rates of runoff and soil erosion, and increased crop losses from pests, diseases and weeds, could significantly magnify production losses. A number of studies have documented the effect of climate variability and change on crop yields (FEWSNET, 2012; MWE, 2014; USAID, 2013). The observed shift in rainy seasons (September-November) and (March-May) and short or prolonged dry seasons in some regions distorts growing seasons; confusing farmers on deciding on timing for planting activities.

Crop production is also directly affected by heavy rains, which damage crops and livestock. Landslides also frequently destroy crops and livestock in the highlands of south-western Uganda (MAAIF, 2018).

1.18.4 Impact and vulnerability of livestock rearing

Climate change affects livestock production through its effects on water and pasture availability, incidence of livestock pests and diseases and mobility of livestock in the country. Increasing temperatures and warming due to climate is expected to alter the feed/water access and intake, mortality, growth, reproduction, maintenance and production of animals - all of which have negative impact on livestock productivity (Kipkoech, Tambi and Bangali, 2015).

Pastoralism is the dominant form of livestock keeping in Uganda, especially in the *cattle corridor*. Given the nature of recourse to mobility to manage climate variability, pastoralism is inherently adaptive. However, the increased occurrences of extreme weather events multiply the impact of factors that constrain pastoralists' livelihoods. Prolonged dry spells and drought will cause severe water shortage, leading to loss of animals, low production of milk, food insecurity, increased food prices, and a general negative effect on the economy. For example, the 2010–2011 Integrated Rainfall Variability Impacts, Needs Assessment by OPM revealed that damage and losses in the agriculture sector were estimated at UGX 2.2 trillion (US$ 907.0 million), accounting for 77% of total damage and losses across all economic sectors. About US$ 45.35 million of the total damage and losses for agriculture was due to animal deaths.

Furthermore, within the livestock sub-sector, 83% of the damage and losses for livestock was attributed to production losses, 9% was due to damage due to animal deaths, and the remaining 8% was due to higher production costs.

1.18.5 Vulnerability of fisheries

Value chain analysis indicate that the impacts of climate change on fisheries in Uganda result from an increase in mean air temperature, changes in rainfall patterns, and an increase in extreme weather events (Timmers, 2012). Small pelagic species (*Mukene, Enziri, and Agogi*) and large species (Nile perch, Tilapia) value chains differ significantly, but may be impacted by climate change and variability in similar ways related to production, processing and transport. Artisanal fish processing in which majority of women and youth are involved and is dependent on firewood and sunshine is highly vulnerable to climate change. Aquaculture value chain shows weaknesses in input supply and delivery, resulting in low productivity. A combination of climate-related threats may further weaken input supply and threaten pond productivity. However, dwindling fish production in fresh water systems, such as those of Uganda, is not only as a result sof climate change, but also due to pollution and overfishing.

1.18.6 Vulnerability of other sectors

The impacts of climate change also affect (directly and indirectly) the other sectors that influence the performance/productivity of the economy.

1.18.7 Impact on water

A study on economic assessment of the impacts of climate change in Uganda finds that between 2010 and 2050, the demand for water in Uganda is expected to increase ten-fold from 408 million cubic metres to 3,963 million cubic metres (MWE, 2015). Droughts will lead to shortage of water for irrigation, livestock and domestic consumption. For example, the damage of drought on water availability is estimated at USD 237 million per year. The largest economic loss on water availability is expected in the Lake Victoria, Albert Nile and Lake Kyoga watersheds (MAAIF, 2018).

1.18.8 Impact on forestry and energy access

Uganda relies largely on traditional biomass energy, which is already short in supply due the high rates of deforestation. The current balance between supply and demand for biomass is fragile and by 2020 and beyond, there will be a large deficit. With biomass energy short in supply, long distances have to be moved to collect biomass, which affects agriculture production. Deforestation arising from increased demand for biomass increases land degradation, which also reduces agricultural productivity. Climate change will certainly reduce availability of biomass and thus the country needs to seek alternative energy sources. There is shortage in supply of electricity and modern energy. This hinders agro-processing and improvement of agriculture value chains. Moreover, Uganda relies on hydro-electricity, which is vulnerable to the impacts of climate change on water availability (MAAIF, 2018).

1.18.9 Impact on transport

Transport infrastructure is also at the risk of climate change impacts and extreme weather events. The roads, bridges and railways are washed away by floods and storms and this affects the marketing of agricultural products. Climate variability is likely to increase in the future, and therefore climate proofing rural transport infrastructure should be a priority.

1.19 Governance and Political System

Uganda is an independent State and a Republic. It is governed by a constitution which is the supreme law. The Constitution of Uganda (Republic of Uganda, 1995) stipulates that power belongs to the people and that the people shall determine how they shall be governed through fair and free elections or referenda. There are periodic elections that are by universal and adult suffrage; and held by secret vote. Uganda has a decentralized system of governance to lower local governments. In Uganda, people's rights and freedoms are respected, and promoted by all organs of Government and by all persons. The organs of Governments are the legislature, the executive and the judiciary. The composition and functions of these organs are as follows:

a) The legislature is an arm of Government established for the purpose of making laws on any matter for the peace, order, development and good governance of Uganda. Parliament is composed of directly elected representatives of constituencies and representatives for the women, youth, workers, army and people with disabilities.

b) The executive is headed by the President who is the Head of State, Head of Government and the Commander-in-Chief of the Uganda People's Defence Forces and the Fountain of Honour. The cabinet consists of the President, Vice President, Prime Minister and Ministers. The functions of Cabinet are to determine, formulate and implement the decisions of Government and other functions as may be provided by the law.
c) The judiciary is charged with the judicial power of Uganda which it exercises by the courts of law which consist of the Supreme Court, the Court of Appeal, the High Court; and such lower courts as Parliament may by law establish.

Currently Uganda is under a multiparty system. The country has over 30 political parties (EC, 2021) with leading ones including the National Resistance Movement (NRM) which is the ruling party, the National Unity Platform (NUP), Forum for Democratic Change (FDC), Democratic Party (DP), and Uganda People's Congress (UPC).

1.20 Institutional Arrangements to Address Climate Change

Uganda continues to demonstrate willingness, readiness and commitment to address climate change as a responsible member of the wider global community. Uganda was one of the first countries to ratify the United Nations Framework Convention on Climate Change (UNFCCC) in 1993 as a Non-Annex 1 Party and the Paris Agreement in 2016. Uganda continues to adopt and implement several measures to address climate change nationally. With respect to the obligation to regularly prepare, publish, report and update its national communications to the UNFCCC, Uganda has so far submitted two national communications to the Conferences of Parties (COP) of the UNFCCC; the first national communication in October 2002 and the Second National Communication (SNC) in December 2014. Besides the two national communications, Uganda has also met other commitments, in preparing and submitting its First Biennial Report (BUR1) and the Nationally Determined Contribution (NDC). The preparation of the Third National Communication (TNC) built on work done under the SNC and FBUR by updating and enhancing the institutional arrangements and effecting additional changes and utilizing the official sector developments in Government's climate change sector. These are outlined below.

The project was coordinated by the Ministry of Water and Environment and supervised by the Climate Change Department (CCD) which was created and staffed after the submission of the SNC. For the purpose of preparation of national communications and BURs, Uganda has adopted a Task Force approach. For the TNC, the MWE assembled and contracted a National Task Force (NTF) comprised of a team of eight (8) experts under the coordination of CCD to undertake the day-to-day work of preparing the TNC. The specific expertise mobilized were:

- GHG Inventory (2)
- Mitigation (1)
- Climate Change modelling (1)
- Adaptation (2)
- Socio-economy (1), and

- Gender (1)

It had earlier been learnt that the limited team of five experts could not possibly handle all the activities involved in preparing the document. A larger pool of national experience, knowledge and skills was therefore drawn upon. This was done using technical working groups guided and coordinated by the experts named above. Some of these groups were already established and operational as technical working groups while others were constituted; namely GHG Inventories, Climate Modelling, Vulnerability and Adaptation (V&A), and Mitigation Actions. This arrangement was strategically made flexible so that it could draw on any specific expertise as would be required. These groups were mobilized and their work coordinated by staff from the CCD. This was both a capacity building effort as well as a move to ensure institutionalization of the working groups. Figure 1.18 shows the arrangement. It is envisagied that these arrangements will continue to be utilized for subsequent reports – that is, the implementation of activities will be coordinated by the Climate Change Department under the supervison of the Ministry of Water and Environment. Once completed, the draft TNC report will be distributed nationally for peer review and eventual approval by the NCCAC. After approval at this level, various fora such as radio talks, workshops and subsequent project meetings will be utilized to disseminate its or parts of its contents. It will also be submitted to the UNFCCC Secretariat and subsequently submitted to the COP.

1.20.1 National Level Institutional Arrangements

At the national level, the Climate Change Policy (approved in 2015) distinguishes and defines two key institutional functions: coordination and implementation. The roles of the institutions intended to address climate change response actions in Uganda are summarised in Table 1.4. Climate Change matters are coordinated by the Climate Change Department under the supervision of the Ministry of Water and Environment.

Leadership for climate finance is assigned to the Ministry of Finance, Planning and Economic Development (MoFPED) which is Uganda’s National Designated Authority (NDA). However, the current institutional framework does not show clear lines of responsibility and accountability between the Ministry of Finance and the other mandated agencies. Securing greater clarity on institutional mandates may be the most important factor that will determine whether the public finance system will allocate the funding necessary to finance agreed climate change actions.

It is hoped that the Climate Change Bill, which is under development, will address many of the shortcomings. To facilitate national level coordination and implementation, the Bill proposes the creation of a ministerial committee on climate change, the Policy Committee on Environment (PCE) which will be chaired by the Prime Minister.

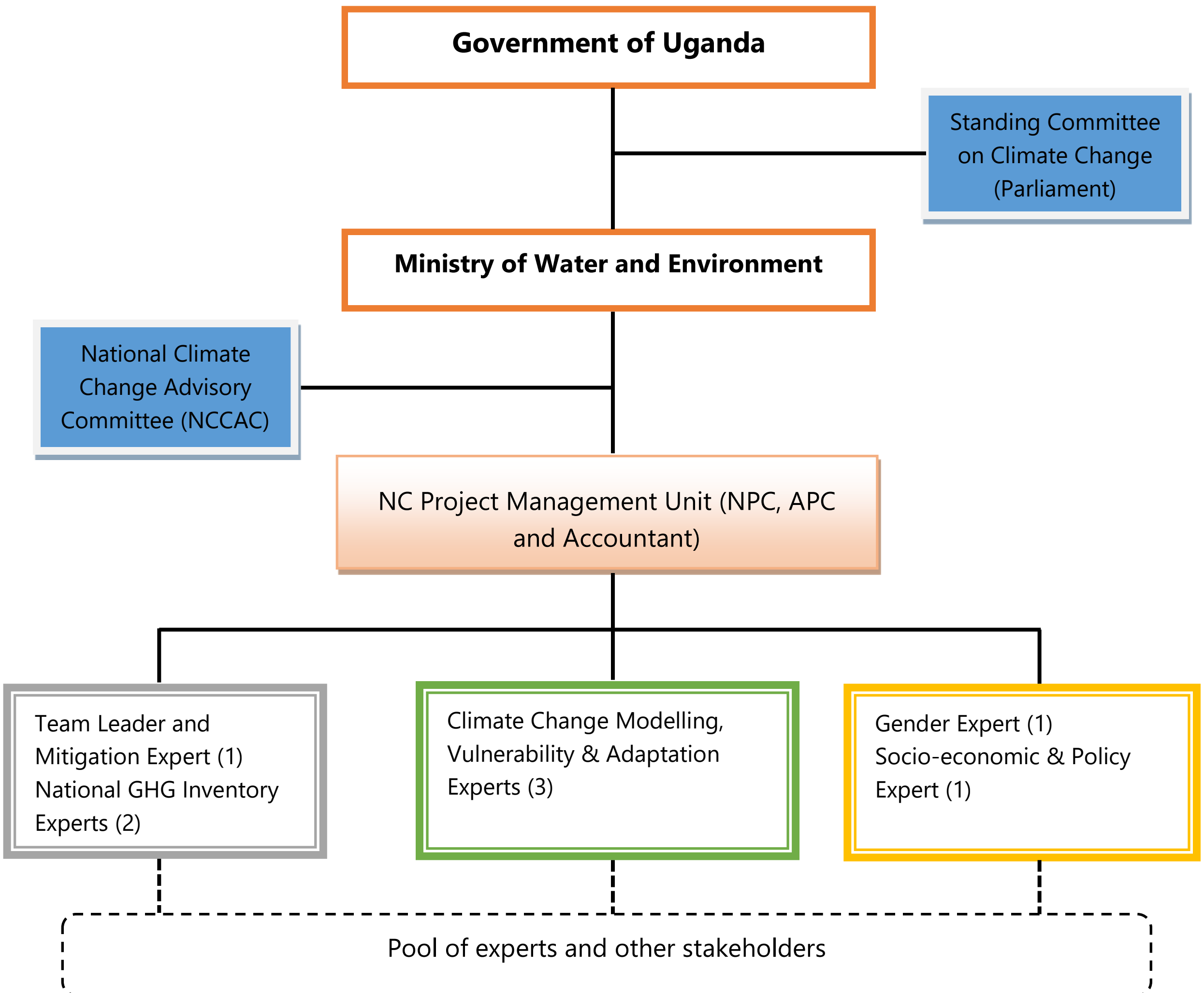


Figure 1.18: Institutional framework for preparing national communications in Uganda

Table 1.4: Domestic institutional arrangements to address climate change response actions

Structure	Function
The Parliament of Uganda' s Standing Committee on Climate Change (SCCC)	Launched on 14 August 2019, the Parliamentary Committee on Climate Change will scrutinize all bills related to climate change mitigation and adaptation, make recommendations to Parliament on legal and institutional mechanisms to address climate change among other mandates. The Committee interacts with all stakeholders mainly line ministries, departments and agencies of government on climate change, civil society organizations, private sector and development partners that champion climate change. Standing committees last two and half years. They are set up at the start of a new term of Parliament and again after two and half years. They comprise about 30 members selected by party whips. Coordinates policy implementation and ensure information flow on resource allocation for the implementation of the Climate Change Policy. The Committee would be chaired by the Prime Minister and will bring together ministers of the various departments at the national level.
The National Climate Change Advisory Committee (NCCAC)	Established by the National Climate Change Policy of 2015 and is chaired by the Minister of Water and Environment. NCCAC is a high-level technical multi sectoral stakeholder representation that guides the Minister on issues related to implementation of the policy strategic interventions. Provides overall coordination and inter-sectoral leadership Coordinates policy formulation and implementation on climate change and serves as an official platform for policy level stakeholder participation. The committee ensures working level coordination and provides technical input to the national Climate Change Policy Committee by bringing together technical representatives from various government departments at the level of Permanent Secretaries or their representatives at national level as well as non-state actors
CCD	Overall coordination of Climate Change
District Climate Committees	These are District and Environment and natural Resources Committees established under Section 144 of the National Environment Act and is designated to be responsible for climate change matters in the district

In terms of reporting, the preparation of the FBUR initiated institutional working together among key Ministries, Department and government agencies. Among the ministries involved were: MWE; MEMD; MWT, MTIC, MAAIF, MFED. The agencies and institutions involved were: NFA, NEMA, KCCA and NWSC among others. These ministries and agencies have since coordinated and supported the collection of the relevant data and information relevant to preparation of climate change reports at national level. In addition, sector working groups have been formed.

1.20.2 GHG Sector Working Groups

With coordination and facilitation from the CCD, several GHG sector working groups have been put in place. The AFOLU – sector working group is the largest. It consists of over 30 experts from NFA, MAAIF, UBOS, NARO, UNMA and other relevant stakeholders from academia and non-governmental organizations. This team have undergone a series of trainings with support from CfRN, the Global Green Growth Institute (GGGI) and the Regional Centre for Mapping of Resources for Development (RCMRD) as well the Capacity Building Initiative for Transparency (CBIT).

In addition to training in GHG compilation, the team identified key GHG personnel, their roles and responsibilities regarding data collection, archiving, QA/QC. The team provided expert knowledge and actions needed to make improvements where gaps were identified in Activity Data and or Emission Factors.

The energy sector, waste sector and industrial processes working groups have also received similar training and efforts to make them fully operational are ongoing. The energy sector working group is comprised of experts from MEMD and MoWT. The waste sector working group is comprised of experts from NEMA, KCCA and NWSC. The process of inclusion of experts from municipalities other than those from Kampala City is underway. All the above working groups have incorporated relevant experts from UBOS and URA to ease access to relevant national statistics. Experts from Ministry of trade and industries have been identified. Together with representation from UBOS and URA they will form the Industrial Processes and Product Use Working group.

1.20.3 Mitigation Working Group

Uganda has made efforts to establish and strengthen national arrangements that enable the formulation, registration and implementation of mitigation actions. This is in form of a national mitigation working group. In addition, establishment of a national mitigation action registry has been done.

The mitigation working group is made up of representatives of the IPCC sectors and other agencies. The members are drawn from the Climate Change Department, Government Departments covering the IPCC Sectors, key Agencies and selected experts from academia. The Climate Change Department is the convener, facilitator, integrator/aggregator, and reporter.

The tasks of the TWG are to:

a) Setting medium and long-term goals;
b) Constructing a national BAU baseline based on an aggregated sector data, and analysing trajectories for national emission reduction;
c) Identifying potential mitigation actions, and their aggregate mitigation potential;
d) Establishment of carbon budgets for each sector;

e) Assessing investment and mitigation costs, system abatement costs, financing and support requirements, and lead time for implementation and impact;

f) Provide assistance with design and implementation of policies, measures and instruments.

g) Review of the mitigation section of the FBUR

Once the TWG has done its work, the actual elaboration and the mitigation actions is conducted under the guidance of the existing official Sector Working Groups (SWG) within the government structure.

The group also supports the process of collecting and subintting information on the progress of impmentation of the mitigatons actions, if any, to the CCD for purposes of reporting in the National Communication and the BURs. The above arrangements have been very useful in smooth preparation of the TNC and will continue to play this role for subsequent reports and indeed other climate change matters.

1.20.4 National Adaptation Technical Working Group (NATWG)

A National adaptation technical working group (NATWG) was established with various functions, including provision of information on adaptation, and undertaking of adaptation assessment. The NATWG was established by identifying and mobilizing additional stakeholders to strengthen the existing adaptation core group under the Climate Change Department. The exercise was guided by the NAPs framework under the UNFCCC (LDC, 2012) which identifies technical issues that call for sectoral expertise. Further guidance emerged from consideration of issues of national concern, namely, gender, MDAs, plus non-state stakeholder representation.

The Criteria for selecting additional experts, was agreed on during stakeholder capacity building workshop, and were as follows: (i) Sectoral institutional representation in line with NCCP Adaptation Thematic Areas, (ii) Technical Knowledge / expertise, (iii) Gender, (iv) Public sector, (v) Private sector, (vi) MBOs (CSOs, FBOs, NGOs) (vii) Cultural institutions, (viii) Academia, (ix) Political institutions, and (x) Relevance. Identification of the sectors was guided by Uganda's NCCP, NDC, SNC, NDPII and NDPIII. A template designed in google form was used to capture personal information of the prospective additional experts for the National Adaptation Technical Working Group. The NATWG is coordinated by the Climate Change Department.

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CHAPTER 2

NATIONAL GREENHOUSE GAS INVENTORY

This report of the Third National Greenhouse Gas Inventory was prepared in accordance with the 2006 IPCC Guidelines for National GHG Inventories, using IPCC 2006 Inventory Software Version 2.691. The emissions calculation, results and analysis, were made for the four main sectors: (1) Energy, (2) Industrial Processes and Product Use, (3) Agriculture Forestry and other Land use (AFOLU), and (4) Waste covering the period 1995 – 2017. The 100-year time horizon global warming potentials (GWP) relative to CO_2 adapted from the Second Assessment Report (SAR) were used to convert the estimated CH_4, N_2O emissions to CO_2 equivalents.

2.1 Description of Uganda's GHG Inventory

As part of our reporting obligations under the UNFCCC, Uganda prepared it first National Communication (NC) in 2002 and later on the Second National Communication (SNC) in 2014. The first GHGI covered the year 1993/94 and was updated to cover the period 1995 to 2000 during the SNC. Both the first and second NCs largely applied the 1996 IPCC guidelines. In line with the Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF), the AFOLU sector applied the 2006 IPCC guidelines since the SNC. The GHGI for the First Biennial Report also applied the 2006 IPCC guidelines across all sectors and covered years from 2000 up to 2015. This aggregation allowed for comparison of the TNC, SNC and FBUR through trend analysis. Since 2010, a number of capacity building programmes have been carried out with supported from CCD as a long-term improvement strategy of the national GHGI.

2.1.1 The Current Institutional Arrangement

All GHGI improvement initiatives are coordinated by the CCD (Figure 2.1). The responsibility of data collection and analysis for each of the four key emission source sectors (namely Energy, IPPU, AFOLU and Waste) is vested in several government Ministry, Department and Agencies (MDAs).

Data from for the sector MDAs is evaluated by the sector working groups comprised of mainly of experts from the government agencies that may be supported by experts from academic institutions, international agencies and civil society. Initial evaluation of the appropriateness of Emission Factors is also conducted at this level. The sector working groups (SWG) work closely with the Task force members. Task force members are derived from sectoral GHG experts who work with the SWG to build consensus on use and application of the Activity Data and Emission Factors. The Task force teams are responsible for final compilation of sector GHG emissions and thereafter forwarded to the National Inventory Compiler who integrates all sectoral Data into the National GHGI database (Figure 2.1).

Before submission to the UNFCCC, the GHGI reports are reviewed and endorsed by the National Climate Change Advisory Committee (NCCAC) and the Parliamentary committee on climate change. Submission is done by the UNFCCC focal person in the Ministry of Water and Environment.

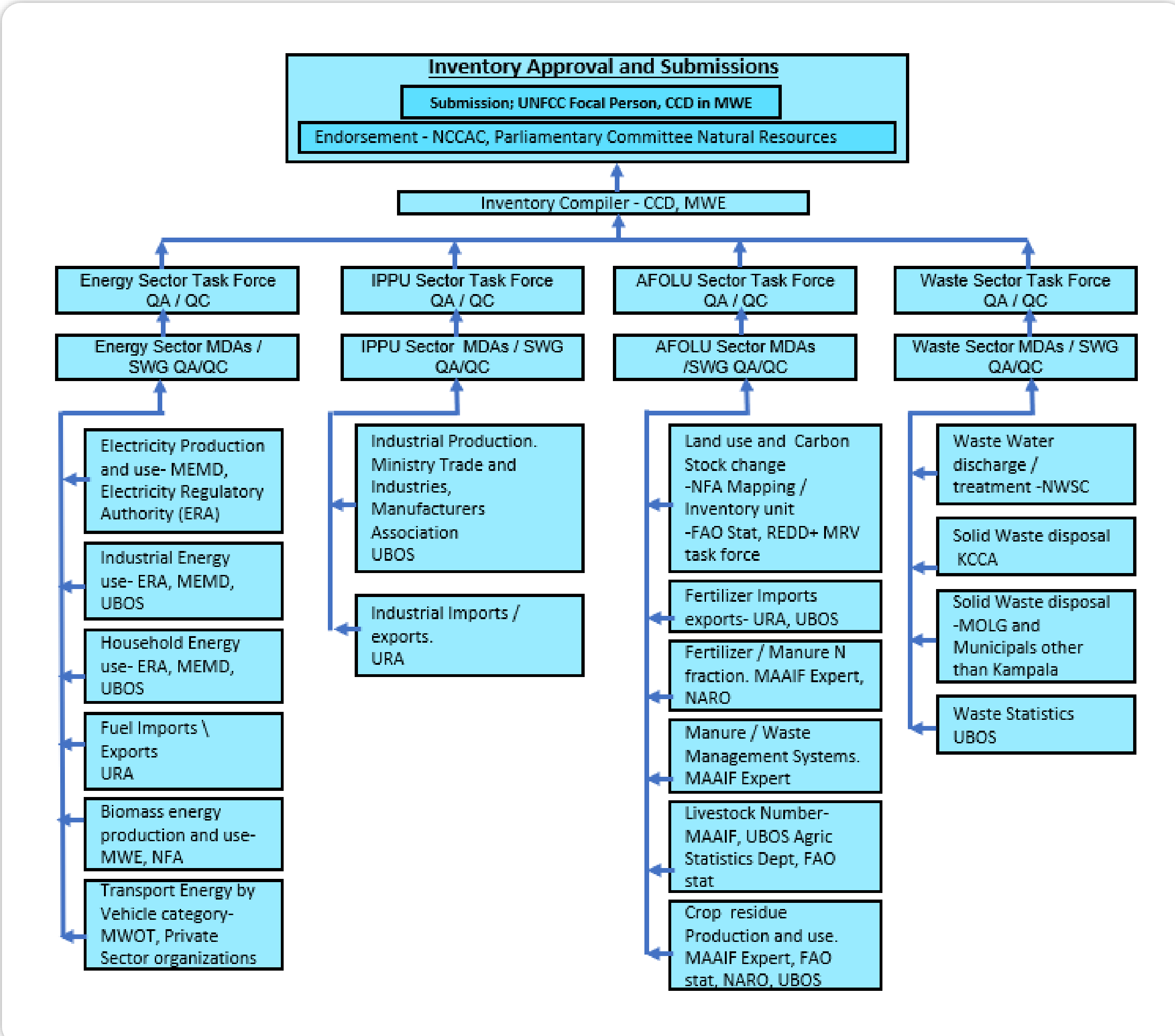

Figure 2.1: Institutional Arrangement of GHG Inventory

2.1.2 Methodology and Data Sources

Like for most developing countries, reliable activity data is not regularly available. In some instances, interpolations and expert judgement were used to derive Activity Data. Estimation of emissions was based on linking emission factors to country specific activity data while applying IPCC methodologies. Apart from the forestry subsector where country specific coefficients were applied, computation of GHG emissions is based on default emission factors as provided in the 2006 IPCC guidelines.

2.1.2.1 Assessment of Completeness of Data

Uganda's ultimate goal is to estimate and report on all relevant categories of sources and sinks, and gases. Availability of reliable activity data is used as an indicator for assessing completeness of each source category using the following criteria (Table 2.1).

Table 2.1: Completeness Criteria

Code	Description
M	Measured (metered or any other regular measurement)
MP	Measured partially (measurement does not cover entire source category)
DM	Derived from other measurements (based statistics or special studies, may not adequately represent the source category)
EO	Estimated from Other (estimated or interpolated from one off survey)
EJ	Expert judgement (available statistics do not adequately cover the source category, adjustments made based expert in key institution and academia)
X	Not known and not estimated
F	For future consideration, not relevant today but considered very important source in near future (within 5 years)

a) Energy Sector Assessment of Completeness

Table 2.2 shows that data sources for electricity generation and combined power / heat categories is measured. Some of the data is acquired from relevant stakeholders through formal requests and publications. Estimation of emissions from energy in the transport category is constrained by paucity of data on fleet of vehicles. This makes estimation of emissions in the energy sector using the sectoral approach a challenge. Charcoal figures are based on special studies. Data on manufacturing industries is not dis-aggregated to capture individual industries.

Table 2.2: Uganda's GHG state of completeness in terms of the Energy Sector

Sector /Sub Sector	Activity Data Requirements - IPCC 2006	Description	State
Fuel combustive activities / Energy industries			
Electricity Generation	Mass or Volume fuel consumed to per kWh	Data available and well documented	M
Combined Power/ Heat	Mass or Volume fuel consumed to per kWh	Data available and well documented at CHP facilities	M
Petroleum Refining	Not Applicable may be after 2022		F
Manufacture of Solid Fuel (Charcoal)	Mass or Volume firewood consumed to per unit of charcoal produced	Data on charcoal production and used is based on special studies	DM

Manufacturin g Industries	Consumption (Mass or Volume) and Conversion factor (TJ/UNIT output)	Data not disaggregated to capture individual industries	DM
Fuel combustive activities / Transport			
Transport/Civi l Aviation	Aggregate fuel consumption domestic and international (LTO and cruise) and average emission factors	The aviation fuel consumption is available in national energy statistics and the energy balance	DM
Transport\Roa d\Rail	Fuel consumed by fleet category (distance and or tonnage)	Data on fleet of vehicles is incomplete, thus emissions cannot be computed by the sub sector	DM
Transport\Wat er & Other	Fuel consumed by water transport category and others (distance and or tonnage)	Data on fleet of vehicles and water vessels is incomplete, thus emissions cannot be computed by the sub sector, and estimates were made based on national energy balance for 2015.	DM

b) IPPU Sector Assessment of Completeness

IPPU is less complete because activity data is only partially available. Cement and lime production are the only ones with reliable estimates. There is limited data on non-energy use of fossil fuel used in lubrication and products used as substitute for ozone depletion substances which finds applications in refrigeration and air conditioning, and fire protection. Data in these subcategories is thus mostly derived from/by interpolation / extrapolation or estimates from other sources (Table 2.3).

Table 2.3: Uganda's GHG state of completeness in IPPU

Sector /Sub Sector	Activity Data Requirements - IPCC 2006	Description	State
Mineral Industry			
Cement	Data of cement production, import and export is available in national statistics. Clicker import data is available.	All data is available	M
Lime	There is limited activity data for lime in the national statistics.	Data not well documented	EO
Non energy products from fuels and solvents use			
Lubricant	There is activity data for lubricant use in the national statistics.	Data not well documented	EO
Substitutes for ozone depleting substances			
Refrigeration andStationary	There is limited activity data for HFC-134a in the national statistics	Data not well documented	EO

Air Conditioning			
Mobile Air Conditioning	There is limited activity data for HFC-134 in the national statistics	Data not well documented	EO
SF6 and PFCs from Other Product Uses	There very limited data. It is not possible to estimate the emission	Data not well documented	X
Fire protection	There is limited activity data for HFC-134 a in the national statistics	Data not well documented	EO
Other			
Food and Beverages Industry	There is limited activity data for industrial products in the national statistics	Data not well documented	EO
Chemical, Metal, Electronics and other Industries	There is limited activity data for those industries in the national statistics	Data not well documented	X

c) Waste Sector Assessment of Completeness

Undoubtedly, a half of the solid waste in Uganda's major urban centres is not managed in landfills. Not all municipalities have reliable data and is partially measured. Though not properly documented, it is estimated that slightly less than 5% of solid waste is incinerated, mainly emitting CO_2. In the case of the domestic sewerage, because of the nitrogen content in food, N_2O emissions also occur. Data from other industries is not well documented in terms of production levels and Biodegradable Organic Matter Content (Table 2.4).

Table 2.4: Uganda's GHG state of completeness in the waster sector

Sector /Sub Sector	Activity Data Requirements - IPCC 2006	Description	State
Managed Disposal Sites	Degradable Organic Carbon (DOC) and Methane fraction of waste by population and waste type (food, paper, textile, sludge, industrial waste, nappies etc.	Data partly available on key Municipalities	MP
Unmanaged and un categorized disposal Sites	Degradable Organic Carbon (DOC) and Methane fraction of waste by population and waste type (food, paper, textile, sludge, industrial waste, nappies etc.)	Data partly available on key Municipalities	MP
Biological Treatment	Waste amount by category (food, paper, textile, sludge, industrial waste, nappies etc) treated mainly by municipalities (anaerobic and or Composite systems)	Data partly available on key Municipalities	MP
Waste Incineration	Amount of waste incinerated by (food, paper, textile, sludge, industrial waste, nappies etc,) fraction of dry matter content, fraction of carbon in dry matter, fraction of fossil carbon in total carbon	Data partly available on key institutions	MP

Open Burning	Population by region, fraction of population that burn waste, kg waste /person/day, fraction burnt (compared to treated), days in a year	Data partly available on key	MP
Waste Water treatment and discharge (Domestic and Industrial)	Low /High income, rural and urban (discharge pathways i.e., sewer type, latrine by depth, latrine type, lagoon type)	Data partly available in key Municipalities	MP

d) AFOLU Assessment of Completeness

Livestock census was last conducted in 2007/8. Livestock statistics before 2008 and after 2008 rely on extrapolation using annual growth rates. Nitrogen from manure management systems and that amount deposited on free range plus nitrogen content in organic and inorganic manure is estimated by expert judgement and from the FOASTAT Database. Data in this subsector is generally not measured but is based on expert judgement and various data splicing techniques.

Area under paddy rice cultivation is to a great extent estimated by expert judgement based on combination of district agriculture and production office records and data from FAOSTAT. Data on fertilizer imports and exports is derived from the Uganda Revenue Authority (URA) database while nitrogen content for fertilizer type is by expert judgement (Table 2.5). Data on application of inorganic fertilizer is not readily available and is indirectly estimated from FAOSTAT.

The National Forestry Authority (NFA) is the key agency that provides data on land use and forestry statistics. Remote sensing techniques are used to generate area statistics while living biomass stocks are provided by the National Forest Inventory (NFI) that is carried out every 5 to 10 years depending on the availability of resources (Table 2.5). However, data on wood extraction is not measured but is estimated from household energy surveys, biomass derived energy studies and international databases such as FAOSTAT (Table 2.5).

MODIS burnt area from fuoco FTP server (fuoco.geog.umd.edu) of the University of Maryland is used to estimated biomass burning and associated emissions.

Table 2.5: Uganda's GHG state of completeness in AFOLU sector

Sector /Sub Sector	Activity Data Requirements - IPCC 2006	Description	State
Livestock			
Livestock Enteric Fermentation	Livestock numbers (annual) disaggregated by key breed categories	Interpolated based on 2007 livestock census, disaggregation by breed types based on expert judgement	EO
Livestock Manure Management (CH_4 and N_2O Direct)	Manure management systems disaggregated by key breed categories	Manure management systems based on expert judgement	EO
Aggregate Sources			
Lime Application	Annual amount of lime application	Lime imports / Exports coupled with expert judgement	EJ

Urea Application	Annual amount of urea application	Fertilizer imports / Exports coupled with expert judgement	EJ
N_2O From Managed Soils (Direct)	Annual organic and chemical fertilizer application (Tonnes) and N fraction in fertilizer	Fertilizer imports / Exports coupled with expert judgement	EJ
Biomass Burning	Area burnt, fuel available for burning and EF burning by land strata	Burnt area estimated based on NASA data on burnt area, active fire also provides clues	DM
N_2O from (Indirect) Manure	Annual nitrogen excretion and fraction of N that volatilizes	Expert judgement /IPCC default values	EJ
N_2O From Managed Soils (Indirect)	Annual organic and chemical fertilizer application (Tonnes) and fraction that volatilizes	Fertilizer imports / Exports coupled with expert judgement	J
LAND			
Mapping of Land Remaining land and land conversion	Area of land category and area of converted land	Based on periodic satellite image interpretation and analysis, Wood extraction statistics	M
Wood supply	Biomass Stock by land category	Based on Forest inventory by NFA	M
Wood demand (extraction)	Wood extraction by land category	Estimated from Household surveys and special studies	EO
CH_4 Rice Cultivation	Annual rice area cultivated or harvested by flood management and agricultural inputs	FAOSTAT -harvested area	DM

2.1.2.2 Methods and Emission Factors

Mainly due to data limitations, Tier 1 has been widely used in the estimation of CO_2, CH_4 and N_2O (Table 2.6) for the non- AFOLU sectors. Where applicable, European Monitoring and Evaluation Program/ European Environment Agency (EMEP/EEA) and Air Pollutant Emission Inventory guidebook are used especially in the compilation of estimates of non-methane volatile organic compounds (NMVOC) sulphur dioxide (SO_2), carbon monoxide and nitrogen oxides (NO_x). The selection of methods and emission factors is as shown in Table 2.6**.**

Table 2.6: Methods and Emission Factors for Energy, IPPU and Waste

GHG sources and Sinks Categories	CO_2		CH_4		N_2O		HFCs	
	Methods applied	Emission Factor	Methods applied	Emission Factor	Methods applied	Emission Factor	Methods applied	Emission Factor
1 - Energy	D, T1	D	D, T1	D	D, T1	D		
1.A - Fuel Combustion Activities	D, T1	D	D, T1	D	D, T1	D		
1.A.1 - Energy Industries	D, T1	D	D, T1	D	D, T1	D		

1.A.2 - Manufacturing Industries and Construction	D, T1	D	D, T1	D	D, T1	D		
1.A.3 - Transport	D, T1	D	D, T1	D	D, T1	D		
1.A.4 - Other Sectors	T1	D	T1	D	T1	D		
2 - Industrial Processes and Product Use	T1	D	T1	D	T1	D	NO	NO
2.A - Mineral Industry	D	D	NE	NE	NE	NE	NO	NO
2.B - Chemical Industry	NE	NE	NE	NE	NE	NE	NO	NO
2.C - Metal Industry	NE	NE	NE	NE	NE	NE	NO	NO
2.D - Non-Energy Products from Fuels and Solvent Use	D, T1	D	D, T1	D	D, T1	D		
2.D.1 - Lubricant Use	T1	D	T1	D	T1	D		
4 - Waste	D	D	D	D	D	D		
4.A - Solid Waste Disposal	T1	D	T1	D	T1	D	NO	NO
4.B - Biological Treatment of Solid Waste	T1	D	T1	D	T1	D	NO	NO
4.C - Incineration and Open Burning of Waste	T1	D	T1	D	T1	D	NO	NO
4.D - Wastewater Treatment and Discharge	T1	D	T1	D	T1	D	NO	NO
MEMO ITEM								
1.A.3.a.i - International Aviation (International Bunkers)	T1	D	T1	D	T1	D	NO	NO

Legend: T1= Tier 1, T2= Tier 2, D= Default IPCC methodology and emission factor, EFs =emission factor specifically developed, NO= Not Occurring, NE= Not estimated

Tier 1 approach is used for the estimation of emissions from livestock, aggregate sources and non-CO_2 emissions. A mixture of Tier1 and Tier2 levels are used for the estimation of emissions from land use. Explicit disaggregated spatial data was used for the estimation of land area and land conversions. (Table 2.7).

Table 2.7: Methods and Emission Factors for AFOLU

GHG sources and Sinks Categories	CO_2		CH_4		N_2O		N_xO		CO	
	Methods applied	Emission Factor	Methods applied	Emission Factor	Methods applied	Emission Factor	Methods applied	Emission Factor	Methods applied	Emission Factor
Livestock										
Enteric Fermentation			D, T1	D						
Manure Management			D, T1	D	D, T1	D				
Land remaining the same	D, T1& T2	D & EFs								
Aggregate sources and non-CO_2										
Emissions from biomass burning			D, T1	D	D, T1	D	D, T1	D	D, T1	D
Liming, Urea application										
N_2O Emissions from soils and manure management					D, T1	D				
Rice cultivation			D, T1	D						

Legend: T1= Tier 1, T2= Tier 2, D= Default IPCC methodology and emission factor, EFs =emission factor specifically developed, NO= Not Occurring, NE= Not estimated

2.1.2.3 Data Sources

MDAs responsible to the energy sector include; National Energy Balance, Statistical Abstracts, Energy and Mineral Statistics by Ministry of Energy and Mineral Development (MEMD), Uganda National Bureau of Statistics (UBOS), Ministry of Finance Planning and Economic Development (MoPFED), Uganda Revenue Authority (URA), Uganda Electricity Regulatory Authority (ERA) Kampala Capital City Authority (KCCA), Ministry of Trade Industry and Cooperatives (MTIC), National Forestry Authority (NFA) under Ministry of Water and Environment (MWE), Ministry of Works and Transport (MOWT).

Data for the IPPU sector is mainly obtained from the Ministry of Trade, Industry and cooperative (MTIC), Uganda Revenue Authority (URA) and Uganda Bureau of Statistics (UBOS).

The AFOLU sector is supported by MDAs in the agriculture sector, environment sector, statistical bodies as well as research and academic institutions. Key data providers from the agriculture sector include; Ministry of Animal Industry and Fisheries (MAAIF), National Agriculture Research Organization (NARO) and UBOS, Uganda Revenue Authority (URA) provides data on fertilizer import and exports. Data on land use and carbon stock changes in mainly provided by the National Forestry Authority. Uganda National Meteorological Authority (UNMA) provides climatic data while UBOS, MEMD and NFA provide data on biomass and other forest product use and consumption.

Waste disposal is mainly a problem in urban settings because of the high population density. Kampala Capital City alone accounts for about 50%. Key institutions that provide data used to estimated emissions in the waste sector include Kampala City Council Authority (KCCA), National Water and Sewerage Corporation (NWSC), Uganda Bureau of Statistics (UBOS). Ministry of Local Government (MOLG) and Municipal authorities provide data on waste general and disposal in urban centres other than Kampala. Ministry of Agriculture provides data on manure / waste generation and management in the agricultural sector. Ministry of Health and UBOS provide data on clinical waste generation and disposal (mainly through incineration). Climatic data, mainly temperature regimes is provided by the Uganda National Meteorological Authority (UNMA).

2.2 GHG Emissions by Sources and Removals by Sinks

2.2.1 Overview of the 1995 – 2017 NGHGI

Uganda's total aggregate emissions reached 94,650 Gigagrams (Gg) Carbon dioxide equivalent (CO_2e) in 2017 (2.2). This is about triple the 1995 emissions which were estimated at 33,330 Gg CO_2e. The AFOLU sector remained the main source of emissions accounting for 84.4% and 83.7% in 1995 and 2017 respectively.

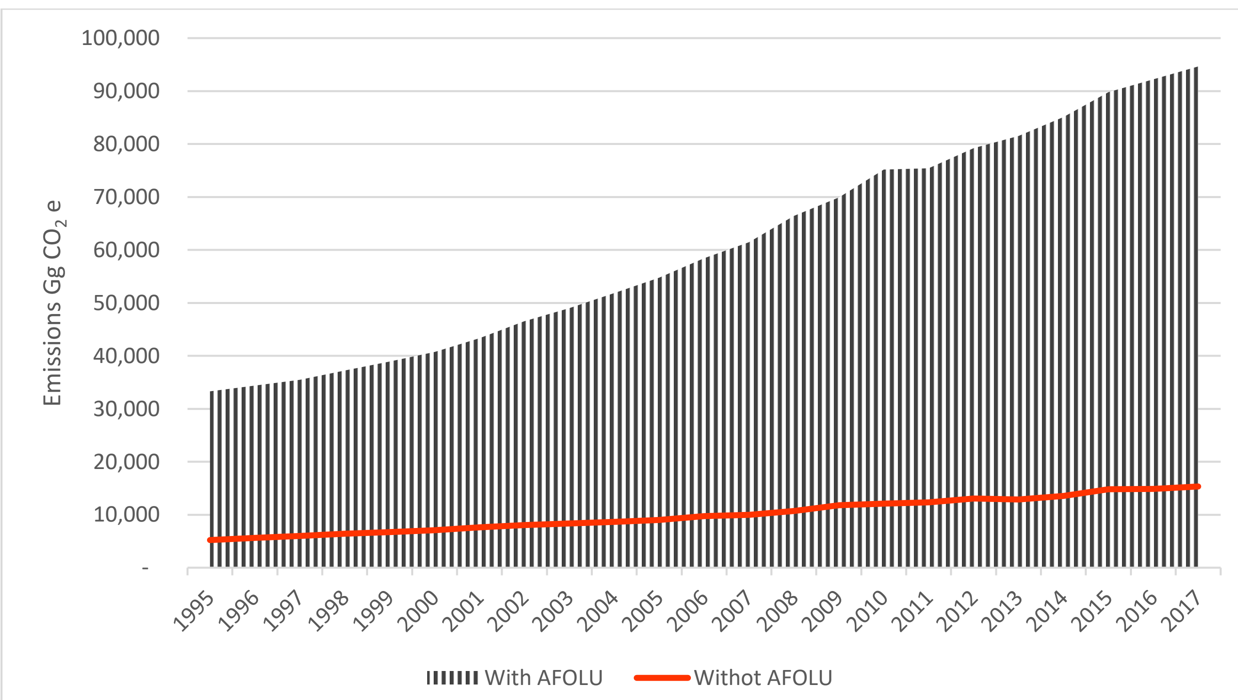

Figure 2.2: National Emission Trends with and without AFOLU

From 1995 to 2017, there was an increase in emissions in all sectors (**Table 2.8**). Over this period, emissions from the energy sector increased by a factor of 3.2. Emissions from IPPU and waste sector almost tripled increasing by a factor of 2.9 and 2.7, respectively. Emissions from Energy Industries, Manufacturing Industries and Construction and transport subsectors increased by a factor 7.8, 8 and 5.4, respectively. Factors influencing increase across sectors include population growth, growth in industrial development and sector wide economic growth.

Table 2.8: Total Greenhouse gases CO_2e by sector

Sectors and sub sectors	1995	2000	2005	2010	2015	2017	Percent change	Change Factor
1. All Energy	**2481**	**3130**	**3969**	**5848**	**7805**	**7961**	221%	3.2
Energy Industries	55	77	126	507	506	425	676%	7.8
Manufacturing Industries and Construction	177	182	379	468	1218	1057	498%	6.0
Other (Residential, Commercial, Institution)	1648	2038	2484	3024	3377	3311	101%	2.0
Transport	602	834	979	1849	2703	3168	447%	5.3
2. Industrial Processes and Product use (IPPU)	**120**	**145**	**203**	**274**	**356**	**349.7**	191%	2.9
Cement production	98	112	158	258	349	343.4	250%	3.5
Lime production	22.0	33.6	44.5	15.4	6.2	6.3	-71%	0.3
Lubricant Use	0.001	0.001	0.003	0.005	0.009	0.012	1083%	11.8
3. AFOLU	28,114	33,666	45,724	63,097	75,003	79,317	182%	2.8
Livestock	6085	6736	8196	10942	12310	12869	111%	2.1
Land	15022	19683	29650	43432	53061	56470	276%	3.8
Aggregate sources and non-CO2 emissions sources on land	7051	7314	7914	8759	9670	10019	42%	1.4
4. Waste	**2615**	**3810**	**4872**	**5961**	**6628**	**7022**	169%	2.7

2.2.2 GHG, Precursors and Other Gases

As guided by Conference of Party (COP) Decision 17/CP.8 all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors are presented in **Table 2.9**. Standard notation keys as per Decision 17. CP. 8 are used and explanation provided below the table.

Table 2.9: Greenhouse gases and precursors

Categories	Net CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2
Total National Emissions and Removals	61531.62162	1051.585	35.597	70.996	2292.07	2749.095	6.91
1 - Energy	4743.440136	123.3623	2.0227	50.067	1821.844	2747.329	6.91
1.A - Fuel Combustion Activities	4743.440136	123.3623	2.0227	50.067	1821.844	2747.329	6.91

1.B - Fugitive emissions from fuels	NA	NA	NA	NA	NA	NA	NA
1.C - Carbon dioxide Transport and Storage	NA			NA	NA	NA	NA
2 - Industrial Processes and Product Use	349.77776	0	0	0	0	1.766	0
2.A - Mineral Industry	349.76526	NE	NE	NE	NE	NE	NE
2.B - Chemical Industry	0	NE	NE	NE	NE	NE	NE
2.C - Metal Industry	0	NE	NE	NE	NE	NE	NE
2.D - Non-Energy Products from Fuels and Solvent Use	0.012496	NE	NE	NE	NE	NE	NE
2.E - Electronics Industry	NE	NE	NE	NE	NE	NE	NE
2.F - Product Uses as Substitutes for Ozone Depleting Substances				NE	NE	NE	NE
2.G - Other Product Manufacture and Use	NE	NE	NE	NE	NE	NE	NE
2.H - Other	NE	NE	NE	NE	NE	1.766	NE
3 - Agriculture, Forestry, and Other Land Use	56429.513	638.81228	30.557529	20.92963	470.22555	0	0
3.A - Livestock		600.58576	0.8279523	NA	NA	NA	NA
3.B - Land	56469.958		NE	NE	NA	NA	NA
3.C - Aggregate sources and non-CO2 emissions sources on land	5.06	38.226517	29.729577	20.92963	470.22555	NE	NE
3.D - Other	-45.505466	NE	NE	NE	NE	NE	NE
4 - Waste	8.8907022	289.41067	3.0166661	0	0	0	0
4.A - Solid Waste Disposal		200.38476		NE	NA	NA	NA
4.B - Biological Treatment of Solid Waste		21.26922	1.2761532	NE	NA	NA	NA
4.C - Incineration and Open Burning of Waste	8.8907022	0.4823518	0.0070708	NE	NE	NE	NE
4.D - Wastewater Treatment and Discharge		67.274337	1.7334422	NE	NA	NA	NA
4.E - Other (please specify)	NE	NE	NE	NE	NE	NE	NE
5 - Other	0	0	0	0	0	0	0
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3			NE	NE	NA	NA	NA
5.B - Other (please specify)	NE	NE	NE	NE	NE	NE	NE
Memo Items (5)							
International Bunkers	321.2066	0.0022462	0.0089848	0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers)	321.2066	0.0022462	0.0089848	NE	NE	NE	NE

1.A.3.d.i - International water-borne navigation (International bunkers)	NA	NA	NA	NA	NA	NA	NA
1.A.5.c - Multilateral Operations	0	0	0	0	0	0	0

*Notation Keys; **NO** (not occurring) **NE** (not estimated), **NA** (not applicable), **IE** (included elsewhere) **C** (confidential)

Given the information gap on F-gases discussed under Section 2.12, only HFC-134a (CH_2FCF_3) from refrigeration and fire protection is reported on (**Table 2.10**).

Table 2.10: Anthropogenic emissions of HFCs, PFCs and SF6

Green House gasess Categories	HFCs		PFCs	SF6
	HFC-134	HFC-23	PFCs	SF6
Total National Emissions and Removals	86.544518		0	0
1 - Energy	0		0	0
1.A - Fuel Combustion Activities				
1.B - Fugitive emissions from fuels				
1.C - Carbon dioxide Transport and Storage				
2 - Industrial Processes and Product Use	86.544518		0	0
2.A - Mineral Industry				
2.B - Chemical Industry	NE		NE	NE
2.C - Metal Industry	NE		NE	NE
2.D - Non-Energy Products from Fuels and Solvent Use				
2.E - Electronics Industry	NE		NE	NE
2.F - Product Uses as Substitutes for Ozone Depleting Substances	86.544518		NE	
2.G - Other Product Manufacture and Use	NE		NE	NE
2.H - Other				
3 - Agriculture, Forestry, and Other Land Use	0		0	0
3.A - Livestock				
3.B - Land				
3.C - Aggregate sources and non-CO2 emissions sources on land				
3.D - Other				
4 - Waste	0		0	0
4.A - Solid Waste Disposal				
4.B - Biological Treatment of Solid Waste				
4.C - Incineration and Open Burning of Waste				
4.D - Wastewater Treatment and Discharge				

4.E - Other (please specify)				
5 - Other	0		0	0
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3				
5.B - Other (please specify)	NE		NE	NE
Memo Items (5)				
International Bunkers	0		0	0
1.A.3.a.i - International Aviation (International Bunkers)				
1.A.3.d.i - International water-borne navigation (International bunkers)				
1.A.5.c - Multilateral Operations	0		0	0

Uganda's aggregate GHG emissions are predominantly CO_2 estimated at 61,532 Gg followed by CH_4 at 1,046 Gg and N_2O at 35 Gg (**Figure 2.3:**). Among the fluorinated gases was HFC at 87 Gg. Among the precursor gases were CO, NO2, NMVOC and SO_2 estimated at 2,292 Gg, 2,749 Gg and 7 Gg, respectively.

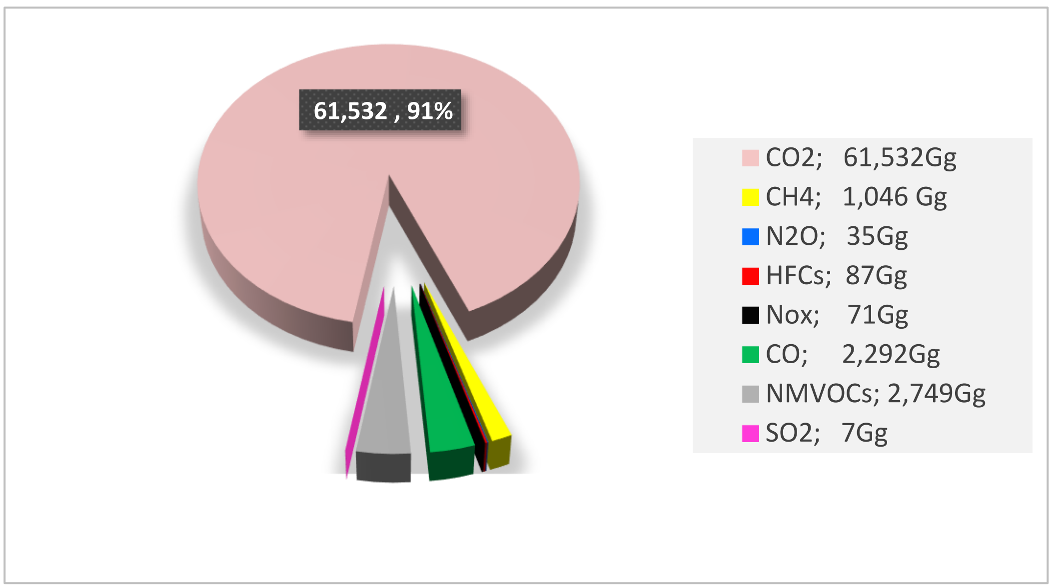

Figure 2.3: GHG and indirect Gases by quantity, 2017

2.2.2.1 Greenhouse Gases

In 2017, the AFOLU sector was the major source of CO_2, CH_4 and N_2O (Table 2.11). CO_2 emissions from AFOLU were estimated at 56,430 Gg or 92% of total CO_2 emissions. This was mainly from deforestation and forest degradation.

Table 2.11: Greenhouse Gases 2017 by sector

Sector	GHG Gases					
	CO_2	Percent	CH_4	Percent	N_2O	Percent
Energy	4,743	8%	123	12%	2	6%
IPPU	350	1%	0	0%	0	0%
AFOLU	56,430	92%	633	61%	30	86%
Waste	9	0%	289	28%	3	9%
	61,532	100%	1,052	100%	36	100%

The energy is the second major source of CO_2 estimated at 4,743 Gg. Most this is from fuel combustion by the road transport sub sector.

The livestock subsector and rice paddy cultivation are major sources of CH_4 accounting for almost 62% of total CH_4 emissions. The waste sector is the second most important source of CH_4 and is mainly from solid waste disposal in the urban areas.

About 86% of N_2O is from AFOLU mainly from direct and indirect emissions in managed soils. The waste sector and energy sector are estimated contribute 9% and 6% of N_2O respectively mainly from waste water treatment and discharge and biological treatment of solid waste. In the energy sector N_2O emissions are from use of Kerosene and diesel oil and LPG in the commercial / institutions and residential sub sectors.

2.2.2.2 Indirect Greenhouse Gases

Gases like CO, NO_X and NMVOC influence the chemical reactions that occur in the troposphere and thus play an indirect role in increasing the radiative effect. The majority of CO and NO_x emissions result from imperfect combustion of fuels in commercial / institutions and residential sub sectors and to some extent in the Energy Sector. The energy sector is the major source of NMVOC and SO_2. In 2017, the energy sector emitted 50 Gg of NO_X and 1,822 Gg of CO which is 71% and 79%, respectively. The AFOLU sector emitted 29% of NO_X and 21% of CO mainly from biomass burning Table 2.12)

Table 2.12: Indirect gases; 2017

Sector	Indirect Gases							
	NO_x	Percent	CO	Percent	NMVOCs	Percent	SO_2	Percent
Energy	50	71%	1,822	79%	2,747	100%	7	100%
IPPU	0	0%	0	0%	2	0	0	0%
AFOLU	21	29%	470	21%	0	0	0	0%
Waste	0	0%	0	0%	0	0	0	0%
Total	71	100%	2292	100%	2,749	100%	7	100%

The only fluorinated gases covered are Hydrofluorocarbons (HFCs), mainly in the air-conditioning, refrigeration and fire subsector, with total fugitive emissions estimated at 86.5 Gg in 2017.

2.2.3 GHG Trends and Time Series

GHG have continued rise from 1995 to 2017 with CO_2 rising at a higher rate than the other GHGs (**Figure 2.4**). CH_4 and N_2O are estimated to have steadily increased from 1995 up to 2012 and thereafter have been fluctuating at around 21,400 Gg and 11,600 Gg of CO2eq respectively. The pattern in CH_4 emissions is partly explained by switching from high dependency on diesel for electricity production to more Hydro Electric sources since 2012. Temporary reduction in fire emissions in the year 2017 has also had an influence on N_2O and CH_4 emissions.

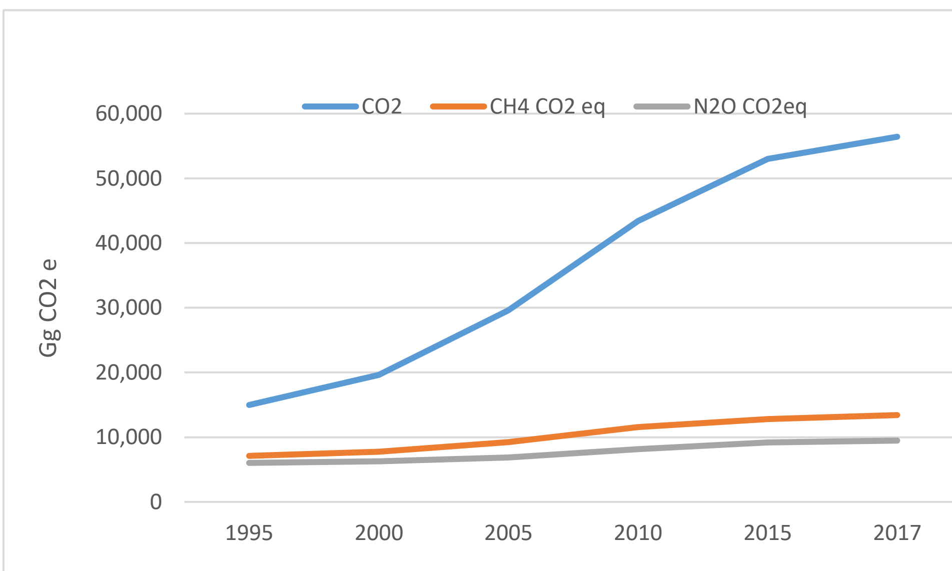

Figure 2.4: Emission trends by gas

2.3 Energy Sector

2.3.1 Energy Sector

The computation of emissions from the energy sector is based on two approaches. The first approach is the reference approach (or top-down approach), which is derived from fuel imports versus exports, while the second is based on the sectoral approach, the amount fuel consumed per activity as shown in the activity data.

2.3.2.1 The Emissions from the Reference Approach

The method used in reference approach is based on the primary fuels supply and distribution. Currently, Uganda imports all petroleum products. The reference approach shows that total emissions have been increasing since 1995. Emission from imported fuels, increased from 968.4 Gg in 1995 to 5,065 Gg in 2017. This is mainly attributable to increased mobility mostly in the transport sector, as well as use of generators that supply power to the grid and increased use of thermal energy industries.

2.3.1.2 Comparison with the sectoral Approach

Both the reference approach and the sectoral approach show that CO_2 emissions have been increasing by a factor of five (5) since 1995. Sectoral approach shows slightly different results from the reference approach (**Figure 2.5**).

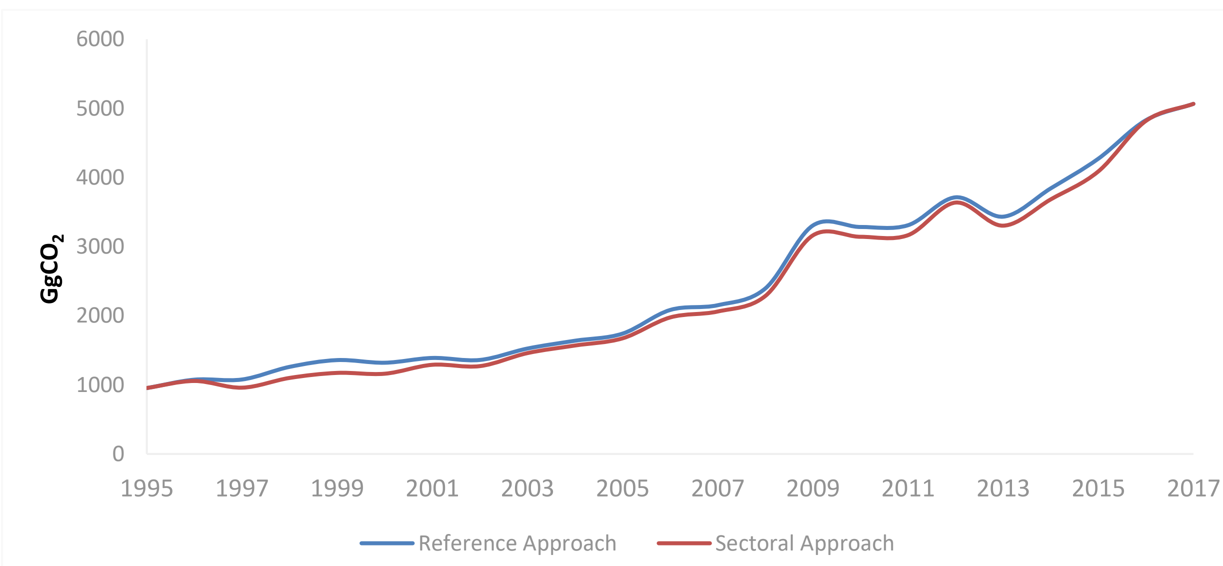

Figure 2.5: The emissions from reference and sectoral approach 1995-2017.

Using the sectoral approach CO_2 emissions in the energy sector in 2017 were estimated at 4,836 Gg. Based on the reference approach CO_2 emissions in energy sector for the same year are estimated at 5,087 Gg CO_2. The difference between these two approaches is about 5%. (Table 2.13).

Table 2.13: Comparison of the reference approach to sectoral approach 2017. Data source; National Energy Balance

Fuel	Reference Approach				Sectoral Approach		Difference	
Fuel Types	Apparent Consumption (TJ)	Excluded consumption (TJ)	Apparent Consumption (excluding non-energy use and feedstock) (TJ)	CO_2 Emissions (Gg)	Energy Consumption (TJ)	CO_2 Emissions (Gg)	Energy Consumption (%)	CO_2 Emissions (%)
Liquid fuels	69548.0	0.0	69548.0	4995.7	66068.1	4744.9	5.26	5.28
Solid Fuels	966.7	0.0	966.7	91.4	966.7	91.4		
Total	**70514.7**	**0.0**	**70514.7**	**5,087.1**	**67034.8**	**4,836.4**	**5.19**	**5.18**

2.3.2 The Sectoral Approach

This approach involves looking at the actual consumption of the specific subcategory. It is also referred to as bottom-up approach. In addition to the sub sectors there is information on International Aviation (International Bunkers) and CO_2 from biomass combustion under memo items.

Total CO_2 emissions in the energy sector in 2017 were estimated at 4,743 Gg CO_2 with the transport sector as the largest source contributing 3,104 Gg or 65% of total CO_2. The manufacturing industries and construction were the second most important sources of CO_2 estimated at 928 Gg or 20% of CO_2. Other sectors (i.e Commercial / Institutions and Residential) were the most important sources of CH_4 emissions contributing 2,297 Gg CO_2e or 89% of CH_4 in the energy sector. The sector was also an important source N_2O estimated at 425 Gg or 68% of total N_2O emissions (Table 2.14).

Table 2.14: Emissions of GHGs and Precusors by Energy Subcategory, 2017

	Emission Gg CO_2 Eq				Emissions Gg			
Gases	CO_2	CH_4	N_2O	HFCs	NO_x	CO	NMVOCs	SO_2
Total Energy Sector	4,743	2,591	627	0	50	1,822	2,747	7
Energy Industries	123	233	69	0	1	398	94	1
Manufacturing Industries and Construction	928	43	86	0	12	40	21	2
Transport	3,104	17	47	0	17	76	2,433	0
Other Sectors *	589	2,297	425	0	21	1,308	200	4

*Commercial / Institutions, Residential, Agriculture /Forest/Fishing

From 1995 to 2008, CH_4 was the most significant gas in the energy sector (**Figure 2.6**). From 2008 onwards, CO_2 emissions become the most significant rising from 2326 Gg to 4836 Gg in 2017 under the sectoral approach. From 1995 to 2009, N_2O emissions almost doubled from 282 Gg CO_2e to 539 Gg CO_2e.

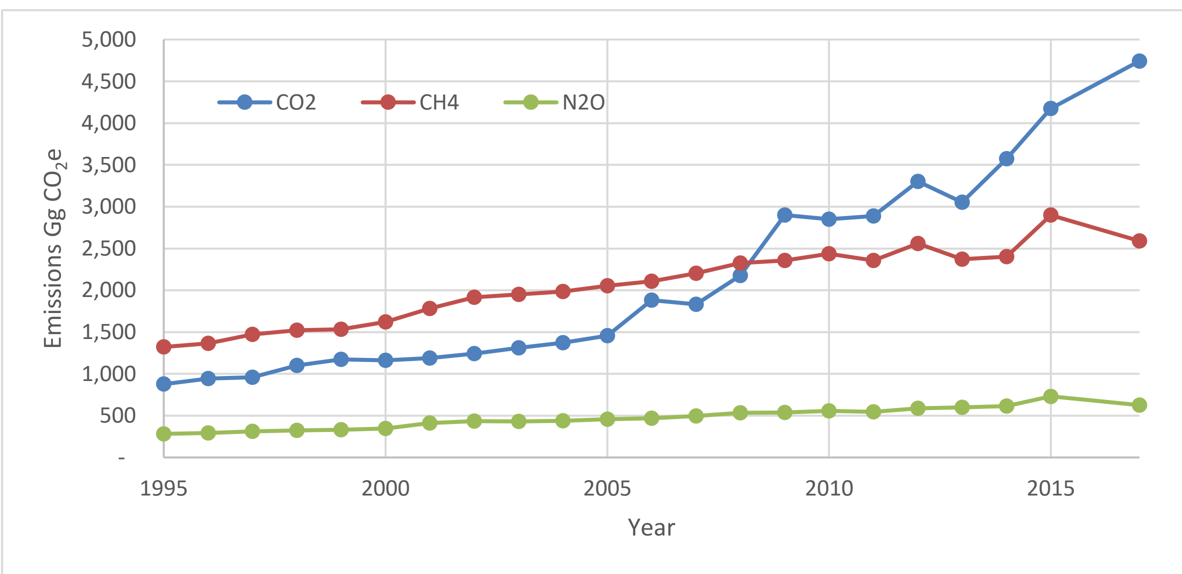

Figure 2.6: The trends of emissions of CO_2, CH_4 and N_2O in the energy sector

2.3.2.1 The Precursor Gases

The energy sector is the major source of precursor gases. The gases that fall in this category are NO_x, CO, NWVOC, and SO_2. Biomass combustion is the main source of precursor gases. The emission of CO increased from 838 Gg in 1995 to 1,821 Gg in 2017. NMVOC emissions increased by a factor of 20 from 141.4 Gg in 1995 to 2,747 Gg in 2017. NO_x increased from 17 Gg in 1995 to 60 Gg in 2017. SO_2 emissions in the energy sector more than doubled, increasing from 2.8 Gg in 1995 to 6.9 Gg in 2017 (Table 2.15).

Table 2.15: The trends of emissions of precursor gases (Gg).

Year	1995	2000	2005	2010	2015	2017
NO_X	17.2	20.2	29.2	38.6	93.4	50.1
CO	838.1	983.3	1270.0	1451.6	2172.9	1821.8
NMOVC	141.4	168.2	223.9	260.7	404.0	2747.3
SO_2	2.8	3.1	4.4	5.8	42.2	6.9

2.3.2.2 Trends of Emissions of main greenhouse gases in Energy Sector

From 1995 to 2017, GHG emissions rose in the energy sub sectors with the o rise all sectors. The general trend of distribution energy category energy industries, manufacturing and construction, transport and others. The trend emissions in energy sector are as shown in **Figure 2.7**.

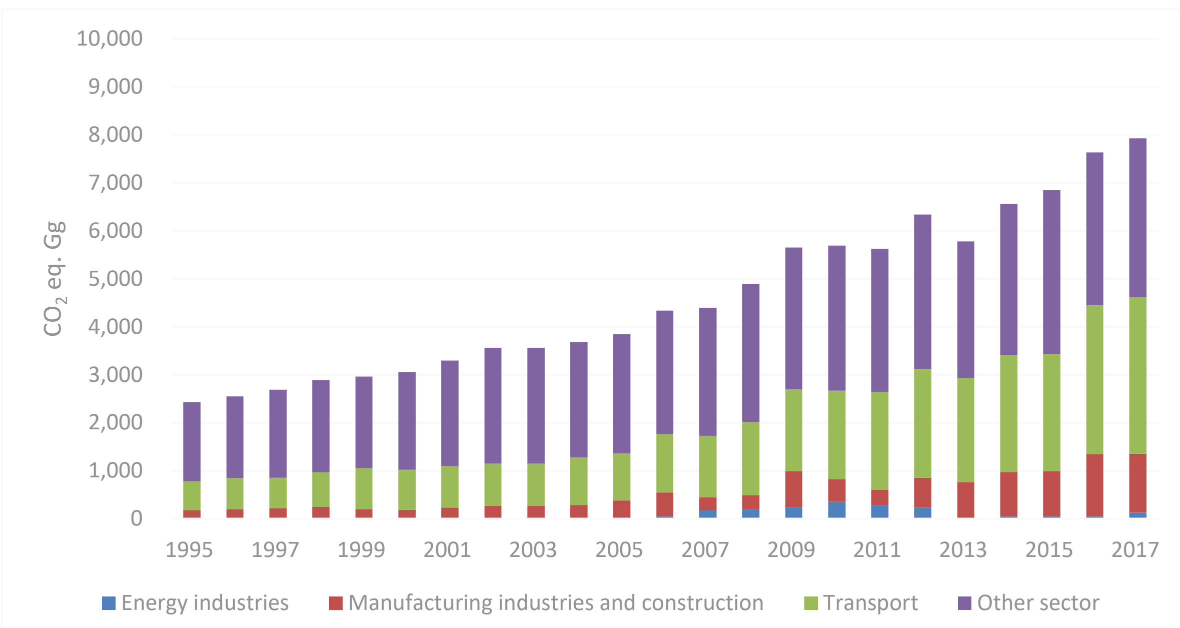

Figure 2.7: The overall emissions from the energy sector 1995 to 2017

2.3.2.3 *Activity data for energy industries*

Electricity generation and charcoal production are the two most significant categories under the energy industries. The main source of electricity in Uganda is hydropower that is supplemented by diesel generators to meet short falls.

Use of diesel generators gained prominence around 2005 when the water level of Lake Victoria dropped by more than one meter and resulted in reduced power generation by the hydropower plants located along the River Nile. To keep electricity generation from the river Nile low, heavy sulphur diesel driven generators were used. Use of diesel generators reached the peak of 3,748 TJ in 2011. In 2013, new hydropower plants were commissioned and the consumption of diesel fuel reduced to 9TJ (Table 2.16).

Charcoal is thermal energy for cooking in the urban areas of Uganda. Charcoal production is estimated to have risen from 9,824 TJ to 55,440 TJ from 1995 to 2017 (Table 2.16).

Table 2.16: The activity data for Energy Industries (TJ)

Category and fuel	1995	1997	1999	2001	2003	2005	2007	2009	2011	2013	2015	2017
Electricity Generation (Diesel/Heavy Sulphur)	11.18	12.19	13.21	14.22	15.24	1,430	2,311.6	1,988.7	3,748.5	9	682	1,656.9
Manufacture of Solid Fuels (Charcoal production)	9824.5	10720.5	13910.1	18963.3	21943.1	23067.4	25315.9	27648.2	28787.0	35825	82760	55440

2.3.2.4 *Emissions from the Energy industries*

Emissions are estimated as a product of fuel energy consumption (TJ) and the emission factor of the fuel for a particular gas as shown in the equation below;

Equation 2-1. Computation of emissions based on energy use

*GHG emission 10-6 (Gg) = fuel consumption (TJ) * Emission Factor (kg/TJ)*

Emission factors by gas for diesel, heavy fuel oil and wood for charcoal production presented shown in Table 2.17.

Table 2.17: The emission factors by gas and fuel type

Fuel	CO_2 (kg/TJ)	CH_4 (kg/TJ	N_2O (kg/TJ	NOx	CO	NMOVC	SO_2 g/GJ
Diesel	74100	3	0.6	65 g/GJ	16.2 g/GJ	0.8g/GJ	46.5
Heavy fuel oil	77400	3	0.6	142 g/GJ	15.1g/GJ	2.3g/GJ	495
charcoal	112000	200	4	10 kg/TJ	7000 kg/TJ	1700 kg/TJ	NAV

Charcoal production is the most significant source of emissions under the energy industries. Charcoal production in Uganda is from low efficiency earth kilns. The CO_2 emission from charcoal production by pyrolysis of wood is reported under AFOLU, while emission of CH_4 and N_2O is reported under manufacture of solid fuel. CH_4 and N_2O mission from charcoal production increased from 53.45 Gg CO2 eq in 1995 to 301.5 Gg CO2 eq in 2017. The high emissions in charcoal production are attributable to use of inefficient charcoal kilns that release relatively high levels of CH_4.

Given the Uganda largely relies on hydropower, emissions from electric thermal power plants are relatively low. Emissions from thermal power plants reached a peak of 350 Gg CO_2e in 2010. In subsequent years it declined reaching a record low of 1.3 Gg CO2 eq in 2013 before rising again to 123.5 Gg of CO_2 eq in 2017. The rise and fall of emissions from diesel power plants corresponds to the share of contribution in electricity in electricity power production.

Over all emissions from the energy industries increased from 54.4 Gg CO_2 eq in 1995 to 425.2 Gg CO_2 eq in 2017 (Table 2.18).

Table 2.18: The trend of emissions in the energy industries 1995-2017

Year	1995	1997	1999	2001	2003	2005	2007	2009	2011	2013	2015	2017
CO2 Gg	0.828	0.903	0.979	1.054	1.054	0.903	171.29	235.99	277.8	0.697	42.96	122.8
CH4 Gg	1.965	2.144	2.782	3.206	3.206	4.614	5.070	5.539	5.769	7.165	16.55	11.09
N2O Gg	0.040	0.044	0.057	0.065	0.065	0.094	0.103	0.112	0.117	0.145	0.333	0.224
CO2 eq	54.44	59.48	76.92	88.53	88.59	126.8	309.6	387.1	435.7	196.2	493.9	425.1

2.3.2.5 *Manufacturing Industries and Construction*

The energy consumption in this sector is not disaggregated because of the low level of industrialization in Uganda. All data is captured under Non-specified Industry. The fuel used in this sector is wood, agricultural wastes, diesel, LPG, HFO, Anthracite Coal, Coking Coal and

OtherBituminous Coal. Some data on LPG, HFO and coal imports is reported in the national energy balance but is not consistent. Data for 2017 is not captured (Table 2.19).

Diesel is used in generators for electricity production for facilities and towns that are not connected to national grid. HFO is used in the boilers to generate steam and hot water. LPG is used for thermal applications. Wood fuel and agricultural wastes are used for thermal energy in industries such as tea and sugar factories. Coal is sometimes used in the cement industries for thermal applications.

Most the energy used in this sector is biomass typically for thermal applications. The consumption of wood increased fivefold from 13,409 TJ in 1995 to 67,200 TJ in 2017. This corresponds to growth in the tea and sugar industries.

LPG consumption increased by over a factor of seventeen from 5.3 TJ to 94.6 TJ between 1995 and 2015. Imports of anthracite, bituminous and coking coal have increased with increasing number of cement industries (Table 2.19). Diesel consumption in the manufacturing and construction sectors increased almost nine-fold from 966 TJ in 1995 to 8,624 TJ in 2017.

Table 2.19: Activity Data for Manufacturing Industries and Construction for 1995-2017 (TJ).

Year	1995	2000	2005	2010	2015	2017
Anthracite Coal	0	0	0	0	0	0
Other Bituminous Coal	0	0	0	0		0.7
Coking Coal	0	0	0	0	895.5	966
Diesel	966	643	1,051	2,076.6	9,136	8,624
Wood	13,409	16,084	34,293	46,743	102,550	67,200
LPG	5.3	14.2	22.52	39.3	94.6	No data
HFO	1037	1323	1678	2875	1125	No data

2.3.2.6 The emission in Manufacturing Industries and Construction

Emissions are estimated as a product of fuel energy consumption (TJ) and the emission factor of the fuel for a particular gas and Equation 2-1 applies. The emission factors used are presented shown in **Table 2.20**.

Table 2.20: The emission factors of the fuel used in the Manufacturing Industries and Construction sector

Fuel type	CO_2 (kg/TJ)	CH_4 kg/TJ	N_2O kg/TJ	NO_x g/GJ	CO g/GJ	NMOVC g/GJ	SO_2g/GJ
Anthracite Coal	98,300	1	I.5	173	931	88.8	900
Other Bituminous Coal	94,600	1	I.5	173	931	88.8	900
Coking Coal	94,600	1	I.5	173	931	88.8	900
Diesel	74,100	3	0.6	315	66	25	27
Wood	112,000	30	4	91	570	300	11
LPG	63,100	1	0.1	74	29	23	0.76
HFO	77,400	3	0.6	315	66	25	27

Emissions in the manufacturing industries and construction almost sevenfold from 176.9 Gg CO_2 eq in 1995 to 1,231 Gg CO_2 eq in 2017. CO_2 is the primary greenhouse gas in sector.

Table 2.21: The emissions from the Manufacturing Industries and Construction.

GHG	**1995**	**1997**	**1999**	**2001**	**2003**	**2005**	**2007**	**2009**	**2011**	**2013**	**2015**	**2017**
CO_2 Gg	150.7	185.6	170.5	148.2	185.9	314.3	198.5	663.3	244.4	578.7	578.7	1101.8
CH_4 Gg	0.42	0.46	0.47	1.31	1.31	1.04	1.18	1.36	1.50	2.82	2.82	2.06
N_2O Gg	0.06	0.06	0.06	0.18	0.18	0.14	0.16	0.18	0.16	0.38	0.38	0.28
Total Emission CO_2 eq	**176.9**	**214.6**	**199.7**	**230.2**	**267.9**	**379.4**	**272.2**	**748.6**	**324.1**	**754.7**	**754.7**	**1231.0**

2.3.2.7 Transport

Transport category largely involves movement of goods, services and general mobility. Transport plays a major role in economic activities as it aids and facilitates growth and development in all other sectors of the economy. Road transport is the most dominant means at national level while railways and marines are under developed.

Plans for pipeline transportation are in advanced stage and will be implemented to the transport crude oil from the western Uganda to the coast through the Republic of Tanzania. There are also plans to improve water borne navigation in Lake Victoria, to facilitate regional water borne navigation.

From 1995 to 2017, energy consumption in the transport sector increased by a factor of five from a total 8,325 TJ to 43,360 TJ. Nearly all vehicles in Uganda are categorized as being without 3-way catalysts. Fuel energy of passenger vehicles using petrol increased from 4,237 TJ in 1995 to 15,958

TJ in 2017. The increase in the consumption of petrol and diesel by small vehicles was by a factor 3.8 and 6.6 respectively. However, the share in total fuel energy consumed reduced from slightly over 50% in 1995 to 37% in 2017.

The most popular public transport used for short distance travel are minibus with capacity of about 14 passengers. This mode of transport falls under the light commercial vehicle (petrol and diesel) category. Light commercial petrol and light commercial diesel respectively consumed 794 TJ and 748 TJ in1995 while in 2017 they consumed 4,560 TJ and 5,141TJ respectively (Table 2.22). Petrol and diesel fuel energy consumption in the category increased by a factor of 5.7 and 6.9 respectively. The share to total fuel energy consumed was in the range of 18% to 22%.

Long distance travel buses with capacity of about 64 passengers and long distance (heavy-duty) freight lorries belong to the heavy-duty truck (diesel) category. Fuel consumption of this category increased almost sevenfold from 1,496 TJ in 1995 10,281 TJ in 2017 (Table 2.22) with a corresponding increase in fuel share from 18% to 24%.

Fuel consumed by motorcycles increased by a factor of 8.6 from 265 TJ in 1995 to 2,280 TJ in 2017 (Table 2.22**)** thus increasing their share of fuel consumption from 3% to 5% of the same period.

Table 2.22: Activity data for transport sector (TJ)

Transport - fuel	1995	2000	2005	2010	2015	2017
Passenger Cars (Petrol)	4,237	4,934	4,512	7,543	13,108	15,958
Passenger Cars (Diesel)	784	1,313	1,917	3,765	4,265	5,141
Light Commercial Vehicle Petrol	794	925	846	2,011	3,745	4,560
Light Commercial Vehicle Diesel	748	1,313	1,917	3,765	4,265	5,141
Heavy Duty Trucks Diesel	1,496	2,625	3,835	7,530	8,530	10,281
L-Category motorcycles Petrol	265	308	282	503	1,873	2,280
Total	8,325	11,419	13,310	25,116	35,786	43,360

2.3.2.8 The emissions in transport sector.

There are three main types of fuel used in the transport sector, namely diesel, petrol and aviation kerosene. The use of aviation gasoline is limited to the small capacity planes. Data on consumption of aviation gasoline is not available and thus emissions from aviation are not included in the national inventory.

The emissions in the transport sector are estimated from the fuel consumed, applying the Tier 1 approach. There is no detailed study on distance travelled by vehicle type and road type.

Equation 2-2. Computation of emissions in the transport sector

$$Emission = \sum_a [Fuel_a . EF_a]$$

Where:

Emissions = Emissions of CO_2 (kg)

$Fuel_a$ = fuel sold (TJ)

EF_a = emission factor (kg/TJ).

a = type of fuel (e.g., petrol, diesel)

Even though the government has put a limit on age for importation of used vehicles, the emission factor for fuel used in transport sector is as shown in Table 2.23 are anticipated to remain applicable in the foreseeable future.

Table 2.23: Emission factors for fuel used in transport sector

Fuel	CO_2 kg/TJ	CH_4 kg/TJ	NO_2 kg/TJ	NOx kg/TJ	CO kg/TJ	NMVOC kg/TJ	SO_2 kg/TJ
Diesel	74100	3.9	3.9	800	1,000	200	6.9
Petrol	69,300	33	2.2	600	8,000	1,500	2.2
Jet Kerosene	71,500	0.5	2				

In 2017, emissions CO_2, CH_4 and N_2O from road transport and railways were estimated at 3,103.5 CO_2 eq, 17 CO_2 eq and 62 CO_2 eq respectively. Emissions from road transport alone were estimated at 3,103 Gg or 99% of CO_2 emissions. NMVOCs and SO_2 were predominantly from the railway transport estimated 2432 and 0.03 Gg respectively (Table 2.24).

Table 2.24: Emissions by transport means (2017)

Categories	GHG gases in Gg						Intermediary gases in Gg						
	CO_2		CH_4		N_2O		NO_x		CO		NMVOCs		SO2
Road Transportation	3,103.5	%	0.8	%	0.2	%	16.2	%	74.9	%	12.8	%	0
Passenger cars	1,486.8	48%	0.5	66%	0.1	46%	4.7	29%	30.9	41%	3.9	30%	0
Light-duty trucks	696.9	22%	0.2	20%	0	23%	3.1	19%	16.6	22%	1.7	13%	0
Heavy-duty trucks and buses	761.8	25%	0	5%	0	26%	8	49%	1.8	2%	0.5	4%	0

Motorcycles	158	5%	0.1	9%	0	5%	0.3	2%	25.6	34%	6.8	53%	0
Total Gg	3,103.5		0.8		0.2		17.2		76.1		2,432.8		0.03
Gg CO2 Eq	3,103.5		17		62								

The emissions from the transport sector increased by a factor of 5.4 from 601.5 Gg CO_2 eq in 1995 to 3261.7 eq in Gg CO_2 eq 2017. CO_2 was the most significant GHG in the transport sector throughout the period (Table 2.25).

Table 2.25: The trend emissions in the transport sector 1995-2017

Gas	1995	1997	1999	2001	2003	2005	2007	2009	2011	2013	2015	2017
CO_2 Gg	588.8	621.8	831.1	841.2	856	959.2	1255.9	1674.3	1999.6	2125.3	2384.7	3103.5
CH_4 Gg	0.186	0.198	0.236	0.232	0.239	0.216	0.248	0.369	0.456	0.571	0.698	0.833
N_2O Gg	0.029	0.03	0.041	0.041	0.042	0.048	0.063	0.084	0.1	0.105	0.134	0.153
CO_2 Gg Eq	601.5	635.3	848.7	858.9	874.1	978.6	1280.8	1708	2040.2	2169.8	2440.8	3168.4

2.3.2.9 Other Sectors

The other sectors include energy consumption in institutions, commercial establishments and residential subsectors. Energy consumption in off road activities, fisheries operations, agriculture and forestry activities also covered under other sectors.

Energy consumption in the agriculture subsector was obtained from the national energy balance though data on energy use in fishing is very scanty.

a) Institutions and Commercial Establishments

The main sources of energy in this sub category are firewood, charcoal and other kerosene. There is limited use of LPG and its use and other kerosene are very low. Charcoal consumption increased fourfold from 2,329 TJ in 1995 to 9,240 TJ in 2017. However, use firewood declined from 28,664 TJ to 7,560 TJ as shown in table 2.26.

b) Residential Subsector

The main sources of energy in this sector are firewood, charcoal and agricultural waste. Use of firewood almost doubled from 164,696 TJ in 1995 to 292,600 TJ in 2017. The consumption of charcoal increased by a factor of 5 from 9,333 TJ in 1995 to 46200 TJ in 2017. This per capital use of charcoal increased well as per capital use of firewood has declined.

The consumption of agricultural waste increased threefold from 9,067 in 1995 to 27,200 TJ in 2017. The consumption of LPG increased tremendously from 21.3 TJ in 1995 to 282 PJ in 2017 while the consumption of other kerosene decreased from 1,283.5 TJ to 369 TJ in the same period. This is attributable to adoption of roof top solar systems for lighting in the rural area (Table 2.26).

c) Agriculture and Fisheries

The most popular fuel in this sector is diesel. It used to drive tractors and other equipment. Petrol is mostly used by small fishing boats. Diesel consumption increased by a factor of 6.5 from 440.04 TJ in 1995 to 2849.67 TJ in 2017 (Table 2.26).

Table 2.26: Trends of the activity data in other sectors, TJ

Commercial/Institutional	1995	2000	2005	2010	2015	2017
LPG	0	11.99	0	0	94.62	70.7
Charcoal	2329	1683	6191	9490	9240	9240
Firewood	28664	38250	46210	55879	8207	7560
Other Kerosene	142.61	155.71	186.44	190.38	0	0
Household /Residential	1995	2000	2005	2010	2015	2017
LPG	21.3	44.81	90.02	157.25	189.24	282
Charcoal	9,333	14612	15778	1713.4	46200	46200
Firewood	164696	182614	227124	265533	345578	292600
Other Kerosene	1283.5	1401.4	1118.6	17926	437.9	369
Agriculture waste	9067	15826	18588	21770	24705	27200
Diesel	0	0	0	0	1516	1714
AGRICULTURE	1995	2000	2005	2010	2015	2017
Diesel	440.04	656.36	1127.92	2214.6	1254.37	2849.67
Gasoline/fishing	0	0			1254.37	

2.3.2.10 Emissions in the Other Sectors

The total emissions from other sectors increased from 1664.9 Gg CO_2 eq in 1995 in 3310.74 Gg CO_2 eq. In 1995, most of the emissions are from the residential sector with 83.3 %. The other emissions are from agriculture sector and commercial / institutional sector, their contribution over the years 2% and 14.7% respectively. The emissions from the residential subsector increased from 1387.4 Gg CO_2 eq. in 1995 to 2793.9 Gg CO_2 eq. in 2017; thus contributing 84.4 % of the total emissions. Those from the agricultural sector increased from 33.5 Gg CO_2 eq. in 1995 to 285.9 Gg CO_2 eq. in 2017. The trends of distribution of the three subsectors in other sectors is as shown in Figure 2.8.

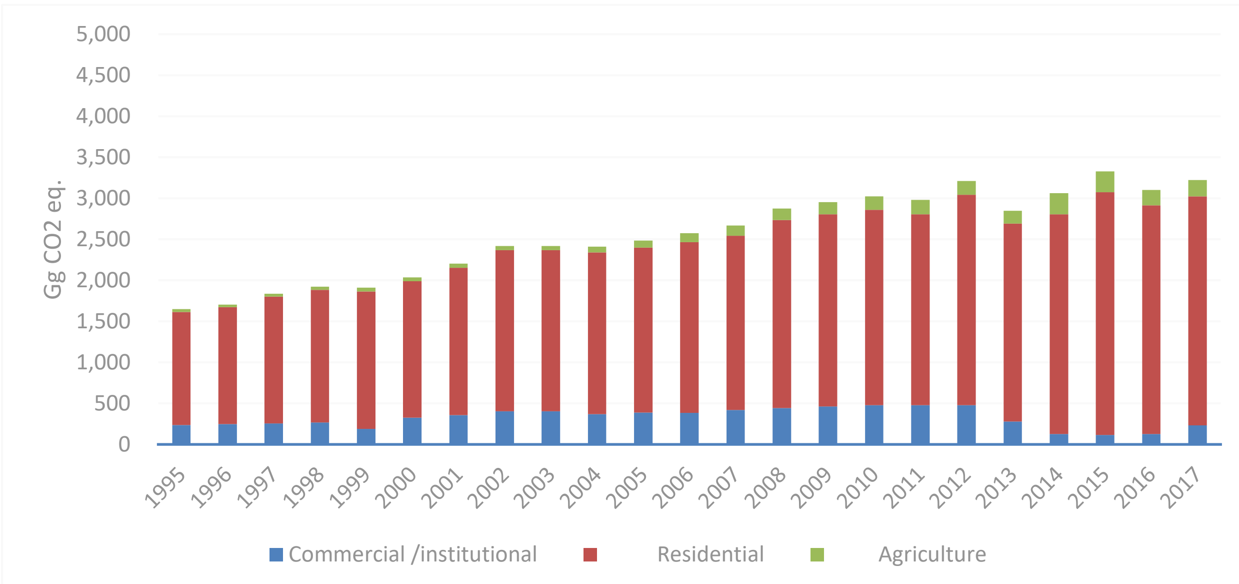

Figure 2.8: Trends of distribution of the emissions in three sub categories in other sectors

It can be noted that emissions from the residential subsector is very high; that is due to the emission of methane, and N_2O which were 84.9% and 83.3 % of the total emission, respectively, arising from biomass combustion in the residential subsector. In 2017, the contribution of commercial/institutional, residential and agriculture subsectors to the total emissions were 7%, 84.4 % and 8.4 %, respectively.

2.4 Industrial Production and Product Use (IPPU)

Uganda's industrial sector is undergoing transformation the sector is developing very fast. Most of the emissions from the IPPU sector are from cement and lime production. There are also other subcategories such non-energy use of petroleum products such as lubricants.

2.4.1 Lime Production and Imports

In the early 1990s, most of the lime was produced by the small-scale producers from inefficient lime kilns. This lime is considered not good for for road construction. The demand for lime declined further when the government started using cement and gravel for construction of major national roads. Lime consumption declined threefold to about 8,200 tonnes (Table2.7).

Table 2.27: The trend of different types of cement production, lime and clinker import (tonnes).

	1995	2000	2005	2010	2015	2017
Total Cement	314,628	367,470	692,710	1,347,000	2,330,500	2,510,500
Pozzalana cement	298,897	349,097	658,075	1,279,650	2,213,975	2,384,975
Portland cement	15,731	18,374	34,636	67,350	116,525	125,525
lime production	28,600	43,582	57,763	20,060	8,042	8,203
Clinker import	41,443	53,559	192,419	362,732	1,033,992	1,176,547

2.4.2 Cement Production (Imports / Exports)

Within the last 10 years, cement factories have increased from two to five factories. Some the factories have installed modern clicker furnace and may thus not lead to substantial increase in emissions.

Cement production increased from 314,628 tonnes in 1995 to 2,510,500 tonnes in 2017, with Pozzalana cement increasing from 298,897 tonnes in 1995 to 2,384,975 tonnes in 2017 (Figure 2.9). About 5% of the cement produced is Portland cement. The production of Portland increased from 15,731 tonnes in 1995 to 125,525 tonnes in 2017. Generally, there is an 8-fold increment in cement production. Although Uganda produces clinker, it is not enough to meet the domestic needs therefore the importation of clinker is increasing at a high rate. Clinker imports increased from 41,443 tonnes from 1995 to 1,176,547 tonnes in 2017. This is an increase by a factor of 28.

Figure 2.9: Trends in types of cement and lime production and clinker imports.

From 1995 to 2017, the emissions from production of cement increased from 98.1 Gg CO_2e to 343.4 Gg CO_2e while those of lime production fell from 551.2 Gg to 27 Gg CO_2e due to reduced lime use in road construction.

2.4.3 Non Energy Use of products

Uganda imports lubricant which are used in the transport sector and industries. Lubricant imports in TJ are presented in Table 2.28.

Table 2.28: Activity data for lubricant

Lubricant	1995	2000	2005	2010	2015	2017
TJ	0.0723	0.0985	0.2007	0.3078	0.5917	0.8520

2.4.4 Products Used as Substitute for Ozone Depleting Substances

Products discussed here are a number of gases used in refrigeration air conditioning and the blowing agents in the foam industries. Mobile air conditioning is the leading consumer of HFC - 134a. This can be attributed to reliance on used vehicles, the road condition and poor maintenance practices.

There was limited data on foam industries covering only three years from 2015 to 2017. Data splicing techniques were used to fill gaps between the period 1995-2014. This an area that needs further improvements for example more engagement with Uganda Revenue Authority.

All the products used in refrigeration, air conditioning and fire protection are imported. There are few companies that export these products to the neighbouring countries. The net consumption of HFC -134a is computed and tabulated in Table 2.29.

Table 2.29: Consumption of HFC -134a (tons)

Year	1995	2000	2005	2010	2015	2017
Refrigeration and stationery air conditioning	3.14	3.85	4.92	6.37	8.58	9.02
Mobile air conditioning	21.99	25.6	26.04	40.49	70.15	87.01
Fire protection	2.37	2.76	3.22	3.75	4.37	4.83

2.4.5 Emissions from Product Use, Refrigeration and Air Conditioning.

There are many used vehicles and other equipment which come charged with refrigerants. The used vehicles releases are due to frequent repairs and maintenance needed. The increment in emissions from these products varies between 11and17 fold as shown in Table 2.30.

Table 2.30: The emissions from Product Use as Substitute for Ozone Depleting Substances (Gg)

	1995	2000	2005	2010	2015.	2017
2.F - Product Uses as Substitutes for Ozone Depleting Substances	5.36	24.50	36.72	72.90	72.21	86.54
2.F.1 - Refrigeration and Air Conditioning	4.90	22.39	33.40	66.69	67.14	81.36
2.F.1.a - Refrigeration and Stationary Air Conditioning	0.61	2.88	4.88	9.21	8.44	10.07
2.F.1.b - Mobile Air Conditioning	4.29	19.51	28.52	57.49	58.69	71.29
2.F.3 - Fire Protection	0.46	2.10	3.32	6.20	5.08	5.18

2.4.6 The Use of SF6

Uganda imports SF6 which is used as insulator in the switch gears in the power substations under Umeme and the Uganda Electricity Transmission Company. Some of the SF6 is used for refilling leaked circuit breakers and filling the circuit breakers which are bought without SF6. Currently there is no system to determine how much SF6 is used for refilling switch gears and emissions related to its use are not accounted for. It was not possible to obtain data on SF6 from URA.

2.4.7 Food and Beverages Industry

The production of beer, beverages and sugar; and similar products that fall in this category have been increasing over the last decades. From 1995 to 2017, the production of beer and beverages increased from 108,109 thousand litres and 61,161 thousand litres to 298,106 thousand litres and 289,313 thousand litres in 2017, respectively. The increment is in the magnitude of 2.8 and 4.7 in the production of beer and beverages respectively. There were many industries that have joined the production of beverages. In addition, the production of sugar increased by a magnitude of four from 81,784 tonnes in 1995 to 325,082 tonnes in 2017 (Table 2.31).

Table 2.31: The trend of production of beer, beverages and sugar (tonnes).

Products	1995	2000	2005	2010	2015	2017
Beer (Thousand litres)	108109	126092	152860	182324	253623	298106
Beverage (Thousand litres)	61161	72623	173598	242334	329556	289313
Sugar (tonnes)	81784	134943	173792	294550	386612	325082

In the process of manufacture of food and beverages such as beer, beverages and sugar NMVOC are emitted. From 1995 to 2017, NMVOC emission from beer and beverages increased from 0.2162 Gg and 0.1223 Gg to 0.596 Gg and 0.5786 Gg respectively. The emission from manufacture increased by a factor of four from 0.1636 Gg to 0.6501 Gg Table 2.32.

Table 2.32: NMVOC emission from foods and beverages (Gg)

Year	1995	2000	2005	2010	2015	2017
Beer	0.2162	0.2521	0.3057	0.3646	0.5072	0.5962
Beverage	0.1223	0.1452	0.3471	0.4846	0.6591	0.5786
sugar	0.1636	0.2698	0.3475	0.5891	0.7732	0.6501

2.5 Waste Sector

There is a growing rate of waste generation especially in the urban areas due to population increase, urbanization and industrial development and thus an increase in GHG emissions from the waste sector.

2.5.1 Activity Data for Waste Sector

The national population is increasing at 3% per annum while the rate of urbanization is close to 6% in the major cities like Kampala. This has a bearing on per capita Municipal Solid Waste (MSW) generation of 0.55 kg/person/day. From 1995 to 2017, the population of Uganda almost doubled, increasing from 19 million to 37 million. Over the same period, the amount of waste generated (in cities) more than doubled, increasing from 3,273.2 Gg on 1995 to 7,596.2 Gg (Table 2.33). Percentage of the waste in managed disposal sites and uncategorised sites is estimated at 43.6% and 56.4% respectively. It is also estimated that 20% the waste is deposited in Biological Treatment Facilities.

Table 2.33: Population increase and waste generation and treatment

Year	1995	2000	2005	2010	2015	2017
Population	19,419,193	22,853,553	26,768,973	31,005,099	35,502,100	37,838,900
Waste Generated (Gg)	3273.2	4587.9	5373.9	6224.3	7127.0	7596.2
Biological Treatment Facilities (Gg)	654.6	917.6	1074.8	1244.9	1425.4	1312.9

Some waste is incinerated at instituions like hospitals and schools. There also government designated incinerating facilities for large tonnage of wastes. The categories of wastes which are incinerated, includes Industrial Waste, Hazardous Waste and Clinical Waste (Table 2.34).

Table 2.34: The amount of waste incinerated (Gg).

Year	1995	2000	2005	2010	2015	2017
Industrial Waste	0.753	0.784	0.816	0.852	0.891	0.901
Hazardous Waste	0.443	0.443	0.443	0.443	0.440	0.458
Clinical Waste	0.440	0.450	0.460	0.471	0.483	0.487

The amount industrial waste incinerated increased by 120% from 0.753 Gg in 1995 to 0.901 Gg in 2017. The Hazardous Waste and Clinical Waste incinerated increased from 0.443 Gg and 0.440 Gg in 1995 to 0.458 Gg and 0.487 Gg in 2017 respectively. The increment in emission incineration from Hazardous Waste and Clinical Waste was 103% and 111%, respectively.

Open burning is practised in both urban and rural areas by a very small percentage of the population. Open burning is however on the increase. Per capita waste generation for the open burning population increased from 747,639 in 1995 to 2,913,595 in 2017. From 1995 to 2017, the amount of waste open burnt increased by a magnitude of 3.9 from 21.83 Gg to 85.08 Gg (Table 2.35).

Table 2.35: The activity data for waste burnt

Year	1995	2000	2005	2010	2015	2017
Population (Open burning)	1,359,344	1,599,749	1,900,597	2,201,362	4,357,883	5,297,446
Per capita Generation for the open burning population	747,639	879,862	1,045,328	1,210,749	2,396,836	2,913,595
Waste open burnt (Gg)	21.83	25.69	30.52	35.35	69.99	85.08

2.5.2 Activity Data on Waste Water Treatment and Discharge

The activity data is driven by the population growth and types of treatment or discharge in the four regions of Uganda i.e., Central, Eastern, Northern and Western regions and the relevant population applied (Table 2.36).

Table 2.36: The regional population growth trends

Year	1995	2000	2005	2010	2015	2017
Central	5,400,875	6,188,489	7,063,500	8,220,800	9,776,800	10,408,700
Eastern	4,759,522	5,685,666	6,827,400	8,301,800	9,266,300	9,832,700
Northern	3,762,606	4,695,625	5,797,900	7,283,300	7,365,500	7,817,800
Western	5,108,530	5,907,826	6,805,700	7,978,700	9,083,500	9,614,600
Total	19,031,533	22,477,606	26,494,500	31,784,600	35,492,100	37,673,800

Currently waste water treatment systems that are applicable are; centralized anaerobic treatment plant, anaerobic shallow lagoon, anaerobic deep lagoon, septic system and latrine. The use of these treatment systems depends on the income group. Three different income groups were considered namely; rural, low income urban and high income urban. The default emissions factors were chosen appropriately.

Uganda industrial sector has been developing over the last three decades and thus increase in emission from industrial waste water treatment and discharge. Estimated production data for beer and malt, beverages, fish processing and sugar refining is presented in Table 2.37.

Table 2.37: Industrial production from selected industries (tons)

Year	1995	2000	2005	2010	2015	2017
Beer & Malt	108,109	126,092	152,860	182,324	253,623	325,083
Beverages	61,161	72,623	173,589	242,334	329,557	289,314
Fish Processing	9,020	14,894	39,201	25,973	20,058	22,943
Sugar Refining	81,784	134,943	173,598	294,550	386,613	298,106

The types of treatment commonly practiced in Uganda are anaerobic deep lagoons and anaerobic shallow lagoons. The specific water generated (m^3) per industrial product (in tons) for beer and malt is 18.15 m^3/ton, while for beverages is 4.087 m^3/ton. The waste water generated from fish processing and sugar refining is 11.1m^3/ton, and 9.2 m^3/ton, respectively.

2.5.3 Overview of Emissions from Waste Sector

The emissions from waste sector have been increasing since 1995. Methane emissions are dominant in the entire waste sector and mostly from the solid waste disposal subcategory. Wastewater originates from a variety of domestic, commercial and industrial sources and may be treated on site or sewered to a centralized plant. Domestic wastewater is from household water use. Emissions are in form of methane (CH_4) nitrous oxide (N_2O).

The total emissions almost tripled increasing from 2,402 Gg CO_2e in 1995 to 6,484 Gg CO_2 eq in 2017. Solid waste is the main sources of emissions contributing 70% of the total emissions in 1995 and 65% in 2017. The contribution of emissions from waste water treatment and discharge increased from 12% in 1995 to 22% in 2017. This could be attributed to growing industrial sector (Figure 2.9). The emission from the biological treatment of waste decreased from 18% in 1995 to 13 % in 2017, while the emission from burning of solid waste and incineration was less than 1% of the total emissions.

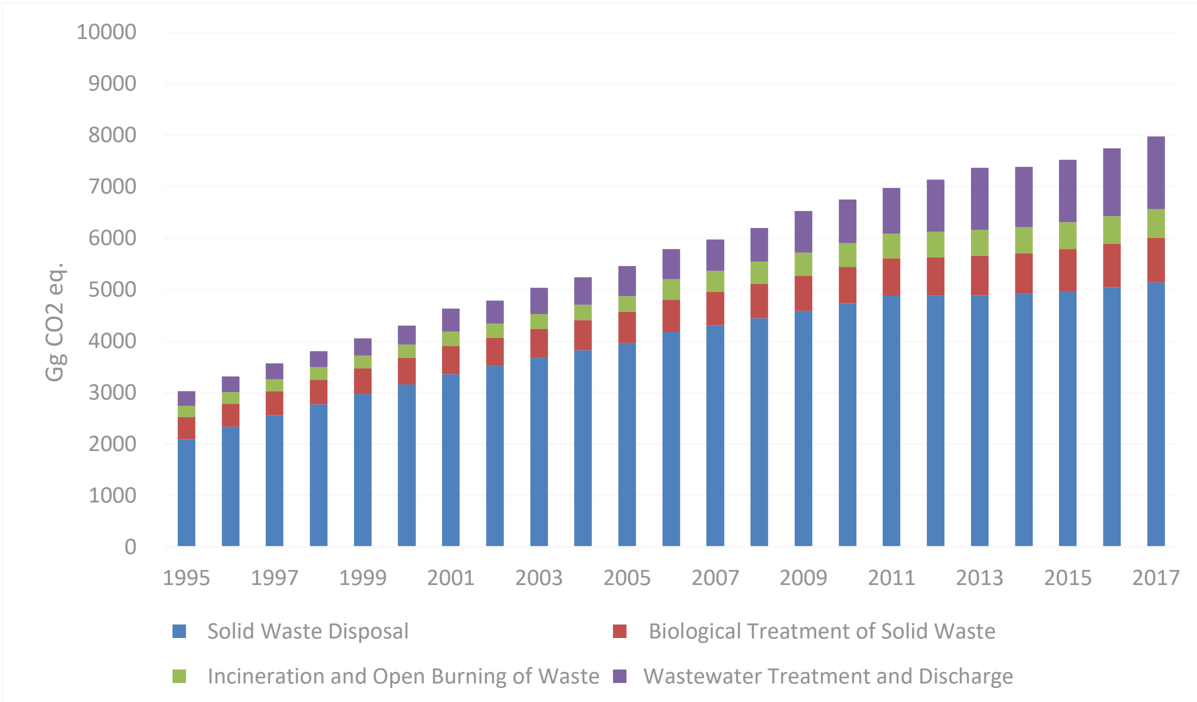

Figure 2.10: The trends of emission in the waste sector

2.5.3.1Trends of Emissions from Solid Waste Disposal

The emission from the solid wastes emanates from the biodegradable fraction of the solid wastes. At the national level, garden and back yard wastes, food and paper constitute over 80% of solid wastes in Uganda. The emissions from the solid waste disposal more than doubled; increasing from 1,672 Gg CO_2 eq in 1995 to 4208 Gg CO_2 eq in 2017 (Figure 2.10). The time series for CH_4 emissions from solid waste.

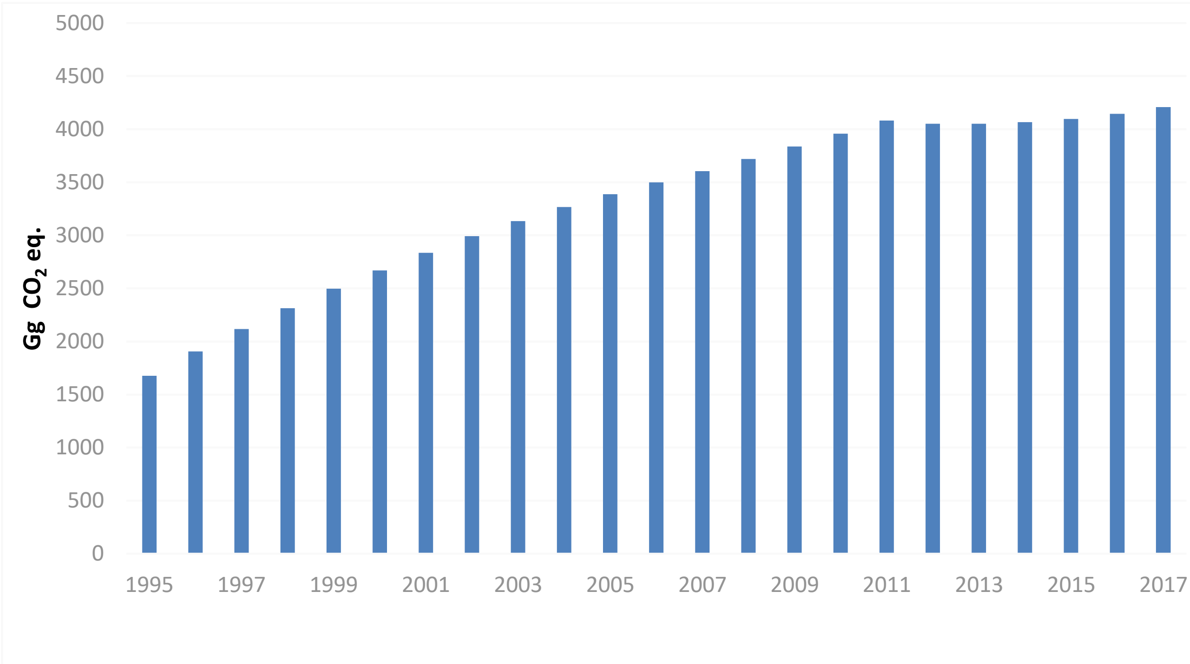

Figure 2.11: The trends of emissions from solid waste disposal

2.5.4.2 Key GHG Emissions from Solid Waste Disposal

a) Nitrous Oxide (N_20) Emission in the Waste Sector.

The nitrous oxide emissions from open burning increased from 0.001 Gg in 1995 to 0.007 Gg in 2017. The emissions from domestic waste water treatment and discharge increased from 0.701 Gg in1995 to 1.8 Gg in 2017.

b) Carbon dioxide (CO_2) Emission in the Waste Sector.

Most of the emissions are generated during the combustion of open burning and incineration of the waste. The emission from open burning of waste increased from 0.878 Gg CO_2eq. in 1995 to 7.179 Gg CO_2eq. in 2017. The emissions from incineration of waste increased from 1.696 Gg CO_2eq. in 2006 to 1.71 CO_2eq. in 2017.

2.5.4.3 Trends in Emissions from Biological Treatment of Solid Wastes

The main source of emissions considered is composting of solid wastes, which are inform of garden, park yard and food waste. The main sources of emission from biological treatment of solid wastes are CH_4 and N_2O. The emissions from the biological treatment of solid waste increased from 432.3 Gg CO_2eq. in 1995 to 842.0 Gg CO_2eq. in 2017. The overall emission doubled. The emission from biological treatment of solid wastes is as shown in Figure 2.12**.** The trends of emissions of CH_4 and N_2O from biological treatment of solid waste are shown in Table 5A in the Annex.

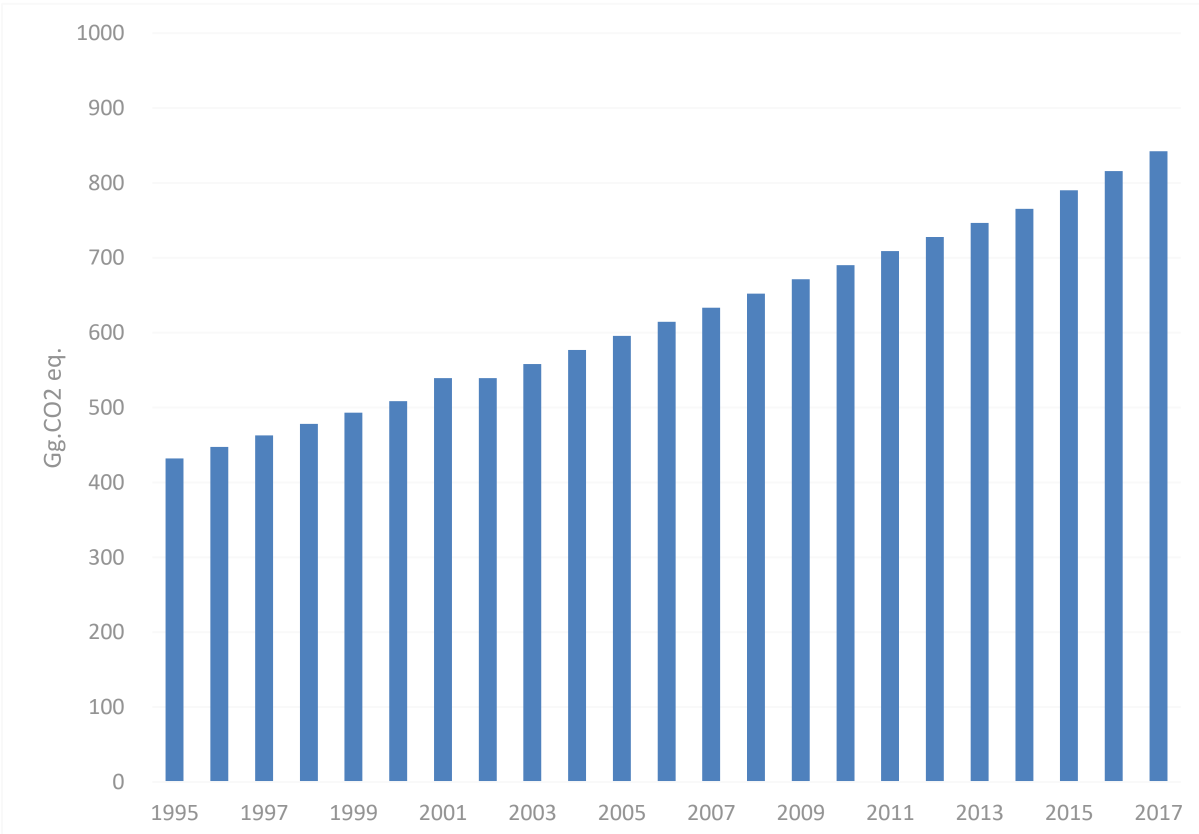

Figure 2.12: The emission from biological treatment of solid wastes

The CH_4 emission from biological treatment of solid waste increased from 10.92 in 1995 to 21.27 in 2017, while the emission of N_2O increased from 0.655 Gg in 1995 to 1.733Gg CO_2 in 2017. The emissions of CH_4 and N_2O from biological treatment of solid wastes is as illustrated in Table 2.38.

Table 2.38: The emissions of CH_4 and N_2O from biological treatment of solid wastes

Gg CO_2	1995	2000	2005	2010	2015	2017
CH_4	10.916	12.846	15.047	17.428	19.956	21.269
N_2O	0.655	0.771	0.903	1.046	1.197	1.276

2.5.4.4 Trends in Emissions from Incineration and Open Burning of Waste.

The CO_2 emissions from open burning and incineration is the most significant, when compared with CH_4 and N_2O. Emissions from open burning increased by a factor of 5.5 from 3.89 Gg CO_2 eq in 1995 to 21.5 Gg CO_2 eq in 2017 (**Figure 2.13**).

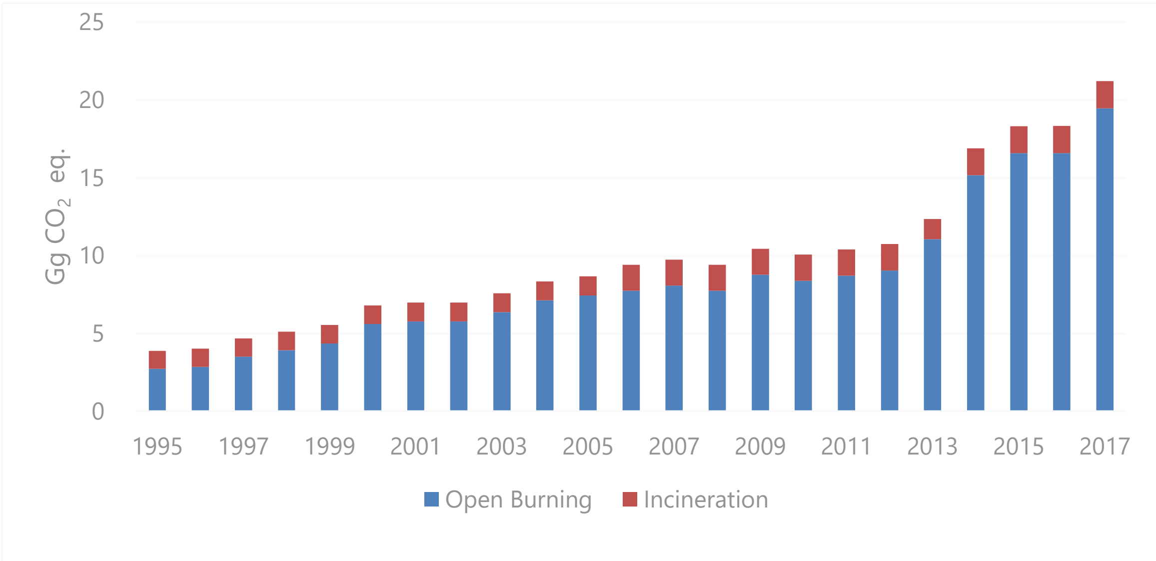

Figure 2.13: The trend of emissions from open burning and incineration of waste.

(a) Emissions from Open Waste Burning

Unwanted material such textiles, plastics and papers are often burnt in open dumps. The resulting emissions are released into the atmosphere. The CO_2 increased from 0.878 Gg in 1995 to 7.179 Gg in 2017, while CH_4 and N_2O emissions increased from 0.073 Gg and 0.001 Gg in 1995, to 0.482 Gg and 0.007 Gg in 2017 respectively. From 1995 to 2017, CO_2, CH_4 and N_2O emissions from open burning increased by a factor of 8, 6.6, and 6.9, respectively. Over the same period, total emissions from waste open burning increased by a factor of seven from 2.73 Gg CO_2 eq in 1995 to 19.462 Gg CO_2 eq in 2017 (Table 2.39). The trend of emissions of CO_2, CH_4 and N_2O from open waste burning.

Table 2.39: The emissions of CO_2, CH_4 and N_2O from openburning waste

	1995	2000	2005	2010	2015	2017
CO_2	0.878	1.399	2.448	2.571	5.080	7.179
CH_4	0.073	0.167	0.199	0.230	0.455	0.482
N_2O	0.001	0.002	0.003	0.003	0.006	0.007
CO_2 eq.	2.730	5.611	7.429	8.384	16.587	19.462

(b) Emissions from Waste Incineration

It is a common practice to incinerate clinical waste at site and educational institutions mainly resulting in CO_2 emissions while emissions of NO_2 and CH_4 are negligible. CO_2 emissions increased from 1.126 Gg in 1995 to 1.712 Gg in 2017. From 1995 to 2017, emissions from CO_2, NO_2 and CH_4 combined increased by a factor of 1.5 from 1.16 Gg CO_2 eq to 1.75 Gg CO_2 eq (Table 2.40). The trend of emissions of CO_2, CH_4 and N_2O from solid incineration is as illustrated in Table 7A.

Table 2.40: Emissions of CO_2, CH_4 and N_2O from waste incineration

	1995	2000	2005	2010	2015	2017
CO_2	1.126	1.161	1.197	1.650	1.692	1.712
CH_4	0.000	0.000	0.000	0.000	0.000	0.000
N_2O	0.000	0.000	0.000	0.000	0.000	0.000
CO_2 eq.	1.160	1.196	1.233	1.687	1.731	1.750

2.5.4 Emissions from Waste Water treatment and discharge

2.5.4.1 Trends in Emissions from Waste Water Treatment and Discharge

Emissions from Domestic Wastewater increased almost fourfold from 492.8 Gg CO_2 eq in 1995 to 1,837 Gg CO_2 eq in 2017. Emissions from the industrial wastewater increased more than 10-fold from 140.6 Gg CO_2 eq in 1995 to 1,668 Gg CO_2 eq in 2017(**Figure 2.14**). This is mainly attributable to increased industrial activity in the country. The emissions trends of CH_4 and N_2O from domestic waste water discharge.

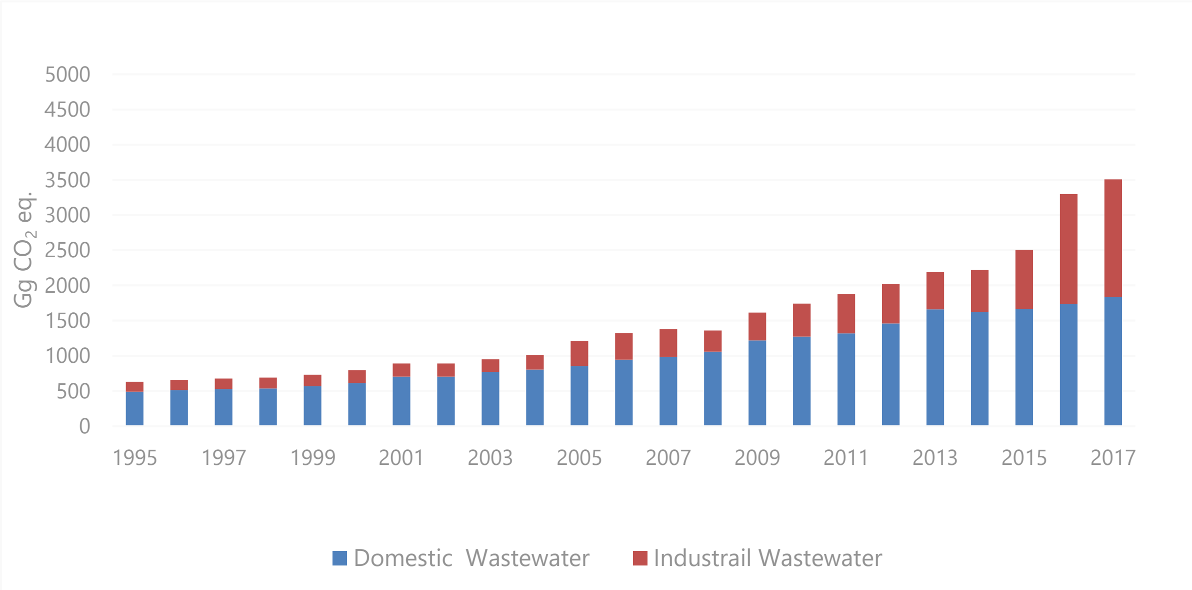

Figure 2.14: Emissions from treatment of Domestic wastewater and Industrial Wastewater discharge

2.5.4.2 Trends in Gases Waste Water Treatment and Discharge

CH_4 and N_2O emission from domestic wastewater increased from 13.31 Gg and 0.688 Gg in 1995 to 61.894 Gg and 1.733 Gg in 2017 respectively (Table 2.41). Industrial waste water treatment and discharge has only CH_4 emissions which increased from 0.454 Gg in 1995 to 5.38 Gg 2017 (Table 2.41).

Table 2.41: Trends of emissions of CH_4 and N_2O emission from Domestic and industrial wastewater treatment and discharge

Domestic Wastewater	1995	2000	2005	2010	2015	2017
CH_4	13.310	17.155	26.648	38.987	55.218	61.894
NO_2	0.688	0.813	0.958	1.462	1.633	1.733
Industrial Wastewater						
CH_4	0.454	0.594	1.150	1.510	2.717	5.381

2.6 AFOLU

2.6.1 Overview AFOLU Sector

Emissions from the AFOLU sector are estimated to have risen from about 28.1 thousand Gg from 1995 up to 79.3 thousand Gg CO_2e with land use change and forestry accounting for a big portion. Enteric fermentation CH_4 was the second most important source followed by direct N_2O emissions from managed soils (**Figure 2.15**).

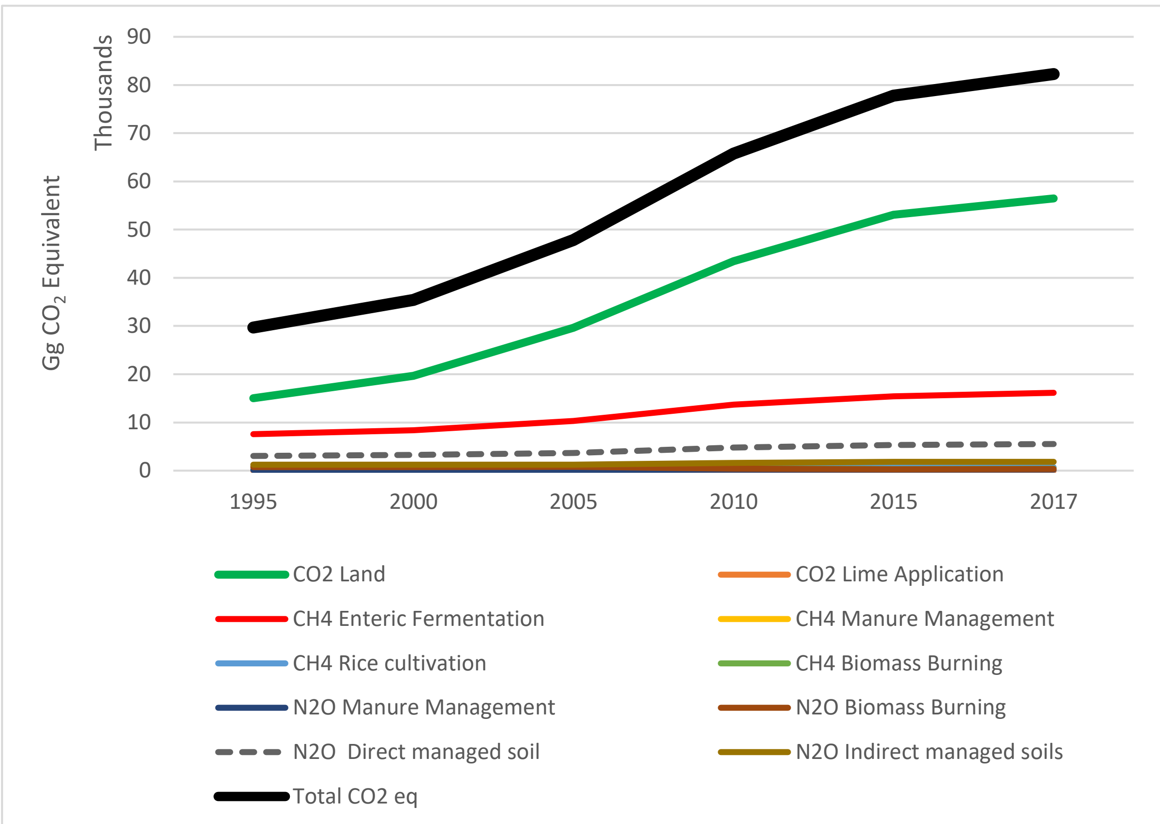

Figure 2.15: Total AFOLU Emissions CO_2 Equivalents

In the terms of greenhouse gases, CO2 was the most significant gas under the AFOLU sector rising from 14,978 Gg in 1995 to 56,430 Gg in 2017 (Table 2.42). CH4 was the second most significant GHG estimated estimated at 711 Gg or 13,415 Gg CO2e in 2017. In 2017 N2O emissions are estimate at 31 Gg or 9,473 CO2e.

Table 2.42: Share of GHG in absolute weight and CO_2e in the AFOLU sector						
GHG	1995	2000	2005	2010	2015	2017
CO_2	14,978	19,616	29,615	43,396	53,023	56,430
CH_4	339	370	440	549	609	639
CH_4 CO_2 eq	7,110	7,767	9,244	11,537	12,794	13,415
N_2O	19	20	22	26	30	31
N_2O CO_2eq	6,027	6,283	6,784	8,049	9,186	9,473

2.6.2 Estimation of Emissions from Agriculture

Agriculture generates greenhouse gas emissions that occur through several processes such as enteric fermentation in ruminants, rice paddy production systems, emissions from managed soils (application of crop residues, animal manure, synthetic fertilizers and mineralization through soil degradation.

a) Livestock

Cattle population, which is the biggest contributor to enteric fermentation emissions is estimated to have risen from about 6 million in 1995 to over 14 million by 2017. (Table 2.43).

Table 2.43: Livestock Population 1995 to 2017

Livestock Category	1995	2000	2005	2010	2015	2017
Dairy cattle	446,610	511,630	657,312	847,247	982,192	1,001,933
Other cattle	5,933,556	6,797,408	8,732,861	1,256,285	3,049,119	13,843,584
Total Cattle	6,380,166	7,309,038	9,390,173	2,103,532	4,031,311	14,845,517
Sheep	924,000	1,081,000	2,515,670	3,621,213	4,197,978	2,024,955
Goats	5,545,000	6,396,000	0,148,594	3,207,840	5,311,507	15,859,649
Breeding Swine	70,684	82,789	128,397	168,911	195,814	198,751
Market Swine	1,272,316	1,490,211	2,439,547	3,209,313	3,720,473	3,776,280
Poultry	21,832,000	26,974,000	5,434,761	3,201,000	5,144,990	35,949,000

Source: UBOS, MAAI, FAOSTAT

b) Enteric Fermentation

i. Enteric Fermentation Emission Factors

IPPCC 2006 provides Tier 1 emission factors for African and developing countries to estimate CH4 emissions from enteric fermentation (IPCC 2006, Vol 4, Ch 10, Table 10.10, 10.11). Emission factors by livestock type are provided in Table 2.44.

Table 2.44: Livestock Methane Enteric Fermentation EF by livestock type

Livestock Category	Enteric Fermentation CH_4 Emission Factor ($EF_{EF.T}$)	Typical Animal Mass (TAM_T)
Unit	[kg CH_4 head^{-1} yr^{-1}]	[kg head^{-1}]
Dairy Cattle	46	275
Non-Dairy Cattle	31	173
Sheep	5	28
Goats	5	30
Breeding Swine	1	28
Market Swine	1	28
Poultry	NA	1.8

Source: IPCC 2006, Vol 4, Ch 10

ii. Emissions from Enteric Fermentation

CH4 emissions from enteric fermentation rose at an average of 5% per annum from about 270 Gg of CH4 in 1995 to over 576 Gg of CH4 in year 2017 (Table 2.45). Non- dairy cattle contributed most of the CH4 enteric emissions (74%) mainly because they account for a large share of the livestock population (Table 2.43) and partly because of relatively heavy body weight at an average of 275 kg (Table 2.44).

Table 2.45: Enteric Fermentation CH_4 Emissions Cattle and Other livestock in Gg

Type of Animal	1995	2000	2005	2010	2015	2017	Share in 2017	Annual Change
Total Cattle	204.5	234.3	301.0	399.6	449.7	475.2	82%	6%
Dairy	20.5	23.5	30.2	40.1	45.2	46.1	8%	6%
Non-Dairy	183.9	210.7	270.7	359.4	404.5	429.2	74%	6%
Other Livestock	65.9	65.9	65.9	90.2	101.5	101.5	18%	2%
Total	270.4	300.2	366.9	489.7	551.2	576.7	100%	5%

c) Manure management

(i) Manure management Emission Factors

Application of IPCC Default emission factors show that cattle and swine have the highest CH4 emission factor for manure management of 1 kg of CH4 head per year while poultry has the lowest at 0.02 per head per year (Table 2.46). In terms of nitrogen excretion, market swine has the highest rate followed by goat at 1.57 kg, 1.37 kg and sheep at 1.17 kg of nitrogen per 1,000 kg of animal mass. Cattle have the lowest nitrogen excretion rates of 0.6 kg of nitrogen per 1,000 kg of animal mass (Table 2.46).

Table 2.46: Livestock Methane Manure management EF and N excretion rate by livestock type

Livestock Category	**Manure Management CH_4 Emission Factor ($EF_{MM.T}$)**	**Typical Animal Mass (TAM_T)**	**N Excretion Rate ($N_{ex.T}$)**
Unit	[kg CH_4 head^{-1} yr^{-1}]	[kg head^{-1}]	[kg N (1,000kg mass)$^{-1}$ day^{-1}]
Dairy Cattle	1	275	0.6
Non-Dairy Cattle	1	173	0.63
Sheep	0.2	28	1.17
Goats	0.22	30	1.37
Breeding Swine	1	28	0.55
Market Swine	1	28	1.57
Poultry	0.02	1.8	0.82

Source: IPCC 2006, Vol 4, Ch 10

In Uganda, four manure management systems were considered and these are solid storage, pit storage below animal confinements, anaerobic digester, poultry manure with litter and poultry manure without litter. Solid storage manure management system has the highest direct N2O – N emissions factor of 0.005 kg N2O -N /kg N followed by Pit storage below animal confinements at 0.005 kg N2O -N /kg N. Given that anaerobic digesters are designed and operated for waste stabilization, and the methane that is produced is captured and utilised or flared, they are estimated to have the lowest emissions (Table 2.47).

Table 2.47: Direct N2O-N EF for various Manure Management Systems	
Manure Management System	**EF for direct N_2O-N emissions from MMS (kg N_2O-N/kg N in MMs)**
Solid storage	0.005
Pit storage below animal confinements	0.002
Anaerobic digester	0.00001
Poultry manure with litter	0.001
Poultry manure without litter	0.001

(ii) CH_4 Manure Management Emissions

CH4 emissions from manure management rose from 13.6 Gg in 1995 to 23.9 Gg in 2017 which is an average increment of 3% per annum (Table 2.48). Non- dairy cattle accounted for 58% of CH4 emissions from manure management. Compared to enteric fermentation, the share CH4 emissions from manure management from non-cattle livestock combined was substantial and accounted for 38% compared to cattle at 62% (Table 2.48). The contribution of swine and goats to CH4 emissions from manure management was also significant given that swine and poultry have substantial number and the same manure management emission factor as cattle.

Table 2.48: **Manure Management CH_4 Emissions for Cattle and Other livestock, in Gg**

Type of Animal	1995	2000	2005	2010	2015	2017	Share in 2017	Annual Change
Total Cattle	6.4	7.3	9.4	12.5	14.0	14.8	62%	6%
Dairy	0.4	0.5	0.7	0.9	1.0	1.0	4%	6%
Non-Dairy	7.1	7.1	8.7	11.6	13.0	13.8	58%	4%
Sheep	0.5	0.5	0.5	0.7	0.8	0.8	4%	3%
Goats	2.2	2.2	2.2	3.0	3.4	3.4	14%	2%
Swine	2.6	2.6	2.6	3.5	3.9	3.9	16%	2%
Poultry	0.7	0.7	0.7	1.0	0.9	0.9	4%	1%
Total GHG emissions	13.6	13.7	15.4	20.6	23.1	23.9	100%	3%

N2O emissions from manure management rose at an average of 3% per annum from 0.5 Gg in 1995 to 0.83 Gg in 2017 (Table 2.49). Non- dairy cattle accounted for largest share of 57% followed by goats at 31% and third by swine 24%.

Table 2.49: Manure Management N_2O Emissions for Cattle and Other livestock, in Gg

Type of Animal	1995	2000	2005	2010	2015	2017	Share in 2017	Annual Change
Total Cattle	0.1	0.2	0.2	0.3	0.3	0.3	41%	6%
Dairy	0.0	0.0	0.0	0.0	0.0	0.0	4%	6%
Non-Dairy	0.1	0.1	0.2	0.3	0.3	0.3	37%	6%
Sheep	0.0	0.0	0.0	0.0	0.0	0.0	0%	
Goats	0.2	0.2	0.2	0.2	0.3	0.3	31%	2%
Swine	0.1	0.1	0.1	0.2	0.2	0.2	24%	2%
Poultry	0.0	0.0	0.0	0.0	0.0	0.0	5%	1%
	0.5	0.5	0.5	0.7	0.8	0.83	100%	3%

2.6.3 Estimation of Emissions from LULUCF

The 13 national land use classes were grouped into six IPCC land categories (Table 2.50).

Table 2.50: Aggregating the 13 National land use classes to match the six IPCC land categories

IPCC Land Use Category	Uganda Land Use Subcategory	Uganda Definitions
Forest land	Forest (general)	A minimum area of 1 ha, minimum crown cover of 30% comprising of trees able to attain a height of 4 metres and above *in situ*
	Tropical high forest, well-stocked	Primary tropical rainforest, multi-storeyed, average 30m, characterized as ≥60% canopy cover
	Tropical high forest, low-stocked	Degraded rainforest, multi-storeyed, occasionally with 30m+ tree remnants, characterized as 30-60% canopy cover
	Woodland	Open dry forest, single storey, ≥4m, ≥30% canopy cover
	Plantations broadleaved	Hardwood plantations, dominant species include: Eucalyptus, Terminalia, Maesopsis
	Plantation coniferous	Softwood plantations, dominant species include: Pines sp.
Grassland	Shrubland	Scattered trees and bushes, <4m, <30% canopy cover
	Grassland	Grassland with few or no bushes, <30% canopy cover
Cropland	Subsistence cropland	Small scale farmland (<2 ha)
	Commercial cropland	Medium and large-scale farmland (>2 ha)
Wetland	Wetland	Land inundated with water for all or part of the year. Papyrus most common permanent wetland
	Open water	Area covered by water for all of the year
Settlement	Settlement	Settled areas

Other Land	Other Land	Bare soil, rocks and other impediments, ice cap on Mt Rwenzori

Biomass stock changes are estimated based on rate of land conversion and or the rate of wood extraction versus the rate of natural replenishment (annual increment or growth). Conversion from land with high biomass stock to one of low stock e.g., Tropical High Forest (THF) to cropland results in net emissions. Conversely, converting grassland or cropland to forest plantation enhance carbon stock through sequestration and thus act as a sink. Forestland that remaining forest may act as a sink, a source or may be in equibrium. The tipping point of being a net sink or a source is determined by the balance between annual growth and annual rate of wood extraction.

Biomass stock coefficients (Emission factors) from Uganda's National Forest Inventory (NFI) are presented in Table 2.51. Where values were not available, IPCC Tier 1 default values were selected for the relevant forest type. For changes in forest C stocks, the IPCC default stock change factor for forest lands, are applied (IPCC 2006, Vol 4, Ch 4, pg 4.42).

Table 2.51: Emission for estimate changes in biomass C stock across Uganda land use subcategories. Source; NFI 2019, FREL 2009, Non-Forest Categories; NBS 2002 report, figures for natural forests adjusted

Land Use Sub-category	Above-ground Biomass	Annual Above-ground Biomass Growth
Unit	[Mg d.m. ha^{-1}]	[Mg d.m. ha^{-1} yr^{-1}]
Forest Land – Tropical High Forest	231	3*
Forest Land – Woodlands	40	2.5*
Forest Land – Forest Plantations	114	12
Cropland – Subsistence Cropland	12	2.4
Cropland – Large scale	2	-
Grassland – Rangeland (open and bush grassland)	8	2
Wetlands - Wetland	0	NA
Settlements	0	NA
Other Land	0	NA
Wetlands – Open Water	0	NA

a) Application of the gain – loss method

The Gain – Loss method or Tier1 approach was used for the estimation carbon stock changes in forest land remaining forestland. This approach compares annual removals of the various forms of wood extraction (timber, pole, firewood etc) including losses due to disturbances and soil carbon losses from drained organic soils with annual increase in biomass carbon.

b) Annual net anthropogenic CO_2 emissions on Land

CO2 emissions related to carbon stock changes on land rose from 15 thousand Gg in 1995 to over 56 thousand in 2017 which is an average of 13% per annum (Table 13). Land remaining forest land accounts for the largest share of the emission (77%) rising from 1,773 Gg in 1995 to estimated 43,065 Gg of CO2 in 2017 (Table 2.52). This increased is due to wood extraction being more than natural replinshment (annual growth) of forests which implies that forests are degrading overtime. Emissions from forest degradation has been increasing at an increasing at an increasing rate from 13% per annum between 1995 and 200 to 41% between 1995 and 2005 and jumping over 100% per annum between 1995 and 2015.

CO_2 sinks or removals on land converted to forest (afforestation, reforestation, forest restoration) are estimated to have changed from the historical sink of 155 Gg per annum to 392 Gg in 2017 (Table 2.52). Emissions from deforestation or conversion of forests to cropland are estimated at 10,611 Gg of CO_2 per annum which has been more or less constant from 1995 to 2017.

At a national level, CO_2 emissions on land that remains cropland are estimated to be in equilibrium with removals equal to natural replenishment or growth. Emissions from Grassland, Settlements and other land combined are estimated at 2,973 Gg of CO_2 per annum. Emissions from utilising organic or peaty soils are reported in Section 3.C under emission from managed soils.

Table 2.52: CO_2 removals and sinks due to Carbon Stock Changes on land

	1995	2000	2005	2010	2015	2017	Share in 2017	Annual Change
All Land	15,022	19,683	29,650	43,432	53,061	56,470	100%	13%
Total Forest land	1,617	6,278	16,245	30,027	39,656	43,065	76%	
Forest land Remaining Forest land	1,773	6,433	16,401	30,182	39,811	43,457	77%	107%
Land Converted to Forest land	(155)	(155)	(155)	(155)	(155)	(392)	-1%	7%
Total Cropland	10,611	10,611	10,611	10,611	10,611	10,611	19%	0%
Cropland Remaining Cropland	-	-	-	-	-	-	0%	
Land Converted to Cropland	10,611	10,611	10,611	10,611	10,611	10,611	19%	
Total GG, WW, SS, OO	2,793	2,793	2,793	2,793	2,793	2,793	5%	

GG, WW, SS, OO Not converted	-	-	-	-	-	-	0%	
Land Converted to G, W, S, O	2,793	2,793	2,793	2,793	2,793	2,793	5%	

G- grassland, W- wetlands, S- Settlement and O- Other land

2.6.4 Aggregate Sources and Non-CO_2 Emissions Sources on Land (3.C)

a) Biomass Burning

Data on burnt area were overlayed with land use land cover data provided by NFA (Table 2.53). The level on uncertainty is expected to be very high due to course spatial resolution of MODIS data in Uganda, fires in forests are limited to open dry forests and rare in rain forests (commonly referred to as Tropical High Forest).

Table 2.53: Area (ha) of Biomass burning in various vegetation types

Biomass Burning	1995	2000	2005	2010	2015	2017
Forest land (dry)	382,953	401,151	446,447	119,956	83,868	74,846
Croplands	476,403	476,403	479,894	249,919	239,443	482,378
Grasslands	2,585,396	2,585,440	2,585,440	2,158,828	1,606,080	1,608,080
All other land	43,238	35,938	30,238	14,535	17,194	17,194

b) Biomass Burning Emission Factors

Majority of the fires occur in the rangelands and cropland in the northern parts of Uganda, followed in the rangelands in the central parts and to some limited extent in the extreme south. Tier 1 emission factors for savannah were mainly applied and fuel available for combustion was based on a consensus reached on the AFOLU sector working group (Table 2.54).

Table 2.54: Emission factors for estimating non-CO_2 emissions from biomass burning; Fuel combustion and Combustion factor

Land Use Category	Mass of Fuel Available for Combustion	Combustion Factor	Biomass Burning Emission Factor – CO	Biomass Burning Emission Factor – CH_4	Biomass Burning Emission Factor – N_2O	Biomass Burning Emission Factor – NO_x

Unit	[Mg ha^{-1}]	[Mg ha^{-1}]	[g CO (kg d.m. burnt)$^{-1}$]	[g CH_4 (kg d.m. burnt)$^{-1}$]	[g N_2O (kg d.m. burnt)$^{-1}$]	[g NO_x (kg d.m. burnt)$^{-1}$]
Open dry forests and Forest plantations	15	0.5	65	2.3	0.21	3.9
*Cropland (Subsistence and large-scale Cropland)	5	1	65	2.3	0.21	3.9
*Grassland (Shrubland and Open grassland)	2.6	1	65	2.3	0.21	3.9
Other land (Mainly papyrus)	5	0.5	65	2.3	0.21	3.9

*Mainly in areas with prolonged drought

c) Emissions from Biomass Burning

In absolute terms, CH4 is the major GHG produced from biomass burning with total CH4 decreasing from 31 Gg in 1995 to 14 Gg in 2017 which is an average decrease of 2% per annum (Table 2.53). Within the same period of time, N2O emissions from biomass burning reduced from 3 Gg to 1 Gg. Given that N2O has a much higher GWP value than CH4, there is no significant difference in terms of CO2 eq between the two gases. NMVOC emissions are not estimated.

Grasslands accounted for highest biomass burning emissions of both CH4 and N2O estimated at 52% followed by Crop land and other combined at 39%. Forest contributed the least at 9% of the emissions from biomass burning (Table 2.55).

Table 2.55: Biomass burning emissions, Gg by of GHG gas by land category

GHG by Land Category		1995	2000	2005	2010	2015	2017	Share in 2017	Annual Change
Sub Total CH_4		31	31	33	17	12	14	100%	-2%
Forest	CH_4	13	14	15	4	1	1	9%	-4%
Grass		12	12	12	10	7	7	52%	-2%
Crop and Other		6	6	6	3	3	6	39%	0%
Sub Total N_2O		3	3	3	2	1	1	100%	-2%
Forest	N_2O	1	1	1	0	0	0	9%	-4%
Grass		1	1	1	1	1	1	52%	-2%
Crop and Other		1	1	1	0	0	1	39%	0%

Like for GHG gases, there has been a down ward trend of precursor gases from biomass burning with CO falling from 717 Gg to 470 Gg from 1995 to 2017 and NOx falling from 43 Gg to 21 Gg respectively in the same period (tTable 2.56). Cropland accounted for the biggest of CO at 48% while grassland accounted for the biggest of NOx at 60% (Table 2.56).

Table 2.56: CO and NO_x from biomass burning emissions, Gg by land category

Gas by Land Category		1995	2000	2005	2010	2015	2017	Share in 2017	Annual Change
Sub Total CO		717	733	776	283	363	470	100%	-2%
Forest	CO	373	391	435	-	41	36	8%	-4%
Grass		336	336	336	281	209	209	44%	-2%
Crop and Other		7	6	5	2	113	225	48%	141%
Sub Total NO_x		43	44	47	17	18	21	100%	-2%
Forest	NO_x	22	23	26	-	2	2	10%	-4%
Grass		20	20	20	17	13	13	60%	-2%
Crop and Other		0	0	0	0	3	6	30%	62%

d) Rice cultivation

Area under paddy rice is estimated to have fluctuated between 102,000 ha in 1995 and 90,000 ha in 2010 and rising again to 97,677 ha in 2017. CH4 emissions related to a paddy rice have also fluctuated in tandem falling from 24.9 Gg in 1995 to 22.01 in 2010 and rising again to 23.89 Gg in 2017 (Table 2.57).

Table 2.57: Area under paddy rice and related CH_4 emissions

	1995	2000	2005	2010	2015	2017
Ha	102,000	102,000	102,000	90,000	95,277	97,677
Gg CH_4	24.9	24.95	24.95	22.01	23.3	23.89

e) CO_2 Emissions from Urea application

It is estimated that from 2015 to 2017, on average Uganda used 6,900 tons of urea for agriculture purposes resulting in CO2 emissions of 5.06 Gg per annum (Table 2.58).

Table 2.58: CO_2 emissions related to Urea application in agriculture

Land category	1995	2000	2005	2010	2015	2017
Ton urea	0	0	0	0	6,900	6,900
CO_2 Gg	0	0	0	0	5.06	5.06

f) Estimation of N_2O emissions from managed soils

Though fertilizer using Uganda is very low, direct and indirect N2O emissions on management soils are important sources of emissions.

(i) N excretion from animals

Nitrogen excretion by type livestock category is provided in terms kg of Nitrogen per 1,000 kg of animal mass per day in Table 2.59. Emissions related attributable to the percentage that is applied as organic fertilizer to soils is accounted in this section.

(ii) N input, N mineralisation

It is estimated that nitrogen in put in soils increased from 460.7 Gg of N per year in 1995 to 808.2 Gg N per year in 2017 (Table 2.59). Most of this was from N deposited on pasture by grazing animals. It is also estimated that on average, 800 ha of organic soils are cultivated.

Table 2.59: N input and N mineralization in soils

	1995	2000	2005	2010	2015	2017
Total Gg N / yr	460.70	485.78	541.97	709.42	786.25	808.19
Inorganic N fertilizer application	1.66	1.66	1.66	4.28	10.49	10.49
Organic N applied as fertilizer (manure)	88.72	90.98	96.03	128.76	137.18	138.76
Urine and dung N deposited on pasture, range and paddock by grazing animals	276.50	299.32	350.45	470.04	526.84	547.21
N in crop residues	93.83	93.83	93.83	106.33	111.74	111.74
N mineralization associated with land use change	103.65	103.65	103.65	121.58	139.73	139.73
Drainage of organic soils (i.e., Histosols), Ha	800	800	800	800	800	800

(iii) Direct N_2O emissions from managed soil

The highest direct N2O from managed soils is contributed by urine and dung deposited on pasture, estimated at 70% followed by mineralisation in soils due to land use practices at 11% (Table 2.60). Application of synthetic fertilizers and drainage of organic soils are the least contributing about 1% and 0.05% respectively of direct N2O from managed soils.

Table 2.60: Direct N_2O (Gg) from managed Soils

Year	1995	2000	2005	2010	2015	2017	Share in 2017
N_2O total	11.5	12.2	13.9	18.1	20.2	20.8	100%
N_2O Inorganic fertilizer	0.0	0.0	0.0	0.1	0.2	0.2	1%
N_2O Organic N fertilizer (manure)	1.4	1.4	1.5	2.0	2.2	2.2	10%
N_2O Urine and dung N deposited by grazing animals	7.0	7.7	9.3	12.4	13.9	14.5	70%
N_2O from crop residues	1.5	1.5	1.5	1.7	1.8	1.8	8%
N_2O mineralization of soil organic matter	1.6	1.6	1.6	1.9	2.2	2.2	11%
N_2O Drainage of organic soils (Histosols)	0.01	0.01	0.01	0.01	0.01	0.01	0.05%

(iv) Indirect N_2O Emissions from Manure Management

Indirect N2O emissions on managed soils estimated as N losses from manure management systems that are lost to the environment through volatilization and subsequent deposition and through leaching and runoff.

It is estimated that the amount of N that volatilizes per annum rose from 594 in 1995 to 899 Gg in 2017 resulting in indirect N2O emissions of 1.86 Gg and 2.81 Gg respectively (Table 2.61). In the same period, leaching and run-off N is estimated to have rose from 791 Gg to 1,151 Gg of N resulting in indirect N2O emissions of 2.8 Gg and 4.07 Gg respectively.

Table 2.61: Estimated N that is volatilized, leached or runoff and related N2O emissions

	1995	2000	2005	2010	2015	2017
Gg N volatilized form N input	594	594	594	798	899	899
Gg N_2O volatilized	1.86	1.86	1.86	2.50	2.81	2.81
Gg N leaching and runoff from N input	791	791	791	982	1151	1151
Gg N_2O from leaching and runoff	2.80	2.80	2.80	3.47	4.07	4.07

2.7 Identification of Key Categories

2.7.1 Trend and Level Assessment

Key category analysis is performed to identify the main activities that contributed most to the emissions/removals for a given year or across the entire time series key categories. These are activities that contribute 95 % of the total annual emissions, when ranked from the largest to the smallest emitter. Alternatively, a key source is one that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of direct GHGs in terms of the absolute level of emissions, the trend in emissions, or both (IPCC, 2000).

In 2017, 14 key categories were identified using the level assessment (L) amounting to 95.4% of the national emissions (Table 2.62). The first four significant sources were from the AFOLU sector namely; degradation of Forest land Remaining Forest land (3.B.1.a), Enteric Fermentation (3.A.1), Land Converted to Cropland (3.B.2.b), Direct N2O Emissions from managed soils (3.C.4).

Significant sources from the Non-AFOLU sector activities were; Solid Waste Disposal (4.A), Road Transportation (1.A.3.b), Other Sectors – Biomass (1.A.4), Wastewater Treatment and Discharge (4.D), Manufacturing Industries and Construction - Liquid Fuels (1.A.2), Other Sectors - Liquid Fuels (1.A.4) and Wastewater Treatment and Discharge (4.D). Aggregated emissions of key categories total to 91,201 CO2e out of the national emissions of 95,611 Gg CO2e.

Table 2.62: Level assessment key categories in 2017

IPCC Category	Gas	Emissions / Removals Gg CO2e	Contribution to level	Cumulative
3.B.1.a - Forest land Remaining Forest land	CO_2	43,457.2	45.5%	45.5%
3.A.1 - Enteric Fermentation	CH_4	12,111.0	12.7%	58.1%
3.B.2.b - Land Converted to Cropland	CO_2	10,611.3	11.1%	69.2%
3.C.4 - Direct N2O Emissions from managed soils	N_2O	6,678.3	7.0%	76.2%
4.A - Solid Waste Disposal	CH_4	4,208.1	4.4%	80.6%
1.A.3.b - Road Transportation	CO_2	3,103.5	3.2%	83.8%
3.B.3.b - Land Converted to Grassland	CO_2	2,727.2	2.9%	86.7%
1.A.4 - Other Sectors - Biomass	CH4	2,295.2	2.4%	89.1%
3.C.5 - Indirect N2O Emissions from managed soils	N_2O	2,132.1	2.2%	91.3%
4.D - Wastewater Treatment and Discharge	CH_4	1,412.8	1.5%	92.8%
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	CO_2	836.6	0.9%	93.7%
1.A.4 - Other Sectors - Liquid Fuels	CO_2	589.1	0.6%	94.3%
4.D - Wastewater Treatment and Discharge	N_2O	537.4	0.6%	94.9%
3.C.7 - Rice cultivation	CH_4	501.7	0.5%	95.4%

For the trend assessment (T) of KCA, 12 categories were identified amounting to 95.6% of the total emissions (Table 2.63). Biomass burning (CH_4) emerged in T assessment but was not on L assessment (Table 2.62). Categories that were in L assemment but not in T assessment are-; Solid

Waste Disposal (4.A), Manufacturing Industries and Construction - Liquid Fuels (1.A.2), Other Sectors - Liquid Fuels (1.A.4) and N_2O emissions from Wastewater Treatment and Discharge (4.D).

Table 2.63: Trends assessment key categories for the period 1995 – 2017

IPCC Category	Gas	Emissions / Removals (Gg CO_2e)		Trend Assessment (Txt)	% Contribution to Trend	Cumulative
		1995	2017			
3.B.1.a - Forest land Remaining Forest land	CO_2	1,772.7	43,457.2	1.139	45.7%	45.7%
3.B.2.b - Land Converted to Cropland	CO_2	10,611.3	10,611.3	0.579	23.3%	69.0%
3.B.3.b - Land Converted to Grassland	CO_2	2,727.2	2,727.2	0.149	6.0%	75.0%
3.A.1 - Enteric Fermentation	CH_4	5,678.0	12,111.0	0.119	4.8%	79.7%
3.C.4 - Direct N_2O Emissions from managed soils	N_2O	3,562.4	6,678.3	0.102	4.1%	83.9%
3.C.1 - Emissions from biomass burning	N_2O	872.7	405.7	0.061	2.5%	86.3%
3.C.5 - Indirect N_2O Emissions from managed soils	N_2O	1,444.8	2,132.1	0.059	2.3%	88.7%
3.C.1 - Emissions from biomass burning	CH_4	647.5	301.0	0.046	1.8%	90.5%
1.A.3.b - Road Transportation	CO_2	588.8	3,103.5	0.042	1.7%	92.2%
1.A.4 - Other Sectors - Biomass	CH_4	1,267.1	2,295.2	0.039	1.6%	93.8%
3.C.7 - Rice cultivation	CH_4	523.9	501.7	0.029	1.2%	94.9%
4.D - Wastewater Treatment and Discharge	CH_4	289.0	1,412.8	0.018	0.7%	95.6%

2.7.2 Recalculation

In the SNC the reporting on land was based on the IPCC 1996 guidelines land sub categories namely; Changes in Woody Biomass stocks (5A), forest & grassland conversion (5B) and Abandonment of Managed Lands (5c). Thus, comparison in emissions between the current GHG inventory and SNC can not be done at land sub categories but rather at all land combined. The current aproach estimates aggragate emissions from land to have rose from 15,000 Gg of CO2e in 1995 to close to 19,683 Gg CO2e in 2000. This is much higher than the SNC estimates of slightly above 10,000 Gg CO2e in 2000.

There were also differences in emission estimates in the livestock sector. In the SNC, CH4 emissions from enteric fermentation and manure management combined were estimated at 241 Gg which is lower than 313 Gg of the TNC.

Aggregate AFOLU emissions in the SNC were estimated at 10,483 CO2e Gg compared to the 26,419 Gg CO2e using the current approach. The current approach has lower estimates for two non- AFOLU sectors. Energy and IPPU emission are estimated at 3,130 CO2e Gg and 145 CO2e Gg compared to 4,886 CO2e Gg and 159 CO2e Gg respectively in the SNC. The current approach however estimates higher emissions from the waste sector at 3,810 CO2e Gg compared to 693 CO2e Gg of the SNC.

2.8 Quality Assurance / Quality Control (QA /QC) Procedures

2.8.1 Quality Control

Given that most sectors depend on secondary data for the estimation of GHG, information on data collection control procedures is not available. As already mentioned activity data and emissions factors for the land sub sector (forestry and other land use) are based on nationally collected data. With support from the REDD+ programme, the forestry sector has introduced QC protocols in data collection processes for the estimation of forest carbon stocks.

Quality Control (QC) processes are embedded in the data collection standard operating procedures. About 10% of the sample plots are re-measured to check for errors and establish the level of certainty. The Land use land cover mapping has introduced map accuracy assessment as a quality control protocol.

Even where secondary data used there are checks to ensure proper application of guidelines and methodologies. Data from for the sector MDAs is evaluated by the sector working groups comprised of mainly of experts from the government agencies that may be supported experts from academic institutions, international agencies. Initial evaluation of the appropriateness of Emission Factors is also conducted at this level. The sector working groups (SWG) work closely with the Task force members.

2.8.2 QA Procedures

The QA procedures allow experts who have not been directly involved in the inventory to scrutinise the inventory system and the emission estimate to provide comments. In Uganda this is achieved through sector working (SWG). The review of the activity data, EF and application of methodologies as provided by the IPCC guidelines.

After GHG compilation a draft report undergoes an extensive third-party review at the international level. Several in country meetings / workshops are held to address issues raised by the SWG and international reviewers. Furthermore, national stakeholders provided input into the draft inventory at a workshop.

Task force members are derived from sectoral GHG experts who work with the SWG to build consensus on use and application of the Activity Data and Emission Factors. The Task force teams are responsible for final compilation of sector GHG emissions and thereafter forwarded to the National Inventory Compiler who integrates all sectoral Data into the National GHGI database.

Before submission to the UNFCCC, the GHGI reports are reviewed and endorsed by the National Climate Change Advisory Committee (NCCAC) and the Parliamentary committee on natural resources. Submission is by the UNFCCC focal person in the Ministry of Water and Environment.

2.8.3 General Uncertainty Assessment

The physical measurements to generate activity data and emission factors carry a wide range of errors. In many instances expert judgement is used to fill activity data gaps and emission factor. All methods and procedures combined contribute to uncertainty levels of the inventory.

The IPCC guidelines require that the inventory estimates be published with the uncertainty range across the sectors. Uganda is however unable to report on the uncertainty for most of the sectors because of high dependency on secondary (with no uncertainty ranges) and expert judgement. Although the IPPCC 2006 inventory software has a sub-menu of uncertainty values to choose from, in such a situation quantitative calculation of the uncertainty generated is not informative and is mainly arbitrary. For the AFOLU sector qualitative uncertainty assessment for the land sub category for the years 2010 to 2015 is provided. IPCC 2006 inventory software generated uncertainty table is provided in Appendex.

2.10.3.1 Estimating map Accuracies

Based on the 7 steps for map accuracy assessment (Olofsson, 2014) and the map accuracy assessment guidelines (FAO (2016), three types of accuracy estimates presented for the 2010 to 2015 maps: overall accuracy (OA), user's accuracy (UA), and producer's accuracy (PA), including their 95% confidence intervals (table 2.64 and Table 2.65).

Overall accuracy ranges between 59% (land managed by NFA) and 81% (private land). Producer's and user's accuracy exhibit very different numbers, with much higher accuracies for the stable classes than for change classes. For the change classes, loss of tropical high forest (THF – NF) has high user's accuracies for private and NFA land, whereas woodlands are generally more difficult to detect.

Table 2.64: Accuracy estimates for private land

Forest Transition	Stratum	PA	CI of PA	UA	CI of UA
F – F	PI-PI	14.27	0.07	0.09	0
	THF-PI	0	0	NA	0
	THF-THF	39.98	0.06	34.08	0.11
	THF-WL	3.3	0.03	1.2	0.01
	WL-PI	0	0	0	0
	WL-WL	42.74	0.05	31.6	0.04
F – NF	PI-NF	0	0	0	0

	THF-NF	27.03	0.06	74.56	0.13
	WL-NF	10.35	0.02	44.67	0.08
NF – F	NF-Pl	0	0	NA	0
NF –NF	NF-NF	95.28	0.01	86.45	0
				OA	**80.81 ± 0.01**

PA = producer's accuracy, UA = user's accuracy, OA = overall accuracy. CI = confidence interval. UA is NA when area of reference data for that map stratum was 0.

Table 2.65: Accuracy estimates for land managed by NFA.

Forest transition	Stratum	PA	CI of PA	UA	CI of UA
F - F	Pl-Pl	67.92	0.1	7.92	0.01
	THF-Pl	2.06	0.03	3.37	0.05
	THF-THF	91.79	0.01	88.19	0.02
	THF-WL	10.83	0.05	25.73	0.09
	WL-Pl	10.82	0.04	5.28	0.02
	WL-WL	44.29	0.03	43.2	0.03
F – NF	Pl-NF	0.6	0.01	1.25	0.03
	THF-NF	8.54	0.03	67.49	0.13
	WL-NF	9.91	0.03	28.23	0.07
NF – F	NF-Pl	0	0	NA	0
NF –NF	NF-NF	84.5	0.02	62.35	0.02
				OA	**59.18 ± 0.01**

PA = producer's accuracy, UA = user's accuracy, OA = overall accuracy. CI = confidence interval. UA is NA when area of reference data for that map stratum was 0.

2.10.3.2 Estimating Biomass Stock Accuracies

Uganda's NFI 2019 report (GOU 2019) estimates the above ground biomass dry matter in the rainforests, commonly knonw as Tropical High Forest (THF) to be 161±9 tons (for low stocked THF) to 257±7 tons per hectare (for well stock THF) at 95% confidence level (Table 2.66). Aboveground biomass stock in open dry forests (woodland) is estimated at 25±2 tonnes per hectare at 95% confidence level which is just a tenth of that found in a well stocked THF. The below ground biomass is estimated to be about 24% of the above ground which translates into 39, 62 and 6 tonnes per hectare for THF low stock, THF well stocked and woodlands respectively.

Table 2.66: Biomass stocks in forests with level of accuracies

	AG Biomass	**Std**		**95% Confidence**
Forest Class	(Tons)	Deviation	Plots	
Tropical high forest low stock	161	154	1,089	±9
Tropical High Forest well stocked	257	186	3,006	±7
Woodland	25	27	998	±2

2.9 GHG Improvement Plan

Uganda is in the process of making improvements to the National GHG Inventory in several sectors. Almost all subsectors of AFOLU are targeted mainly because AFOLU is a Key Category (KC).

UBOS has just conducted a livestock census and issues of livestock characterisation have been addressed. Under the SIRGE[1] project are more efforts for livestock characterisation, improved data collection on animal feeds and formation of country specific emission factors (Table 2.67). Once the data is available there will be need for recalculating emissions from livestock.

Mapping of land use, land use change is taking advantage of freely available high temporal and high-resolution satellite imagery. This will enable Uganda to update that land use land cover statistics annually or biennially and to map and report on small forests / woodlots (1 hectare of less) that are scattered all over the landscape. In addition, map accuracy assessment has now been adopted in as part of the QA and QC in the mapping process. Once this is accomplished from 1995 to 2020, it will enable recalculation of emissions from land for all the years.

There are consultations between CCD and Uganda Revenue Authority on developing mechanisms of constantly accessing import and exports data of petroleum products, industrial products and agriculture inputs such as fertilizers. This is anticipated to improve on the estimation across all sectors.

Under the energy sector, there are ongoing efforts to make improvements in data reporting formats such as use tons, ktons, TJ, and Ktoe in MEMD reports such as the Uganda energy balance,

[1] Strengthen an Innovative System for the Reduction of Greenhouse Gas Emissions and Environmental Impacts of the Nascent Beef Industry in Uganda in Support to Rural Sustainable Transformation

energy abstract reports and UBOS annual reports. It is envisaged that more disintegrated data will be captured. This will be coordinated by CCD.

Due to the decline in lime usage in road construction, data on lime production is scanty. There are efforts to get information from the directorate of Geological Survey and Mines because the sharp change in emissions makes lime a key category.

Currently clinker usage is indirectly estimated from cement production. There are efforts by the Ministry of Trade Industries and Cooperatives (MTIC) to compile data on actual clinker production. This will enable Uganda move to Tier 2 in this respect. MTIC is in addition compiling data on usage of coal in the iron and steel industries. There are efforts to get data on transformer usage of SF6 from Umeme and Uganda Electricity Transmission Company.

Table 2.67: Planned improvements in GHG inventory

Category	Planned Areas for Improvement	Responsible entity	Expected time to be affected
3.A.1 Livestock Enteric fermentation	Livestock characterization	UBOS, MAAIF	Medium term; Report expected by end of 2023- ready for use in next inventory
3.A.2 Livestock Manure management	Document manure management systems	MAAIF	Medium term; Report expected by end of 2023- ready for use in next inventory
3.B Land remaining the same land and land conversion	Updating LUC maps annually (from 2years)	NFA with support from FAO, RCRMD-NASA	Medium term; Ready by next inventory
3.B Land remaining the same land and land conversion	Assess level certainty for the entire map time series	NFA Mapping Unit	Medium term; Ready by next inventory
3.B Biomass stock in land remaining the same land	Continuously update biomass Stock changes by land category	NFA Forest Inventory Unit	Long term; When funding is available
3.B.1 Forest land and 3.B.2 Cropland	Establish wood extraction	NFA and MWE with support from FAO FLEGET	Long term; When funding is available
3.C.1 (a, b, c and d) Biomass burning	Refined data on area burnt, fuel available for burning and Emission Factor for land category that is burnt	NFA Mapping Unit with support from FAO, NASA, RCMRD	Long term; When funding is available
3.C.(2,3,4,5 and 6) Application of N and urea in soils	Annual application of urea and N fertilizer (organic and chemical)	Data harmonization between CCD, MAAIF and URA on fertilizer imports and exports	Medium to long term; mainly requires improved coordination amongst government agencies.
3.C.7 Rice cultivation	Mapping of area under paddy rice, flood management, agricultural inputs and harvesting	NFA Mapping Unit and MAAIF	Medium term; Ready by next inventory
1.A	Harmonisation of data formats under energy balance use of TJ, Tons and TOE	MEMD	Medium term; Ready by next inventory

2.A.1	Data in domestic clinker production	MTIC	Medisum term; Ready by next inventory
2.C.1	Data on coal consumption in iron and steel industry	MTIC	Medium term; next inventory
2.G.2 FS6 Application	Data on importation & emission of FS6 used in the switch gears	UMEME/ Uganda Electricity Transmission Company	Medium term; ready by next invenotry
1.A.3 Transport	Initiatives to collect data on vehicle fleet, load factors, distances travel for various transport categories, boats, Fuel economy	MWT /MEMD	Long term; When funds are available
4.C.2 Open burning	Data on solid waste open burning and the amount	NEMA	Medium term: But highly dependent on availability of funds
4.C.1	Data on solid incineration burning and the amountt	NEMA	Medium term: when funds are available
1.A.1.a.ii Energy Industries	Bagasse consumption in sugar industry (thermal and electricity) Cogeneration	MEMD/ Private sector	Medium term/next inventory
1.A.1.a.I Energy Industries	Fuel consumption by UNERECO	MEMD	Next inventory
4.B Biological treatment of solid waste	The fraction of biomass undergoing composting	NEMA	Medium term: when funds are available
2.A.2 Lime industry	Lime production and consumption	MEMD	Short term/next inventory
2.D.2 Paraffin wax as feedstock	Data on consumption of paraffin wax	MTIC /NEMA	Next inventory
2.F.1.a Stationary Refrigeration and air conditioning	ODS consumption, Imports, re export	MTIC /NEMA URA	Medium term for detailed study
2.F.1.b Mobile Refrigeration and air conditioning	ODS consumption, Imports, re export	MTIC /NEMA/URA	Medium term for detailed study

2.D.1 Lubricant	Non energy use of petroleum	MEMD	next inventory
1.B.2.a Oil and gas exploration	Gas vented /flared	MEMD	next inventory
1.A.3.c Railway Transport	Diesel consumption	MWT / Uganda Railway Corporation	next inventory
1.A,4.c	Agriculture, fishing, forestry	MAAIF	Medium term
2F5 Solvents	Solvents use in paints	MTIC	Medium and long term
1.A.3a.ii Domestic aviation	Aviation fuel	MWT / UCA	Next inventory

Key:

- RUFORUM - The Regional Universities Forum for Capacity Building in Agriculture
- FLEGT - The FAO-EU Forest Law Enforcement, Governance and Trade Programme
- RCMRD - The Regional Centre for Mapping of Resources for Development
- IRGE - Strengthen an Innovative System for the Reduction of Greenhouse Gas Emissions and Environmental Impacts of the Nascent Beef Industry in Uganda in Support to Rural Sustainable Transformation

2.10 References for the Inventory

National Environment Management Authority (2017). Report on "Towards Sustainable Waste Management for Green Jobs, Wealth Creation and Improved Livelihoods".

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2.11 ANNEXES

Annex I: Non- AFOLU Annexes

Energy Sectoral Table (2017)

	Emissions (Gg)						
Categories	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
1 - Energy	4743.4401	123.362	2.023	50.067	1821.844	2747.329	6.91
1.A - Fuel Combustion Activities	4743.4401	123.362	2.023	50.067	1821.844	2747.329	6.91
1.A.1 - Energy Industries	122.77629	11.093	0.223	0.7853	398.105	94.25381	0.82
1.A.1.a - Main Activity Electricity and Heat Production	122.77629	0.00497	1E-03	0.2353	0.02502	0.00381	0.82
1.A.1.a.i - Electricity Generation	122.77629	0.00497	1E-03	0.2353	0.02502	0.00381	0.82
1.A.1.a.ii - Combined Heat and Power Generation (CHP)				0	0	0	0
1.A.1.a.iii - Heat Plants				0	0	0	0
1.A.1.b - Petroleum Refining				0	10	0	0
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries		11.088	0.222	0.55	388.08	94.25	0
1.A.1.c.i - Manufacture of Solid Fuels		11.088	0.222	0.55	388.08	94.25	0
1.A.1.c.ii - Other Energy Industries				0	0	0	0
1.A.2 - Manufacturing Industries and Construction	928.00804	2.06009	0.277	11.56	39.88	20.5	2.09
1.A.2.a - Iron and Steel				0	0	0	0
1.A.2.b - Non-Ferrous Metals				0	0	0	0
1.A.2.c - Chemicals				0	0	0	0
1.A.2.d - Pulp, Paper and Print				0	0	0	0
1.A.2.e - Food Processing, Beverages and Tobacco				0	0	0	0
1.A.2.f - Non-Metallic Minerals				0	0	0	0
1.A.2.g - Transport Equipment				0	0	0	0
1.A.2.h - Machinery				0	0	0	0
1.A.2.i - Mining (excluding fuels) and Quarrying				0	0	0	0

1.A.2.j - Wood and wood products				0	0	0	0
1.A.2.k - Construction				0	0	0	0
1.A.2.l - Textile and Leather				0	0	0	0
1.A.2.m - Non-specified Industry	928.00804	2.06009	0.277	11.56	39.88	20.5	2.09
1.A.3 - Transport	3103.5289	0.8325	0.153	17.121	76.107	2432.781	0.034
1.A.3.a - Civil Aviation				0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers) (1)							
1.A.3.a.ii - Domestic Aviation				0	0	0	0
1.A.3.b - Road Transportation	3103.5215	0.8325	0.153	16.151	74.895	12.781	0
1.A.3.b.i - Cars	1486.8064	0.54666	0.071	4.69	30.91	3.87	0
1.A.3.b.i.1 - Passenger cars with 3-way catalysts				0	0	0	0
1.A.3.b.i.2 - Passenger cars without 3-way catalysts	1486.8064	0.54666	0.071	4.69	30.91	3.87	0
1.A.3.b.ii - Light-duty trucks	696.8931	0.17051	0.035	3.14	16.56	1.69	0
1.A.3.b.ii.1 - Light-duty trucks with 3-way catalysts				0	0	0	0
1.A.3.b.ii.2 - Light-duty trucks without 3-way catalysts	696.8931	0.17051	0.035	3.14	16.56	1.69	0
1.A.3.b.iii - Heavy-duty trucks and buses	761.83396	0.0401	0.04	7.979	1.812	0.459	0
1.A.3.b.iv - Motorcycles	157.98806	0.07523	0.007	0.342	25.613	6.762	0
1.A.3.b.v - Evaporative emissions from vehicles				0	0	0	0
1.A.3.b.vi - Urea-based catalysts	0			0	0	0	0
1.A.3.c - Railways	0.00741	3E-07	6E-08	0.97	1.212	2420	0.034
1.A.3.d - Water-borne Navigation				0	0	0	0
1.A.3.d.i - International water-borne navigation (International bunkers) (1)							
1.A.3.d.ii - Domestic Water-borne Navigation				0	0	0	0
1.A.3.e - Other Transportation				0	0	0	0
1.A.3.e.i - Pipeline Transport				0	0	0	0
1.A.3.e.ii - Off-road				0	0	0	0
1.A.4 - Other Sectors	589.1269	109.377	1.37	20.6	1307.752	199.7938	3.965
1.A.4.a - Commercial/Institutional	131.46857	4.13314	0.041	2.8586	9.8781	5.1165	0.185
1.A.4.b - Residential	173.274	105.203	1.327	17.551	1297.693	194.6553	3.569

1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	284.38433	0.04104	0.002	0.191	0.181	0.022	0.212
1.A.4.c.i - Stationary				0.154	0.172	0.02	0.212
1.A.4.c.ii - Off-road Vehicles and Other Machinery	197.48213	0.0285	0.002	0.037	0.009	0.002	0
1.A.4.c.iii - Fishing (mobile combustion)	86.9022	0.01254	8E-04	0	0	0	0
1.A.5 - Non-Specified	0	0	0	0	0	0	0
1.A.5.a - Stationary	0	0	0	0	0	0	0
1.A.5.b - Mobile	0	0	0	0	0	0	0
1.A.5.b.i - Mobile (aviation component)				0	0	0	0
1.A.5.b.ii - Mobile (water-borne component)	0	0	0	0	0	0	0
1.A.5.b.iii - Mobile (Other)				0	0	0	0
1.A.5.c - Multilateral Operations (1)(2)							
1.B - Fugitive emissions from fuels	0	0		0	0	0	0
1.B.1 - Solid Fuels	0	0		0	0	0	0
1.B.1.a - Coal mining and handling	0	0		0	0	0	0
1.B.1.a.i - Underground mines	0	0		0	0	0	0
1.B.1.a.i.1 - Mining	0	0		0	0	0	0
1.B.1.a.i.2 - Post-mining seam gas emissions	0	0		0	0	0	0
1.B.1.a.i.3 - Abandoned underground mines				0	0	0	0
1.B.1.a.i.4 - Flaring of drained methane or conversion of methane to CO2	0	0		0	0	0	0
1.B.1.a.ii - Surface mines	0	0		0	0	0	0
1.B.1.a.ii.1 - Mining	0	0		0	0	0	0
1.B.1.a.ii.2 - Post-mining seam gas emissions	0	0		0	0	0	0
1.B.1.b - Uncontrolled combustion and burning coal dumps				0	0	0	0
1.B.1.c - Solid fuel transformation				0	0	0	0
1.B.2 - Oil and Natural Gas				0	0	0	0
1.B.2.a - Oil				0	0	0	0
1.B.2.a.i - Venting				0	0	0	0
1.B.2.a.ii - Flaring				0	0	0	0
1.B.2.a.iii - All Other				0	0	0	0

1.B.2.a.iii.1 - Exploration				0	0	0	0
1.B.2.a.iii.2 - Production and Upgrading				0	0	0	0
1.B.2.a.iii.3 - Transport				0	0	0	0
1.B.2.a.iii.4 - Refining				0	0	0	0
1.B.2.a.iii.5 - Distribution of oil products				0	0	0	0
1.B.2.a.iii.6 - Other				0	0	0	0
1.B.2.b - Natural Gas				0	0	0	0
1.B.2.b.i - Venting				0	0	0	0
1.B.2.b.ii - Flaring				0	0	0	0
1.B.2.b.iii - All Other				0	0	0	0
1.B.2.b.iii.1 - Exploration				0	0	0	0
1.B.2.b.iii.2 - Production				0	0	0	0
1.B.2.b.iii.3 - Processing				0	0	0	0
1.B.2.b.iii.4 - Transmission and Storage				0	0	0	0
1.B.2.b.iii.5 - Distribution				0	0	0	0
1.B.2.b.iii.6 - Other				0	0	0	0
1.B.3 - Other emissions from Energy Production				0	0	0	0
1.C - Carbon dioxide Transport and Storage	0			0	0	0	0
1.C.1 - Transport of CO2	0			0	0	0	0
1.C.1.a - Pipelines	0			0	0	0	0
1.C.1.b - Ships	0			0	0	0	0
1.C.1.c - Other (please specify)	0			0	0	0	0
1.C.2 - Injection and Storage	0			0	0	0	0
1.C.2.a - Injection	0			0	0	0	0
1.C.2.b - Storage	0			0	0	0	0
1.C.3 - Other	0			0	0	0	0

IPPU Sectoral Table (2017)

Categories	(Gg)			CO2 Equivalents(Gg)						
	CO2	CH4	N2O	HFCs	PFCs	SF6	NOx	CO	NMVOCs	SO2
2 - Industrial Processes and Product Use	349.777756	0	0	86.5445184	0	0	0	0	1.766	0
2.A - Mineral Industry	349.76526	0	0	0	0	0	0	0	0	0
2.A.1 - Cement production	343.44895						0	0	0	0
2.A.2 - Lime production	6.31631						0	0	0	0
2.A.3 - Glass Production	0						0	0	0	0
2.A.4 - Other Process Uses of Carbonates	0	0	0	0	0	0	0	0	0	0
2.A.4.a - Ceramics	0						0	0	0	0
2.A.4.b - Other Uses of Soda Ash	0						0	0	0	0
2.A.4.c - Non Metallurgical Magnesia Production	0						0	0	0	0
2.A.4.d - Other (please specify) (3)	0						0	0	0	0
2.A.5 - Other (please specify) (3)							0	0	0	0
2.B - Chemical Industry	0	0	0	0	0	0	0	0	0	0
2.B.1 - Ammonia Production	0						0	0	0	0
2.B.2 - Nitric Acid Production			0				0	0	0	0
2.B.3 - Adipic Acid Production			0				0	0	0	0
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0				0	0	0	0
2.B.5 - Carbide Production	0	0					0	0	0	0
2.B.6 - Titanium Dioxide Production	0						0	0	0	0
2.B.7 - Soda Ash Production	0						0	0	0	0
2.B.8 - Petrochemical and Carbon Black Production	0	0	0	0	0	0	0	0	0	0
2.B.8.a - Methanol	0	0					0	0	0	0
2.B.8.b - Ethylene	0	0					0	0	0	0
2.B.8.c - Ethylene Dichloride and Vinyl Chloride Monomer	0	0					0	0	0	0
2.B.8.d - Ethylene Oxide	0	0					0	0	0	0
2.B.8.e - Acrylonitrile	0	0					0	0	0	0

2.B.8.f - Carbon Black	0	0					0	0	0	0
2.B.9 - Fluorochemical Production	0	0	0	0	0	0	0	0	0	0
2.B.9.a - By-product emissions (4)				0			0	0	0	0
2.B.9.b - Fugitive Emissions (4)							0	0	0	0
2.B.10 - Other (Please specify) (3)							0	0	0	0
2.C - Metal Industry	0	0	0	0	0	0	0	0	0	0
2.C.1 - Iron and Steel Production	0	0					0	0	0	0
2.C.2 - Ferroalloys Production	0	0					0	0	0	0
2.C.3 - Aluminium production	0				0		0	0	0	0
2.C.4 - Magnesium production (5)	0					0	0	0	0	0
2.C.5 - Lead Production	0						0	0	0	0
2.C.6 - Zinc Production	0						0	0	0	0
2.C.7 - Other (please specify) (3)							0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use (6)	0.012496	0	0	0	0	0	0	0	0	0
2.D.1 - Lubricant Use	0.012496						0	0	0	0
2.D.2 - Paraffin Wax Use	0						0	0	0	0
2.D.3 - Solvent Use (7)							0	0	0	0
2.D.4 - Other (please specify) (3), (8)							0	0	0	0
2.E - Electronics Industry	0	0	0	0	0	0	0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor (9)				0	0	0	0	0	0	0
2.E.2 - TFT Flat Panel Display (9)					0	0	0	0	0	0
2.E.3 - Photovoltaics (9)					0		0	0	0	0
2.E.4 - Heat Transfer Fluid (10)					0		0	0	0	0
2.E.5 - Other (please specify) (3)							0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	86.5445184	0	0	0	0	0	0
2.F.1 - Refrigeration and Air Conditioning	0	0	0	81.3600538	0	0	0	0	0	0
2.F.1.a - Refrigeration and Stationary Air Conditioning				10.0710388			0	0	0	0
2.F.1.b - Mobile Air Conditioning				71.289015			0	0	0	0
2.F.2 - Foam Blowing Agents				0			0	0	0	0

2.F.3 - Fire Protection				5.18446458	0		0	0	0	0
2.F.4 - Aerosols				0			0	0	0	0
2.F.5 - Solvents				0	0		0	0	0	0
2.F.6 - Other Applications (please specify) (3)				0	0		0	0	0	0
2.G - Other Product Manufacture and Use	0	0	0	0	0	0	0	0	0	0
2.G.1 - Electrical Equipment	0	0	0	0	0	0	0	0	0	0
2.G.1.a - Manufacture of Electrical Equipment					0	0	0	0	0	0
2.G.1.b - Use of Electrical Equipment					0	0	0	0	0	0
2.G.1.c - Disposal of Electrical Equipment					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	0
2.G.2.a - Military Applications					0	0	0	0	0	0
2.G.2.b - Accelerators					0	0	0	0	0	0
2.G.2.c - Other (please specify) (3)					0	0	0	0	0	0
2.G.3 - N2O from Product Uses	0	0	0	0	0	0	0	0	0	0
2.G.3.a - Medical Applications			0				0	0	0	0
2.G.3.b - Propellant for pressure and aerosol products			0				0	0	0	0
2.G.3.c - Other (Please specify) (3)			0				0	0	0	0
2.G.4 - Other (Please specify) (3)							0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0	1.766	0
2.H.1 - Pulp and Paper Industry							0	0	0	0
2.H.2 - Food and Beverages Industry							0	0	1.766	0
2.H.3 - Other (please specify) (3)							0	0	0	0

Waste Sectoral Table (2017)

Categories	Emissions [Gg]						
	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
4 - Waste	8.890702223	289.4106651	3.01666614	0	0	0	0
4.A - Solid Waste Disposal	0	200.3847562	0	0	0	0	0
4.A.1 - Managed Waste Disposal Sites				0	0	0	0
4.A.2 - Unmanaged Waste Disposal Sites				0	0	0	0
4.A.3 - Uncategorised Waste Disposal Sites				0	0	0	0
4.B - Biological Treatment of Solid Waste		21.26922	1.2761532	0	0	0	0
4.C - Incineration and Open Burning of Waste	8.890702223	0.482351841	0.007070788	0	0	0	0
4.C.1 - Waste Incineration	1.711646933	2.23624E-06	0.000124723	0	0	0	0
4.C.2 - Open Burning of Waste	7.179055289	0.482349605	0.006946065	0	0	0	0
4.D - Wastewater Treatment and Discharge	0	67.27433708	1.733442152	0	0	0	0
4.D.1 - Domestic Wastewaster Treatment and Discharge		61.89365498	1.733442152	0	0	0	0
4.D.2 - Industrial Wastewater Treatment and Discharge		5.380682098		0	0	0	0
4.E - Other (please specify)				0	0	0	0

Annex II AFOLU Tables

AFOLU Sectoral Table (2017)

Categories	(Gg)					
	Net CO2 emissions / removals	Emissions				
		CH4	N2O	NOx	CO	NMVOCs
3 - Agriculture, Forestry, and Other Land Use	56473.87634	609.814302	29.63283197	18.14123898	362.6138046	0
3.A - Livestock	0	574.2351049	0.80985781	0	0	0
3.A.1 - Enteric Fermentation	0	551.176479	0	0	0	0
3.A.1.a - Cattle	0	449.703567	0	0	0	0
3.A.1.a.i - Dairy Cows		45.180878		0	0	0
3.A.1.a.ii - Other Cattle		404.522689		0	0	0
3.A.1.b - Buffalo		0		0	0	0
3.A.1.c - Sheep		20.98989		0	0	0
3.A.1.d - Goats		76.557535		0	0	0
3.A.1.e - Camels		0.0092		0	0	0
3.A.1.f - Horses		0		0	0	0
3.A.1.g - Mules and Asses		0		0	0	0
3.A.1.h - Swine		3.916287		0	0	0
3.A.1.j - Other (please specify)		0		0	0	0
3.A.2 - Manure Management (1)	0	23.05862594	0.80985781	0	0	0
3.A.2.a - Cattle	0	14.031312	0.320940142	0	0	0
3.A.2.a.i - Dairy cows		0.982193	0.035428756	0	0	0
3.A.2.a.ii - Other cattle		13.049119	0.285511385	0	0	0
3.A.2.b - Buffalo		0	0	0	0	0
3.A.2.c - Sheep		0.8395956	0	0	0	0
3.A.2.d - Goats		3.36853154	0.252665096	0	0	0
3.A.2.e - Camels		0	0	0	0	0
3.A.2.f - Horses		0	0	0	0	0
3.A.2.g - Mules and Asses		0	0	0	0	0
3.A.2.h - Swine		3.916287	0.196122242	0	0	0
3.A.2.i - Poultry		0.9028998	0.04013033	0	0	0

3.A.2.j - Other (please specify)		0	0	0	0	0
3.B - Land	56469.95849	0	0	0	0	0
3.B.1 - Forest land	43065.17496	0	0	0	0	0
3.B.1.a - Forest land Remaining Forest land	43457.19593			0	0	0
3.B.1.b - Land Converted to Forest land	-392.02097	0	0	0	0	0
3.B.1.b.i - Cropland converted to Forest Land	-136.9137			0	0	0
3.B.1.b.ii - Grassland converted to Forest Land	-242.71478			0	0	0
3.B.1.b.iii - Wetlands converted to Forest Land	-11.06424			0	0	0
3.B.1.b.iv - Settlements converted to Forest Land	-1.32825			0	0	0
3.B.1.b.v - Other Land converted to Forest Land	0			0	0	0
3.B.2 - Cropland	10611.34191	0	0	0	0	0
3.B.2.a - Cropland Remaining Cropland	0			0	0	0
3.B.2.b - Land Converted to Cropland	10611.34191	0	0	0	0	0
3.B.2.b.i - Forest Land converted to Cropland	10470.44519			0	0	0
3.B.2.b.ii - Grassland converted to Cropland	137.8989333			0	0	0
3.B.2.b.iii - Wetlands converted to Cropland	0			0	0	0
3.B.2.b.iv - Settlements converted to Cropland	2.99706			0	0	0
3.B.2.b.v - Other Land converted to Cropland	0.000733333			0	0	0
3.B.3 - Grassland	2727.190088	0	0	0	0	0
3.B.3.a - Grassland Remaining Grassland	0			0	0	0
3.B.3.b - Land Converted to Grassland	2727.190088	0	0	0	0	0
3.B.3.b.i - Forest Land converted to Grassland	2575.058255			0	0	0
3.B.3.b.ii - Cropland converted to Grassland	150.8165817			0	0	0
3.B.3.b.iii - Wetlands converted to Grassland	0			0	0	0
3.B.3.b.iv - Settlements converted to Grassland	1.589921667			0	0	0
3.B.3.b.v - Other Land converted to Grassland	-0.27467			0	0	0
3.B.4 - Wetlands	0	0	0	0	0	0
3.B.4.a - Wetlands Remaining Wetlands	0	0	0	0	0	0
3.B.4.a.i - Peatlands remaining peatlands	0		0	0	0	0
3.B.4.a.ii - Flooded land remaining flooded land				0	0	0
3.B.4.b - Land Converted to Wetlands	0	0	0	0	0	0
3.B.4.b.i - Land converted for peat extraction			0	0	0	0
3.B.4.b.ii - Land converted to flooded land	0			0	0	0
3.B.4.b.iii - Land converted to other wetlands				0	0	0

3.B.5 - Settlements	55.89136667	0	0	0	0	0
3.B.5.a - Settlements Remaining Settlements	0			0	0	0
3.B.5.b - Land Converted to Settlements	55.89136667	0	0	0	0	0
3.B.5.b.i - Forest Land converted to Settlements	52.82603333			0	0	0
3.B.5.b.ii - Cropland converted to Settlements	3.065333333			0	0	0
3.B.5.b.iii - Grassland converted to Settlements	0			0	0	0
3.B.5.b.iv - Wetlands converted to Settlements	0			0	0	0
3.B.5.b.v - Other Land converted to Settlements	0			0	0	0
3.B.6 - Other Land	10.36016667	0	0	0	0	0
3.B.6.a - Other land Remaining Other land				0	0	0
3.B.6.b - Land Converted to Other land	10.36016667	0	0	0	0	0
3.B.6.b.i - Forest Land converted to Other Land	0.716833333			0	0	0
3.B.6.b.ii - Cropland converted to Other Land	0			0	0	0
3.B.6.b.iii - Grassland converted to Other Land	9.445333333			0	0	0
3.B.6.b.iv - Wetlands converted to Other Land	0			0	0	0
3.B.6.b.v - Settlements converted to Other Land	0.198			0	0	0
3.C - Aggregate sources and non-CO2 emissions sources on land (2)	5.06	35.57919703	28.82297416	18.14123898	362.6138046	0
3.C.1 - Emissions from biomass burning	0	11.68714922	1.067087537	18.14123898	362.6138046	0
3.C.1.a - Biomass burning in forest lands		1.446719636	0.132091793	2.453133296	40.88555494	0
3.C.1.b - Biomass burning in croplands		2.7535945	0.25141515	2.9930375	110.14378	0
3.C.1.c - Biomass burning in grasslands		7.387968	0.6745536	12.527424	208.7904	0
3.C.1.d - Biomass burning in all other land		0.098867081	0.009026994	0.167644181	2.794069688	0
3.C.2 - Liming	0			0	0	0
3.C.3 - Urea application	5.06			0	0	0
3.C.4 - Direct N2O Emissions from managed soils (3)			20.87808211	0	0	0
3.C.5 - Indirect N2O Emissions from managed soils			6.877804514	0	0	0
3.C.6 - Indirect N2O Emissions from manure management			0	0	0	0
3.C.7 - Rice cultivation		23.89204781		0	0	0
3.C.8 - Other (please specify)				0	0	0
3.D - Other	-1.142149251	0	0	0	0	0
3.D.1 - Harvested Wood Products	-1.142149251			0	0	0
3.D.2 - Other (please specify)				0	0	0

AFOLU Uncertainity

2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO2 equivalent)	Year T emissions or removals (Gg CO2 equivalent)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year T	Type A Sensitivity (%)	Type B Sensitivity (%)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)	Uncertainty in trend in national emissions introduced by activity data uncertainty (%)	Uncertainty introduced into the trend in total national emissions (%)
3.B - Land												
3.B.1.a - Forest land Remaining Forest land	CO_2	1772.6949	43457.196	6	4	7.2111026	4.2874563	0.6590637	0.7362723	2.6362547	6.2474777	45.980817
3.B.1.b.i - Cropland converted to Forest Land	CO_2	-44.628393	-136.9137	2	4	4.472136	1.637E-05	0.0003809	0.0023197	0.0015235	0.006561	4.537E-05
3.B.1.b.ii - Grassland converted to Forest Land	CO_2	-98.40468	-242.71478	2	2	2.8284271	2.058E-05	0.0001628	0.0041122	0.0003256	0.011631	0.0001354
3.B.1.b.iii - Wetlands converted to Forest Land	CO_2	-11.06424	-11.06424	0	0	0	0	0.0002932	0.0001875	0	0	0
3.B.1.b.iv - Settlements converted to Forest Land	CO_2	-1.32825	-1.32825	0	0	0	0	3.52E-05	2.25E-05	0	0	0
3.B.1.b.v - Other Land converted to Forest Land	CO_2	0	0	0	0	0	0	0	0	0	0	0
3.B.2.a - Cropland Remaining Cropland	CO_2	0	0	3	2	3.6055513	0	0	0	0	0	0
3.B.2.b.i - Forest Land converted to Cropland	CO_2	10470.445	10470.445	3	2	3.6055513	0.0622224	0.2769781	0.1773952	0.5539562	0.7526242	0.8733106
3.B.2.b.ii - Grassland converted to Cropland	CO_2	137.89893	137.89893	3	2	3.6055513	1.079E-05	0.0036543	0.0023363	0.0073085	0.0099123	0.0001517
3.B.2.b.iii - Wetlands converted to Cropland	CO_2	0	0	0	0	0	0	0	0	0	0	0
3.B.2.b.iv - Settlements converted to Cropland	CO_2	2.99706	2.99706	0	0	0	0	7.942E-05	5.078E-05	0	0	0
3.B.2.b.v - Other Land converted to Cropland	CO_2	0.0007333	0.0007333	0	0	0	0	1.943E-08	1.242E-08	0	0	0
3.B.3.a - Grassland Remaining Grassland	CO_2	0	0	3	2	3.6055513	0	0	0	0	0	0
3.B.3.b.i - Forest Land converted to Grassland	CO_2	2575.0583	2575.0583	3	2	3.6055513	0.0037635	0.0682099	0.0436279	0.1364199	0.1850973	0.0528714
3.B.3.b.ii - Cropland converted to Grassland	CO_2	150.81658	150.81658	3	2	3.6055513	1.291E-05	0.0039966	0.0025552	0.0079932	0.0108408	0.0001814

Annex III: First National Communication Emissions Estimates, 1995

No.	GREENHOUSE GAS SOURCE AND SINK CATEGORY	CO2 (Gg)	CH4 (Gg)	N2O (Gg)	NOX	CO	NMVO C
	Total (Net) National Emission						
1	All Energy (Fuel Combustion + Fugitive)						
	A Fuel Combustion	* 708.610					
	Energy & Transformation including	--	--	--	--	--	--
	Industry (SIC)	--	0.207	0.053	--	--	--
	Transport	507.150	0.126	0.540	3.950	27.270	4.990
	Commercial/Institutional	63.000	--	--	--	--	--
	Residential	114.140	--	--	--	--	--
	Agriculture/Forestry	0.979	0.001	0.014	0.000	0.006	0.002
	Other (UEB Generators)	1.483	0.001	0.000	0.021	0.010	0.004
	Biomass Burned for Energy	13,763.000	74.520	4.704	22.810	822.930	--
	B Fugitive Fuel Emission						
	Oil Natural Gas Systems						
	Coal Mining						
2	Industrial Processes	--	--	--	--	--	--
	A. Iron and Steel	--	--	--	--	--	--
	B Non-Ferrous Metals						
	C Inorganic Chemicals						
	D Organic Chemicals						
	E non-metallic Mineral Products	43,4300.000					
	F Other (Foam)	0.070					

3	Solvent Use						
	A Paint Application	--	--	--	--	--	0.935
	B Degreasing and Dry Cleaning						0.057
	C Chemical Products Manufacture/Processing	--	--	--	--	--	--
	D Other	--	--	--	--	--	--
4	Agriculture						
	A Enteric Fermentation	--	197,400		--	--	--
	B Animal Wastes	--	7.050	--	--	--	--
	C Rice Cultivation	--	23.536	--	--	--	--
	D Agriculture Soils (Fertiliser Use)			0.002			
	E Agricultural Waste Burning	# 264.500	1.780	0.380	8.540	37.050	--
	F Savannah Burning	# 72,130.0	960.000	40.000	1,165.000	16,830.000	--
5	Lands Use Change and Forestry						
	A Forest clearing & On-Site Burning of Cleared Forest	2,834.750	1.971	0.014	0.319	17.243	--
	B Grassland conversion	6,641.900	4.015	--	--	--	--
	C Abandonment of Managed Lands	--	--	--	--	--	--
	D Managed (Forests Removals)	1,354.000	--	--	--	--	--
6	Waste						
	A Landfills	--	2.926	--	--	--	--
	B Waste water	--	--	--	--	--	--
	C Other (Pit Latrines)	--	1.600	--	--	--	--

* - Total emission

\# - Part of the natural cycle

Annex IV: Second National Communication Emissions Estimates, 2014

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)								
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissio ns	CO_2 Remova ls	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions and Removals	**11,759**	**-1,651**	**520**	**55**	**104**	**3,947**	**299**	**4**
1 Energy	**1,212**		**146**	**2**	**60**	**2,592**	**297**	**4**
A Fuel Combustion (Sectoral Approach)	1,212		146	2	60	2,592	297	4
1 Energy Industries	48							
2 Manufacturing Industries and Construction	102		1		3	47	1	
3 Transport	808				8	55	10	
4 Other Sectors	254		145	2	49	2,491	285	4
5 Other (please specify)								
B Fugitive Emissions from Fuels								
1 Solid Fuels	NO							
2 Oil and Natural Gas	NO							
2 Industrial Processes	**159**						**2**	
A Mineral Products	159							
B Chemical Industry	NO			NO				
C Metal Production	NO			NO				
D Other Production	NO						2	
E Production of Halocarbons and Sulphur								NE
Hexafluoride								

F Consumption of Halocarbons and Sulphur								
Hexafluoride								
G Other (please specify)								
3 Solvent and Other Product Use	**NE**			**NE**				
4 Agriculture			**272**	**52**	**12**	**222**		
A Enteric Fermentation			230					
B Manure Management			11	1				
C Rice Cultivation			22					
D Agricultural Soils				51				
E Prescribed Burning of Savannas			6		3	159		
F Field Burning of Agricultural Residues			3		9	63		
G Other (please specify)								
5 Land-Use Change & Forestry	**10,387**	**-1,651**	**69**	**1**	**32**	**1,132**		
A Changes in Forest and Other Woody								
Biomass Stocks	6,373	-467						
B Forest and Grassland Conversion	3,501	-993						
C Abandonment of Managed Lands		-192						
D CO_2 Emissions and Removals from								
Soil	513							
E Other (Non CO2 due to fires)			69	1	32	1,132		
6 Waste			**33**	**NE**				
A Solid Waste Disposal on Land			31					

B Wastewater Handling			2	NE				
C Waste Incineration	NE							
D Other (please specify)			NE	NE				
7 Other (please specify)								
Memo Items								
International Bunkers	**96**							
Aviation	96							
Marine								
CO_2 Emissions from Biomass	**30,419**							

CHAPTER 3

CLIMATE VARIABILITY AND CHANGE, CLIMATE CHANGE VULNERABILITY AND ADAPTATION MEASURES

3.1 Background and Introduction

Uganda aspires to become a middle-income country by the year 2030 (Vision 2040). The economy of the country upon which the aspiration is hinged is dependent on natural resources, where agriculture employs over 70% of the population, making the country recognize climate as a key resource (MWE, 2007). Thus, the country is highly vulnerable to impacts of climate variability and change.

This chapter analyses the state of climate variability for the period 1981-2010 as well as projected climate over Uganda for the period 2030 to 2060 classified as 2030s, 2040s and 2050s. Furthermore, the chapter highlights the state of: climate change vulnerability, impacts, and adaptation measures. It further provides updates on: Uganda's NAP processes, and Uganda's National Adaptation Technical Working Group (NATWG).

3.2 Climate Analysis for Uganda for the period 1981-2010

Observed climate data from the Uganda National Meteorological Authority (UNMA) was collected from 18 weather stations across the country that have consistent observed data over the period 1981-2010. Another set of merged satellite and observed data also provided by UNMA was used to fill the missing records in the original UNMA data set.

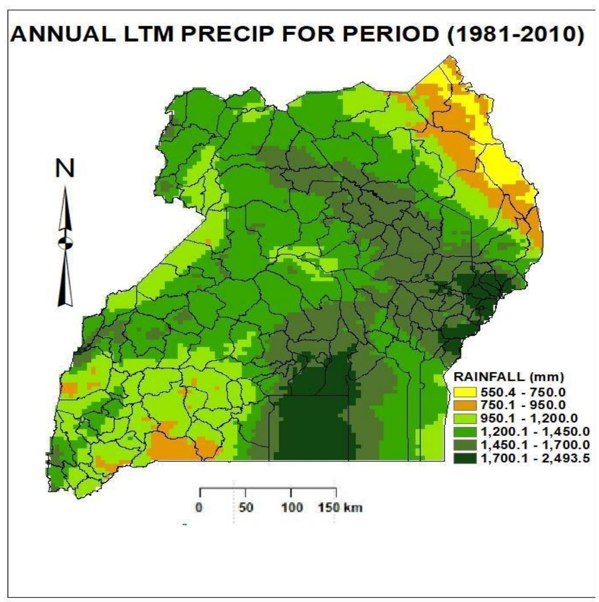

Figure 3.1: Mean annual rainfall climatology of Uganda for a period 1981-2010

GIS techniques were used to produce relevant maps for average rainfall and temperature in the stated climate period. Other climate characteristics such as the average rainy days, extreme rainfall (daily rainfall > 20mm) and extreme temperature (daily maximum temperature > 32^{o}C) were also analysed in the 1981-2010 climate period.

The results are presented in the subsections below.

3.2.1 Annual Rainfall

Total annual rainfall for the period 1981-2010 varied between 750- 2400mm with highest amounts of 1700-2400mm observed around the Lake Victoria and the Mt. Elgon region while the least amounts (750-950mm) are observed in the Karamoja region and some lower cattle corridor districts, such as, Isingiro (Figure 3.1).

Further analysis was done on seasonal rainfall and the results are presented in figures 3.2. Analysis of rainfall data for the period 1981-2010 shows that the country still has two major rainfall seasons of March to May (MAM) and September to November (SON) for most parts of the country especially central, and south and western Uganda while the northern region also receives rainfall in the June to August (JJA) season. In all the regions the season of December to February (DJF) is always dry (Figure 3.2).

The MAM season is still a major season in all parts of the country especial the Central, Eastern and Western parts of the country. High amounts of between 450- 1000mm are observed in the Lake Victoria basin as well the Elgon region because of the Land-Lake breeze effects as well as topography in Elgon region. The rest of the country receives a total seasonal rainfall of about 250-450mm apart from the Karamoja area that receives on average seasonal of less than 150mm.

The JJA season is mainly a wet season for Northern parts of the country with most places in Western and Southern Uganda receiving less than 150mm for this period. The SON season is also for the entire country because of the apparent movement of the sun north and south of the equator that creates two major seasons in countries around the equator.

The DJF is a dry period in most parts of the country especially in the Northern parts. However, places around Lake Victoria and South Western Uganda are observed to receive some significant amounts of between 150-350mm which used to be a dry period for the entire country.

3.2.1.1 Rain Days and Extreme Rainfall Analysis

Analysis was also done the number of rain days per decade for the period as well average number of days with daily rainfall greater than 20mm in the specified climate period. A rainy day is taken as a day whose rainfall is greater than 1mm. From analysis the total annual rain days varied from 65 to more than 110 days across the country with fewer days observed of 55-75 observed in the Karamoja region and over 110 rain days observed around Lake Victoria as well as the Elgon area (Figure 3.3).

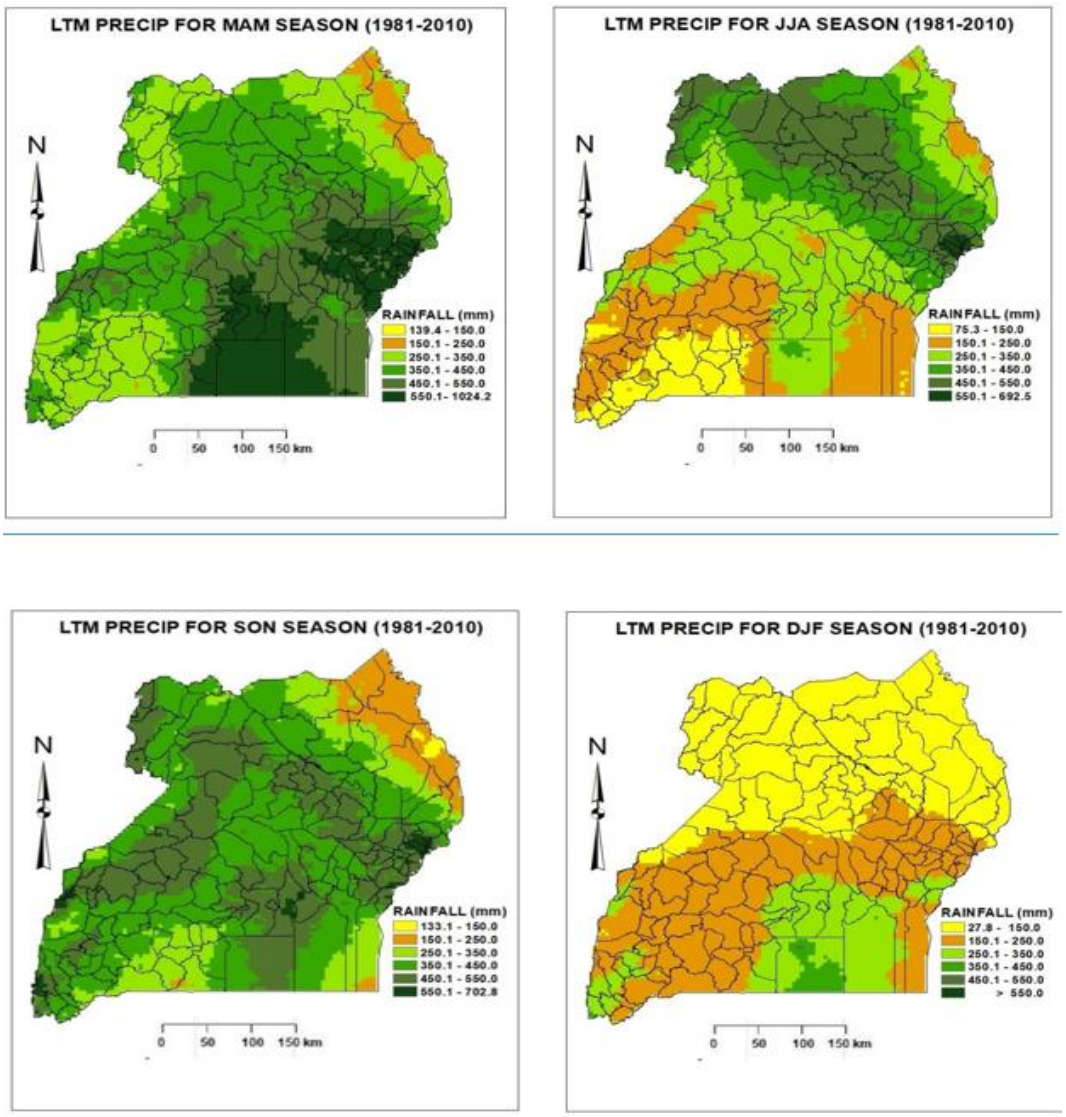

Figure 3.2: Average Seasonal rainfall in the major seasons of Uganda for the period 1981-2010

Counts of extreme rainfall with days greater than 20mm follows a similar pattern with over 25 days observed around Lake Victoria, Elgon Region and central Northern region (figure 3.3). Further analysis of extreme rainfall shows that days with more than 50mm rainfall of 4-5 are observed in the Lake Victoria basin as well as the Elgon region.

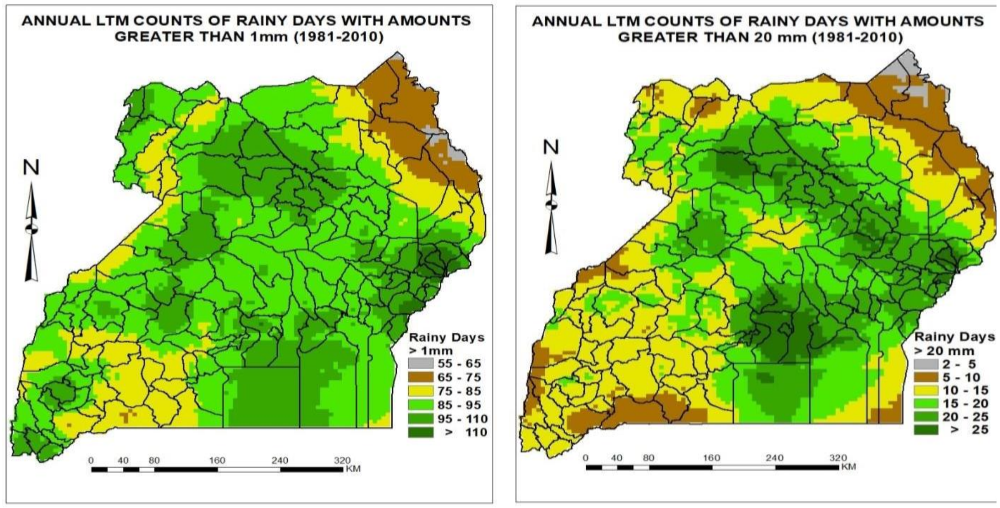

Figure 3.3: Annual counts of Rainy days (>1mm) and Rainy days Greater than 20mm

3.2.2 Annual Temperature Variation

Analysis was done for the mean annual minimum, maximum and mean temperature for the period 1981-2010. Mean annual temperatures of between 24.6 and 26.4°C are observed in the Northern parts of country. The lowest mean temperature of between 12.4 and 20 °C is observed on Mt. Elgon, Mt. Rwenzori and the Kigezi highlands in South Western Uganda. The rest of the country recorded an annual mean temperature of between 20.1°C and 24.4°C (Figure 3.4).

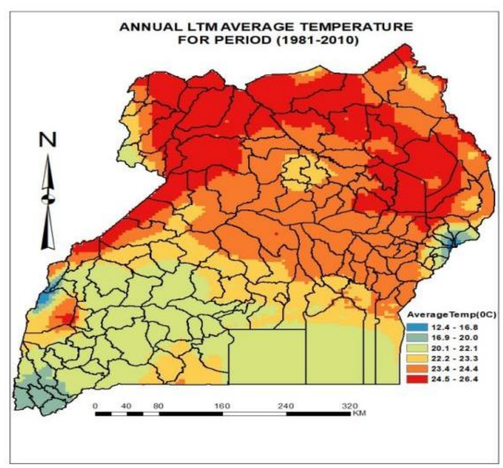

Figure 3.4: Annual mean temperature for 1981 – 2010 climate period

Analysis of mean maximum and minimum temperature show a similar pattern across the country with maximum temperatures of between 30.4 – 31.8 °C observed in most parts of Northern Uganda while other parts of the country are between 18 and 30 °C (Figure 3.5).

Further analysis of the number of hot days (daily temperature greater than 32°C) reveal that most of these events in the northern parts of country compared to the southern parts and there are more events in the 2001-2010 decade compared to other decades.

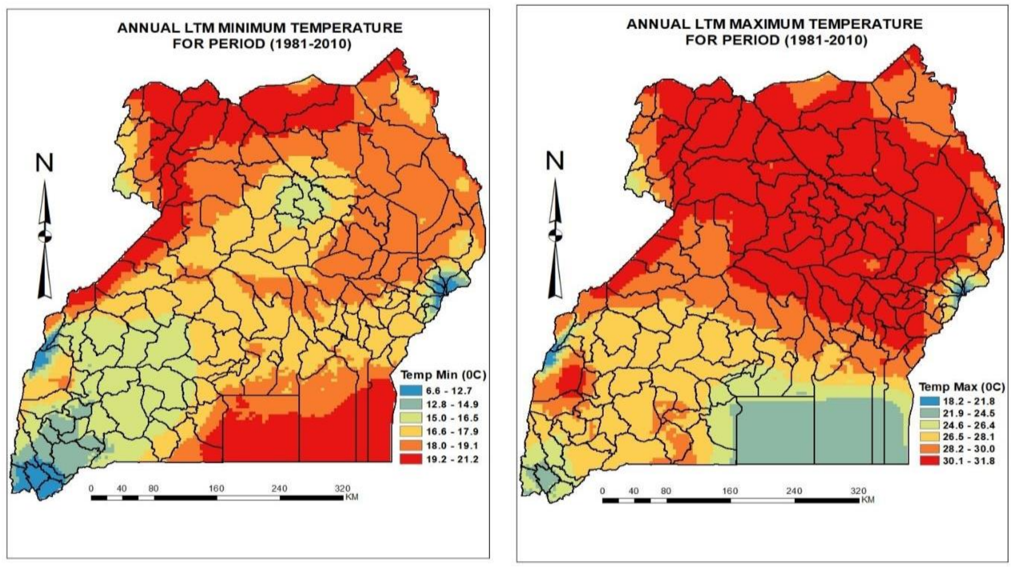

Figure 3.5: Mean annual Minimum and Maximum temperature for the period 1981-2010

3.3 Projected Climate over Uganda for the Period 2030 - 2050

The Second National communication (SNC) used statistical downscaling to understand the possible future climate of Uganda, however new data sets and developments like the Coordinated Regional Downscaling Experiment (CORDEX) by the World Climate Research Program (WCRP) are now available and this has contributed much in understanding the future climate of the region and Africa as a whole.

3.3.1 Methodology for Climate Scenario Development

Analysis on future projections was therefore done using the CORDEX grand ensemble that has all the GCM-RCM combinations in the data set for RCP 2.6, RCP 4.5 and RCP 8.5 to understand future dynamics of climate over Uganda. For RCP 2.6 an ensemble of 13 RCM-GCM runs was used while for RCP 4.5 and RCP 8.5 an ensemble of 25 models were used in the analysis. CORDEX Africa downscaling initiative has 11 Regional Climate Modelling (RCM) centers downscaling most of the Global Circulation models (GCMs) under the Coupled Model Inter-comparison Project 5(CMIP5). The model runs ae for a period of 1950 to 2100 which captures both the recent historical and the future period as used in most IPCC reports. The details of the RCMs and GCMs used under the CORDEX Africa is represented in Table 3.1. The data was analyzed using the climate data operator as well as R software to understand the rainfall and temperature projections for the identified periods. The projections are given as ranges from the minimum to the maximum as represented from the different RCPs to capture the uncertainties in the rainfall and temperature projections. Temperature analysis was done at climate level (2031-2060) as well decade level (2030s, 20402 and 2050s) to understand the projected temperature changes relative to the 1981-2010 baseline. The results of temperature are reported as incremental values relative to the basin. Analysis for Rainfall was also done at climate level and decade level but additional analysis was done on seasonal disaggregated data to understand seasonal rainfall projections in each of the decades as well as the entire climate period of 2031-2060. The rainfall projections are presented as percentage increases relative to the 1981-2010 climate period. Also covered here is a review of previous climate projection studies in the country that have been reported in literature.

Table 3.1: CORDEX Africa RCMs, their driving GCMs and RCPs downscaled by each RCM

AFR-44 CORDEX simulations			
RCM	Driving GCM	RCPs	Period
SMHI-RCA4	CCCma-CanESM2	45, 85	1951-2100
	CNRM-CERFACS-CNRM-CM5	45, 85	1951-2100
	MOHC-HadGEM2-ES	26,45, 85	1951-2099
	NCC-NorESM1-M	26,45, 85	1951-2100
	ICHEC-EC-EARTH	26,45, 85	1951-2100
	MIROC-MIROC5	26,45, 85	1951-2100
	NOAA-GFDL-GFDL-ESM2M	45, 85	1951-2100
	MPI-M-MPI-ESM-LR	26,45, 85	1951-2100
	IPSL-IPSLCM5A-MR	45, 85	1951-2100
	CSIRO_QCCCE-CSIRO-Mk3-6-0	45, 85	1951-2100
KNMI-RACMO22T	ICHEC-EC-EARTH	45, 85	1950-2100
	ICHEC-EC-EARTH	26	1950-2100
	MOHC-HadGEM2-ES	26, 45, 85	1951-2099
DMI-HIRHAM5	ICHEC-EC-EARTH	45, 85	1951-2100
	NCC-NorESM1-M	45, 85	1951-2100
CLMcom-CCLM4-8-17	CNRM-CERFACS-CNRM-CM5	45, 85	1950-2100
	MOHC-HadGEM2-ES	45, 85	1951-2099
	ICHEC-EC-EARTH	45, 85	1950-2100
	MPI-M-MPI-ESM-LR	45, 85	1950-2100
CCCma-CanRCM4	CCCma-CanESM2	45, 85	1950-2100
BCCR-WRF331C	NCC-NorESM1-M	45, 85	1951-2100
MPI-CSC-REMO2009	ICHEC-EC-EARTH	26,45, 85	1950-2100
	MPI-M-MPI-ESM-LR	26,45, 85	1950-2100
GERICS-REMO2009	IPSL-IPSLCM5A-LR	26,85	1950-2100
	MIROC-MIROC5	26	1950-2100
	MOHC-HadGEM2-ES	26	1950-2099
	NOAA-GFDL-GFDL-ESM2G	26	1950-2100

UQAM--CRCM5	CCCma-CanESM2	45	1951-2100
	MPI-M-MPI-ESM-LR	45	1951-2100
CNRM-ALADIN53	CNRM-CERFACS-CNRM-CM5	45, 85	1951-2100
ICTP-RegCM4-3	MPI-M-MPI-ESM-LR	85	1979-2099

3.3.2 Review of Previous Climate Projection Studies

A review of studies such as McSweeney *et al.,* (2007); Christensen *et al*. (2013); Hepworth and Goulden, (2008); Caffrey *et al.,* (2013); USAID, (2013); and MWE, (2015a) on climate projections has been done. Most of the studies reported on the mean temperature and rainfall projections using some selected models. A summary of the findings are presented in Tables 3.2 and 3.3.

Table 3.2: Previous studies on Rainfall projections over Uganda

Study	Period	Trend
McSweeney et al., 2007	2090-2099	annual rainfall changes of -8 to +46% relative to 1970-1999 average
Hepworth and Goulden ,2008	2020-2029 2080-2089 2080s	Annual rainfall expected to increase by 7% relative to 1960-1990 average Annual rainfall expected to increase by 13% relative to 1960-1990 average December to February (DJF) season rainfall which is usually a dry season is expected to increase by 13%
Carol et al., 2012	2070-2100	-MAM rain increment of 0.2 mm day^{-1} - SON rainfall, decrease of 0.7 mm day^{-1}
USAID, 2013	2015-2045	No significant changes are expected in total annual rainfall relative to 1961-1990 average A significant increase in rainfall is expected in the December to February (DJF) season which is usually a dry season
Caffrey et al., 2013	2035 2065 2100	Precipitation will not change significantly compared to 1971-2000 average Precipitation will increase on average by 4% relative to 1971-2000 average Precipitation will increase on average by 11% relative to 1971-2000 average
MWE, 2015	2046-2065 2076-2095	annual rainfall changes of -10 to +5% for RCP4.5 and 1 to 5% for RCP8.5 relative to 1985-2005 average Decrease in the Lake Victoria expected to be up to 70mm per month under RCP 4.5 and by 100mm under RCP 8.5 annual rainfall changes of -5 to -20% for RCP4.5 and -20 to 20% for RCP8.5 relative to 1985-2005 average

Table 3.3: Previous studies on temperature projections over Uganda

Study	Period	Trend
McSweeney et al., 2007	2060-2069 2090-2099 2090-2099	annual temperature increase of 1.0 to 3.1°C relative to 1970-1999 average annual temperature increase of 1.4 to 4.9°C relative to 1970-1999 average June to August (JJA) season expected to warm faster than other seasons with an increase in mean temperature of 1.5 to 5.4 relative to the 1970-1999 average
Hepworth and Goulden ,2008	2020-2029 2080-2089	annual temperature increase of 0.7 to 1.5°C relative to 1960-1990 average annual temperature increase of 1.3 to 4.3°C relative to 1960-1990 average
Carol et al., 2012	2070-2100	MAM and SON temperature increase of 0.9ºC relative to 1960-1991 average JJA temperature increase of 0.6ºC relative to 1960-1991 average
Christensen et al 2013	2035 2065 2100	Annual mean temperature increase of 0.6°C to 1.5°C relative to 1986-2005 average Annual mean temperature increase of 1.6°C to 3.2°C relative to 1986-2005 average Annual mean temperature increase of 2.4°C to 5.6°C relative to 1986-2005 average
USAID, 2013	2030-2039	Annual temperature increase greater than 2°C relative to 1961-1990 average
MWE, 2015	2046-2065 2076-2095	Annual temperature increase of 1.5 to 2°C relative to 1986-2005 average under RCP4.5 Annual temperature increase of 2 to 3°C relative to 1986-2005 average under RCP 8.5 Annual temperature increase of 2 to 2.5°C relative to 1986-2005 average under RCP 4.5 annual temperature increase of 4 to 5°C relative to 1986-2005 average under RCP8.5

3.3.3 Temperature Projections over Uganda for the Period 2030 - 2060

Mean annual Temperature projections at climate level (2031-2060) show projected temperature increases of 1 to 1.5°C under RCP 2.6 and RCP 4.5 for most parts of the country while RCP 8.5 projects an increase in temperature of 1.5 to 2.5 °C relative to the 1981-2010 average (Figure 3.6). In terms of decadal changes, temperature projections show a similar pattern across the country for the 2030s (2031-2040) under the three RCPs scenarios with annual mean temperatures projected to increase by 0.5 to 1.5 °C relative to the 1981-2010 average. The changes begin manifesting in 2040s (2041-2050) with RCP 8.5 projecting more temperature increases compared to other scenarios and is pronounced in the 2050s (2051-2060) where RCP 8.5 projects temperatures across the country to be in the range of 1.5 to 3 °C relative to the 1981-2010 average. The results of decadal temperature projections are represented in Figure 3.7. The Northern and South Western regions of the country are projected to have the highest temperatures increase of between 2.5 and 3°C compared to other areas especially in the 2050s.

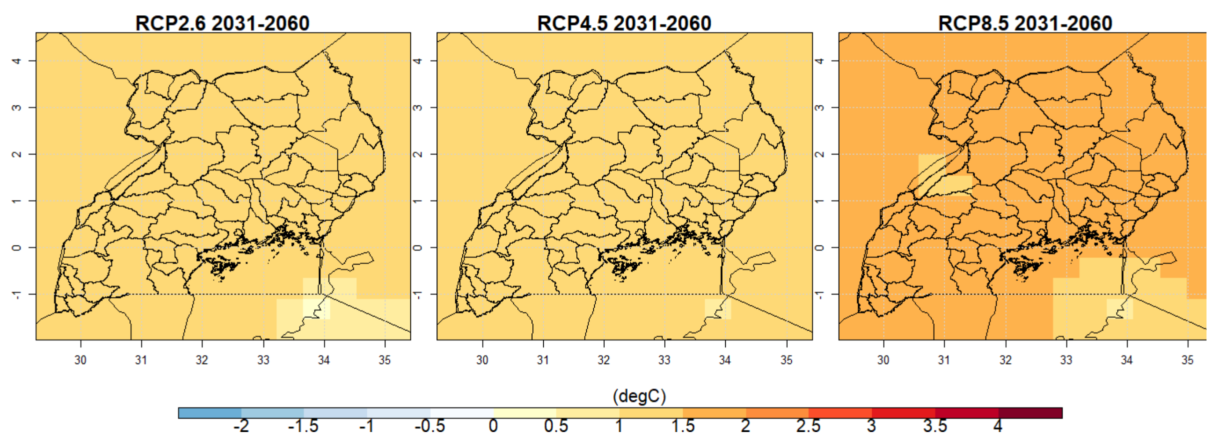

Figure 3.6: Projected mean annual temperature changes for the 2031-2060 climate period in relation to the 1981-2010 average

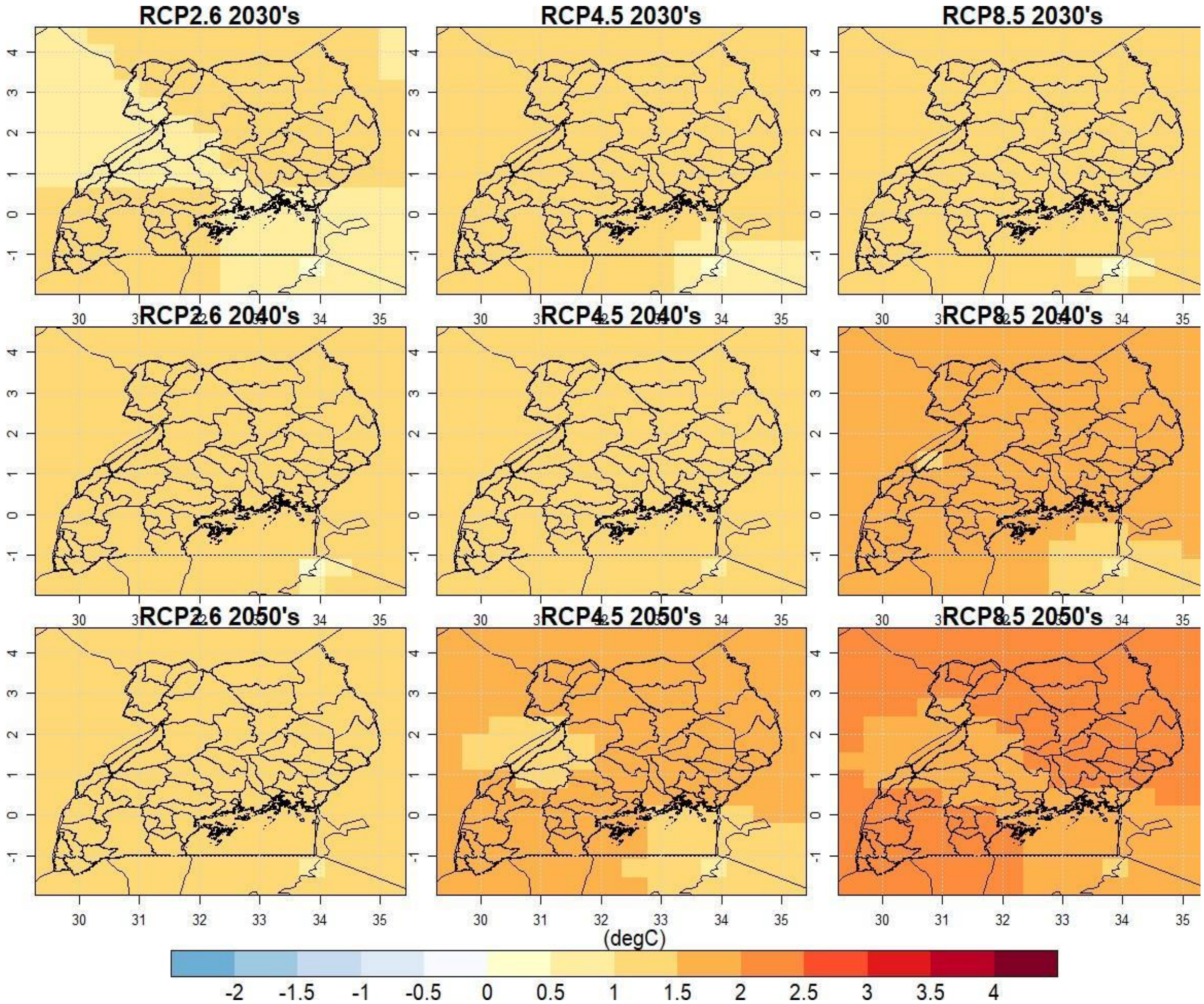

Figure 3.7: Projected mean annual temperature changes per decade from 2030 to 2050s relative to the 1981-2010 average

3.3.4 Rainfall Projections over Uganda

Mean total annual rainfall unlike temperature does not show a similar pattern across the country where some areas rainfall is projected to increase and others rainfall is projected to decrease. Figure 3.8 shows the mean annual rainfall projections for the climate period 2031-2060 for the three RCP scenarios analyzed. Under RCP2.6 much of the country rainfall is not expected to change in the climate period 2031-2060 compared to the 1981-2010 average apart from the Masindi, Hoima area as well as Karamoja region where rainfall is projected to decrease by 5 to 10 % relative to the baseline.

Under RCP 4.5 no significant changes are also projected across the country with only South Western highlands projected to have an increase in rainfall of between 5 to 10% relative to the baseline. Under RCP 8.5 mean annual rainfall in the 2031-2060 period is expected to decrease by 5 to 15% in most parts of central Uganda, increase by 5 to 10% in South Western Uganda while other parts of the country are projected not to have significant changes in annual rainfall (Figure 3.8).

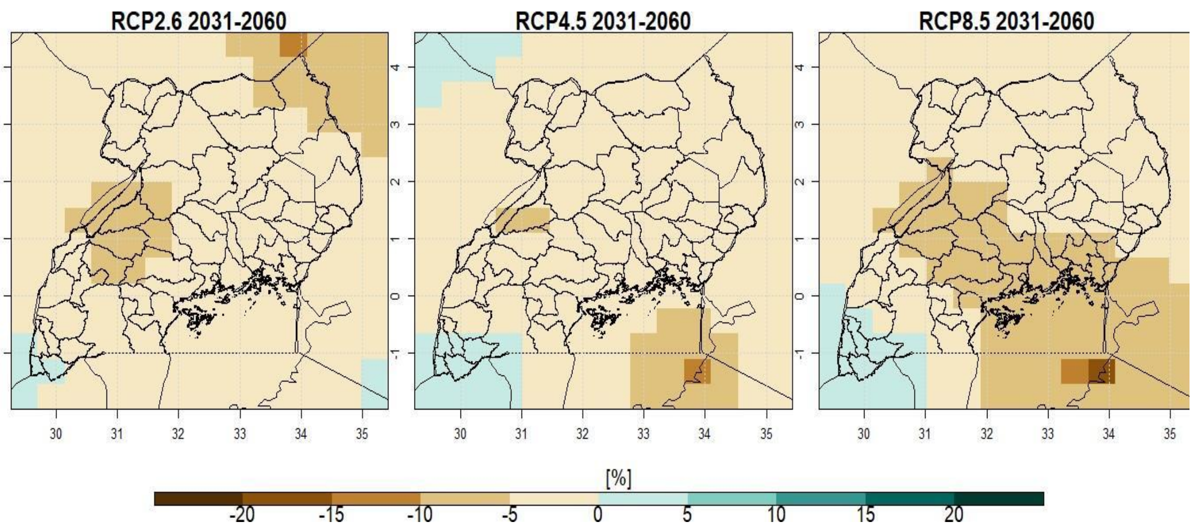

Figure 3.8: Projected mean total annual precipitation for the 2031-2060 climate period in relation to the 1981-2010 average

Analysis of rainfall changes per decade do not show different patterns as those observed in the combined climate period of 2031-2060 as represented in Figure 3.8. Significant changes are only projected in the 2040s under RCP 4.5 and RCP 8.5. For the 2040s under RCP 4.5 the Northern region, Western Region and Karamoja area are projected to have an increase in rainfall of 5 to 10% relative to the baseline while other parts will not have any significant changes in annual rainfall. Under RCP 8.5 the central parts of the country are projected to have reduced rainfall of about 5 to 15% while other areas are not expected to have significant rainfall changes in this period (Figure 3.9). Seasonal projections show that rainfall is projected to increase especially in the SON season as observed in Figure 3.10.

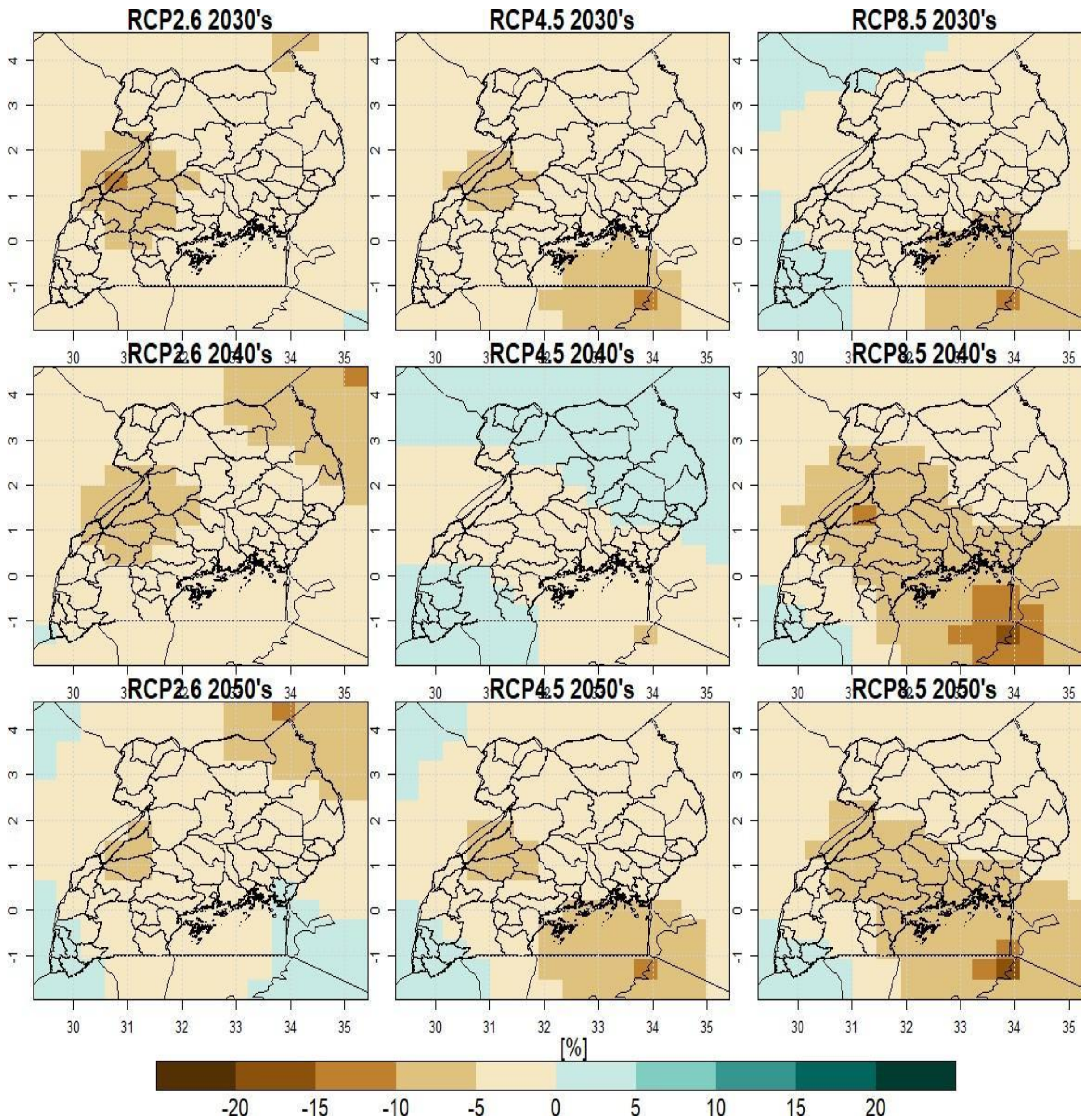

Figure 3.9: Projected mean total annual precipitation per decade from 2030 to 2050s relative to the 1981-2010 average

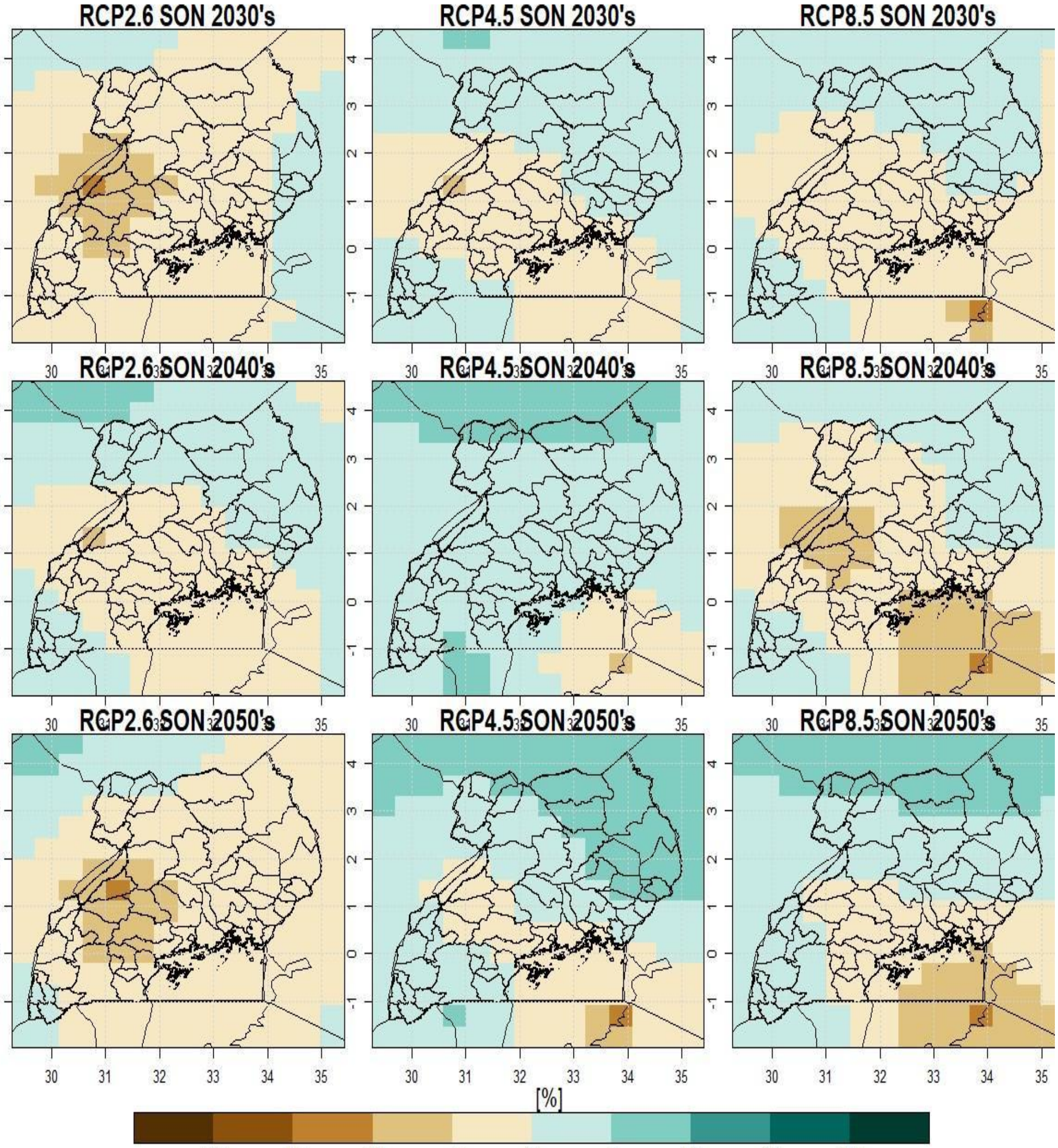

Figure 3.10: Projected SON Seasonal precipitation per decade from 2030 to 2050s relative to the 1981-2010 average

3.4 Uganda's Vulnerability to Climate Change

Climate change vulnerability in Uganda is reflected at both national, sub-national and at sectoral level for the major sectors of the economy. The vulnerability of Uganda's population to climate variability and change is determined by the nature of the changes in climate to which the country is exposed and by national capacities to manage, recover from, and adapt to the expected changes. This section includes a description of key climate vulnerabilities in relation to flood risk as well as landslide risk. Also highlighted, is the assessment of vulnerability in some of the key economic sectors specified in the "Uganda National Climate Change Policy 2015".

3.4.1 Current drivers of vulnerability in Uganda

According to the Human Development Report by the United Nations Development Programme (UNDP, 2020), Uganda is ranked among the countries with low levels of human development with an index of 0.544 ranked as 159 out of 189 countries on the Human Development Index. However, with this low rank, the country has made some good efforts especially in life expectancy at birth that has increased from 46.2 in 2000 to 63.4 in 2019 (UNDP, 2020). With respect to education, Uganda children are in school for an average of 6.2 years, which is below the global expected average of 11.4 years. Table 3.4 below shows the HDI components of the country in relation to some selected countries in the region.

Table 3.4: Uganda HDI component Indicators for 2019 in relation to some selected countries

Country	HDI Value	HDI Rank	Life expectancy at birth	Expected years of schooling	Mean years of schooling	GNI Per capita (US $)
Uganda	0.544	159	63.4	11.4	6.2	2123
Madagascar	0.528	164	67.0	10.2	6.1	1596
Tanzania	0.529	163	65.5	8.1	6.1	2600
SSA average	0.547		61.5	10.1	5.8	3686

Source: UNDP (2020)

Uganda's population was 42.72 million in the year 2018 ranks number 31 in the entire world and its growth rate of 3.32% makes it one of the fastest growing population in the world. (UBOS, 2019). This increased population is expected to exert more pressure on the already stressed natural resources and thus contributing to more population's exposure to climate risk and vulnerability.

According to the University of Notre Dame's Global Adaptation Index (ND-GAIN), which measures levels of vulnerability to climate change as well as the readiness of countries to respond to it, Uganda is the 40th most vulnerable country of the 180 countries included in the index.5 Vulnerability is assessed according to the following sectors: food, water, health, ecosystem services, human habitat, and infrastructure

3.4.2 Vulnerability in Relation to Major Hazards

The major climate hazards in Uganda include floods, droughts, landslides, earth quakes, heavy storms and epidemics among others. The new methodology of vulnerability assessment understand vulnerability as an internal property of a system enables assessment of hazard specific vulnerability by selecting hazard-relevant indicators for sensitivity and adaptive capacity. Vulnerability is therefore a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (Jagmohan and Nijavalli, 2019). In this review vulnerability to geo-hazards, landslides and drought is discussed in this section.

According to Staudt et al. (2014), the major hazards classified as geo-hazards in Uganda include landslides, floods, earthquakes and volcanic eruptions. They mapped out areas that are prone to these geo-hazards across the country using GIS. The mountainous areas of Elgon in Eastern Uganda and Rwenzori in Western Uganda were identified as areas that are more prone to landslides. Areas in Eastern and Northern Uganda are more prone to floods. Figure 3.11 below shows the results of Staudt et al., (2014) from their mapping project. In the past decades, Uganda has experienced more erratic rainfalls, leading to the frequent bursting of rivers, mudslides and landslides that cause loss of life and loss of property in the communities, especially those living in mountainous areas. At the same time, people living in low-lying lands are experiencing floods. Prolonged dry seasons are also frequent, leading to loss of crops and livestock (MWE, 2015a).

Musinguzi and Imaculate (2014) mapped the risk of landslides in Uganda with mountainous areas of Elgon region, Rwenzori Region and the Kigezi highlands as areas that have a higher risk compared to others.

Other studies have mapped out other hazards such as floods especially the flash floods. The risk to flooding especially flash flooding is common near major rivers and in low lying planes of Eastern Uganda. A number of flooding events have been reported in Teso region, Butareja district and Ntoroko in Western Uganda. Figure 3.12 below shows the areas the more prone to flooding events across the country (Think hazard, 2020)

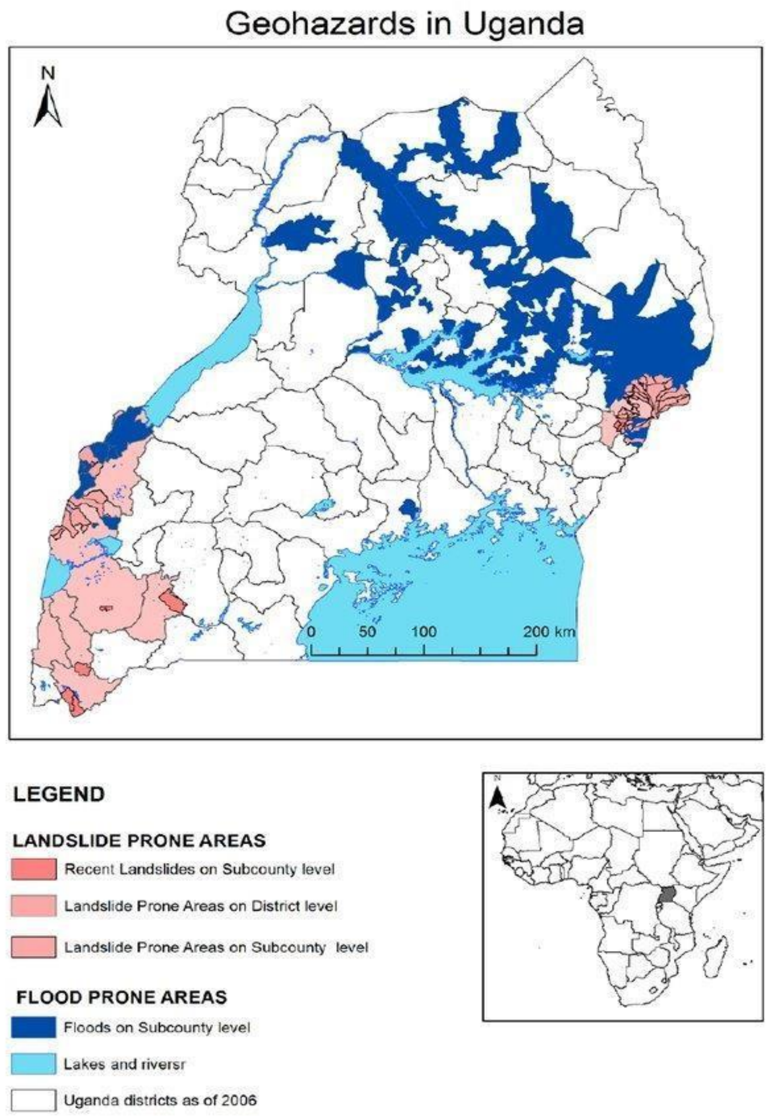

Figure 3.11: Uganda Geo-Hazards (adopted from Staudt *et al.*, 2014)

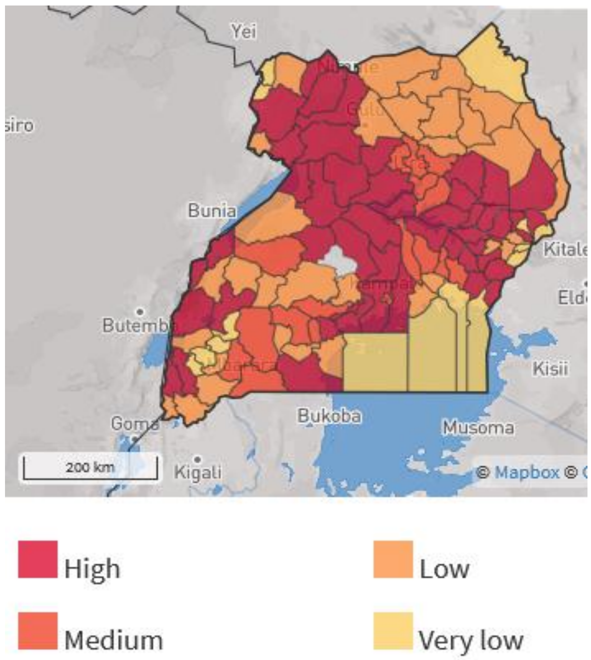

Figure 3.12: Flood risk mapping

(Adopted from Think hazard; https://thinkhazard.org/en/report/253-uganda)

3.5 Vulnerability in Key Sectors of the Economy

The "Uganda National Climate Change Policy 2015" (NCCP) highlights key sectors that are vulnerable to the impacts of climate change, and the same sectors are prioritized in Uganda's "Third National Development Plan (NDPIII) 2020/21 – 2024/25". This section analyses the vulnerability of the sectors to the impacts of climate change. These sectors are: Agriculture, Water, Wetlands, Health, Forestry, Energy, Disaster Risk Management, Transport and Works, Wildlife and Tourism, Human Settlements and Social Infrastructure, and Biodiversity.

3.5.1 Vulnerability in Agriculture Sector

Agriculture is an important sector in Uganda because it contributes 21.9 of Uganda's GDP and accounts for 64.6% of the total working population. In terms of gender more employed women (70.5%) are employed in the agricultural sector compared to 58.5% of the total employed men (UBOS, 2019). More than 80% of Uganda rural population, most of them small holder farmers, rely on subsistence agricultural production which is mainly rain-fed and very few depend on irrigation. The rain-fed agriculture is dependent on climate and therefore farmers or agriculture in general is susceptible to any changes in climate. Agriculture is central to Uganda's economic growth, poverty reduction strategy, and industrialization (agro-processing and light manufacturing), (NPA, 2020). There is gender disparity with regard to vulnerability to climate change, in that, women who are the majority in the agriculture sector, are more vulnerable compared to men who have more opportunities for alternative livelihood activities.

This section discusses the general impacts of climate change in the agriculture sector as well as vulnerability of the different sub-sectors within the agriculture sector i.e. crop, livestock, and fisheries sub-sectors. Furthermore, the section lists the adaptation options for each sub-sector recommended in the NCCP, as starting points for implementation of adaptation measures in each sub-sector.

3.5.1.1 General Impacts of Climate Change in Agriculture Sector

In Uganda, climate change affects agriculture in the following ways;

a) Reducing area suitability of some agricultural crops
b) Altering the length of the growing season
c) Reducing the yield potential
d) Increasing the incidence of plant pests and diseases

Increased temperatures may diminish soil moisture and accelerate soil erosion affecting arability and therefore reduces on the extent of agricultural land. Increased temperatures may also reduce the number of days in which conditions are conducive to crop growth leading to shortening of the growing season. Temperatures may also alter the occurrence and distribution of pests and diseases that may harm crops and livestock.

Increased cases of extreme events especially floods and droughts may lead to increased water stress on crops leading to decreased yields. Droughts may also lead to decrease in the quantity and quality of grazing areas and water resources which may lead to loss of livestock. These extreme events may also lead to ecosystem shifts and land degradation that may result in species loss with high land semi-arid ecosystems at greatest risk.

The Crop Sub-sector is facing a challenge of high mortality rate of seedlings planted due to the effects of climate change (MAAIF, 2018a). The observed shift in rainy seasons (September-November) and (March-May) and short or prolonged dry seasons in some regions distorts growing seasons, reduces suitable cultivation areas, and affects the timing of planting activities by farmers. In addition, the outbreak of pests and diseases and their prevalence has been linked to climate change and variability. If no action is taken on climate adaptation, Uganda could lose up to USD 1.5 billion on food crops (cassava, groundnuts, maize, millet, pigeon peas, potatoes, rice, sorghum, soybean, sugar cane and sweet potato), due to climate change impacts by 2050 (MAAIF, 2020a).

3.5.1.2 Vulnerability in the Crop Sub-sector

The "Uganda Agricultural Census of 2008/2009" identified 17 major food crops grown in the country (UBOS, 2019). These major food crops are: Cereals (Maize, Millet, Sorghum, Rice); Root crops (Cassava, Sweet potatoes, Irish potatoes); Pulses (Beans, Cow peas, Field peas, Pigeon peas). The major cash crops in Uganda are coffee, tea, cotton and tobacco in their respective order of importance and contribution to the total export earnings. Wincern *et al.* (2019) developed crop suitability maps for eight key crops based on spatially-explicit temperature and rainfall data in Uganda using the Eco-crop model (Figure 3.14). The crops considered were Bananas, Beans, Cassava, Groundnuts, Arabic Coffee, Robusta coffee, Maize and Sorghum. From their analysis

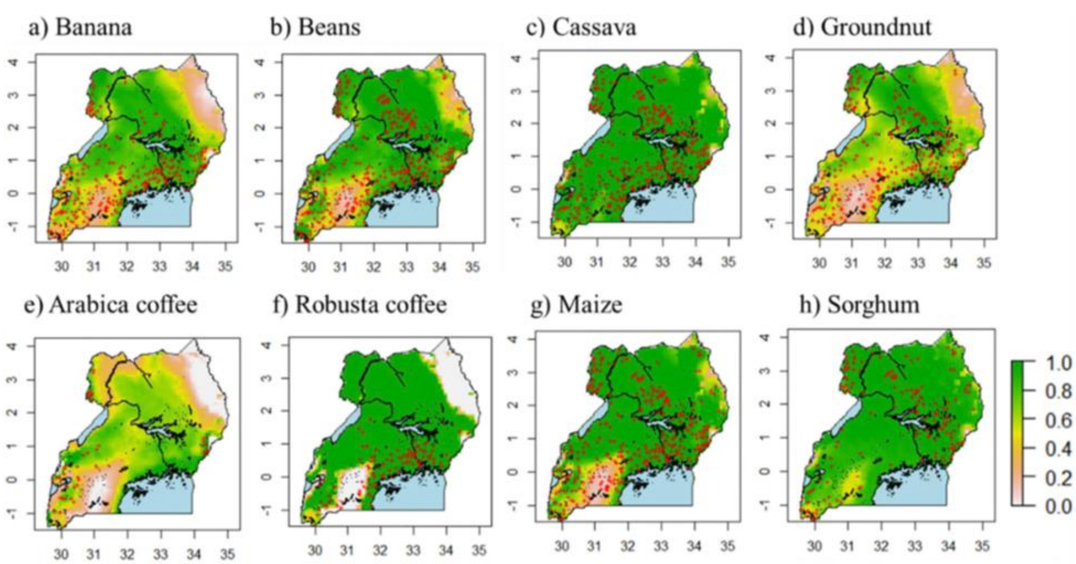

Figure 3.13: Crop suitability under current climate for eight key crops. A suitability score = 1 means highly suitable, a suitability score = 0 means not suitable

(Adopted from Wichern *et al.*, 2019)

Cassava, Maize and Sorghum are grown in almost all parts of the country as seen in high suitability values compared to other crops (Figure 3.13). Ground nuts are highly suitable in Northern Uganda while Arabic coffee as expected in highly suitable around Elgon region of Eastern Uganda and the Rwenzori Mountains.

Wincern *et al.* (2019) then developed future suitability scenarios for the identified crops using different combinations of future temperature and rainfall changes. Analysis presented in this report is the one where temperatures increase by 3°C from the current temperature and rainfall decreasing by 10% distributed across the country. The result under this scenario are represented on Figure 3.14. From analysis the suitability levels for all crops reduces under this scenario but the negative values are expected for beans in Northern Uganda. Sorghum and Cassava are the most performing crops under this scenario.

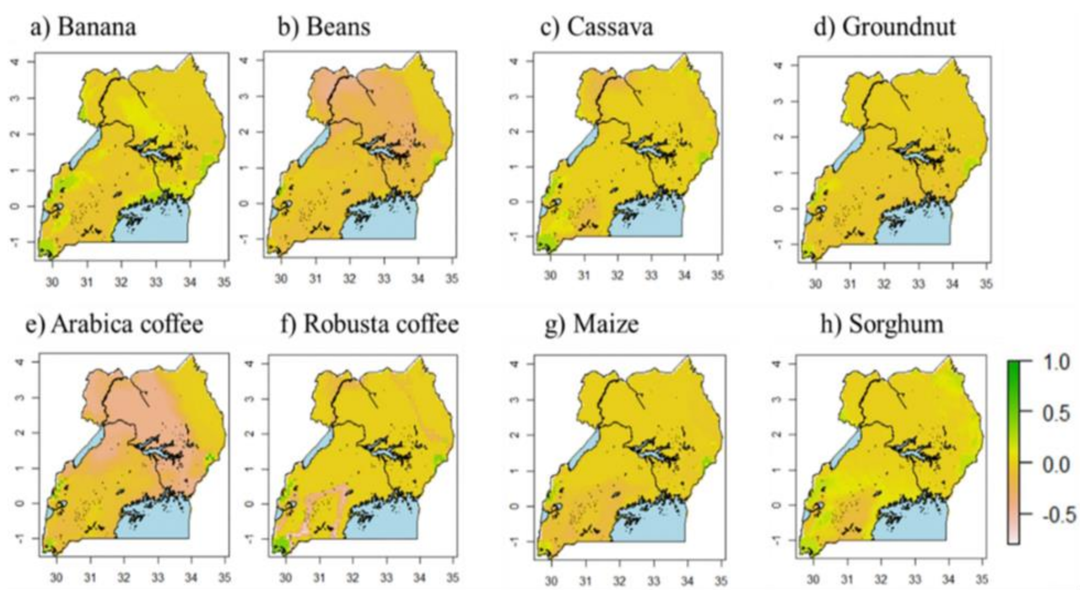

Figure 3.14: Change in crop level suitability under climate scenario +T3-R10 compared to current climate

(Adopted from Wichern *et al.*, 2019)

Another study was done by OXFAM in 2013 and Bunn et al., (2015) on Coffee suitability in the country. This is because Coffee is a major cash crop in Uganda accounting for about 20–30% of foreign exchange earnings and contributes about 2% of the total national GDP (UCDA, 2018). Coffee is currently produced across most parts of Uganda with Arabica grown in the highland areas on the slopes of Mount Elgon in the east; and Mt. Rwenzori and Mt. Muhabura, in the southwestern and northwestern regions, respectively. Most of the Robusta coffee is produced in a wide belt around Lake Victoria as well areas in the northern part of the country (Figure 3. 15).

Figure 3.15: Coffee growing areas in Uganda

Most areas will become less suitable, and particularly those at lower altitudes (1500m) will be severely affected. Lower areas that are currently still suitable for Arabica coffee require adaptation strategies in order to sustain the livelihood of farmers depending on Arabica coffee. The lowest Arabica growing areas (<1300m) are likely to become completely unsuitable and farmers may have to switch crops. On the other hand, areas that are currently often considered too cool

(>2100m) will see suitability improvements in the decades to come. Unfortunately, this area is limited in size, soils are often stony, and a substantial part of the area is under nature conservation (OXFAM, 2013)

Climate change will affect the crop physiology. It will have an impact on the flowering stage and fruit filling stage of Arabica coffee. The unpredictable rains will cause coffee to flower at various times throughout the year, causing the farmers to harvest small quantities continuously. This is opposed to distinct wet and dry seasons that lead to the preferred harvest of large quantities during a short (± 2 months) harvest season. Prolonged droughts can cause flower abortion.

Increased temperatures and sunshine can cause premature ripening of the beans, which will have a direct negative impact on the quality of the coffee and yield quantities (OXFAM, 2013). With future climate change, projections show that about 25% of the land currently suitable for Arabic coffee will be lost by the year 2050 with also net loss of land suitable for Robusta coffee with a potential to shift in higher altitudes (Figure 3.16). In general coffee production is expected to reduce by 50-75% due to loss of suitable land and decreasing yields (MWE, 2015). Suitability levels for Robusta Coffee is expected to reduce in most parts of Northern Uganda while South Western Uganda is projected to be highly suitable.

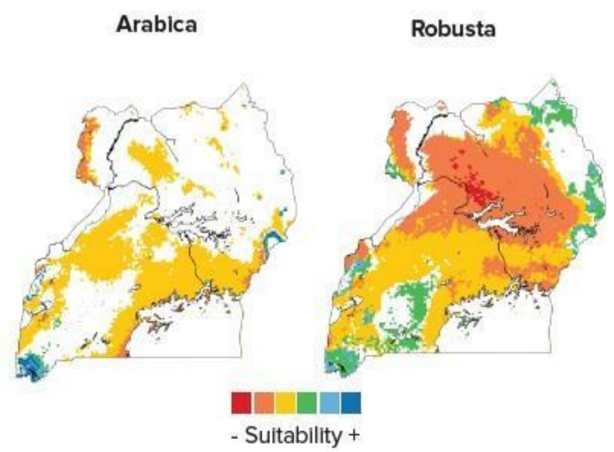

Figure 3.16: Coffee suitable areas in Uganda by 2050

(Adopted from Bunn *et al.,* 2015)

The recommended adaptation options for Crop Sub-sector according to the Uganda National Climate Change Policy 2015 are:

a) Promote and encourage highly adaptive and productive crop varieties and cultivars in drought-prone, flood-prone and rain-fed crop farming systems
b) Promote and encourage conservation agriculture and ecologically compatible cropping systems to increase resilience to the impacts of climate change
c) Strengthen water harvesting and irrigation farming to build resilience to droughts and floods
d) Promote and encourage agricultural diversification and improved postharvest handling, storage, value addition and marketing
e) Support community-based adaptation strategies through expanded and climate smart extension services

f) Develop innovative insurance schemes (low-premium micro-insurance policies) and low interest credit facilities to insure farmers against crop failure due to droughts, pests, floods and other weather-related events.

3.5.1.3 Vulnerability in the Livestock Sub-sector

The livestock sub-sector's contribution to GDP in Uganda is currently estimated at 1.9%. In recent years, livestock population growth rates have been estimated to grow at 1.4, 2.5, 4.3 and 3.0 for cattle, sheep, goat and chicken, respectively (MAAIF, 2018). The 2008 Uganda livestock census projected average weekly milk production per milked to be around 8.5 litres and egg production rates per week at 4 and 5 for exotic layers and indigenous chicken, respectively. The low productivity was mainly attributed to poor husbandry practices including, feeding and nutrition, poor breeding and animal health.

The livestock subsector is not well studied like the crop subsector as far as climate change is concerned because livestock are more resilient compared to the crops. The economic assessment report highlights that livestock product projections in 2050 for the scenarios given shows no significant differences between production in the climate change scenarios for different models and the no climate change scenario. They further observed that changes in overall trends in precipitation and temperature will not result in great impacts on the yield of livestock and that the key climate change impacts to focus on may be those from droughts and floods.

Climate change may affect livestock in the following ways as reported in the report on economic assessment of climate change in Uganda (MWE, 2015) as follows:

- The quantity and quality of feeds
- Heat stress altering feed intake, mortality, growth, reproduction, maintenance, and production.
- Livestock diseases due to change to diseases themselves and the spread of disease through flooding.
- Water availability, especially since water consumption increases with warmer weather.
- Biodiversity: the livestock sector is a significant driver of habitat and landscape change and can cause biodiversity loss.

Pastoralism is the dominant form of livestock keeping in Uganda, especially in the cattle corridor. Given the nature of recourse to mobility to manage climate variability, pastoralism is inherently adaptive. However, the increased occurrences of extreme weather events multiply the impact of factors that constrain the lives of pastoralists. Prolonged dry spells and drought will cause severe water shortage, leading to loss of animals, low production of milk, food insecurity, increased food prices, and a general negative effect on the economy (MAAIF, 2018c). For example, the MAAIF report highlights a study by the Office of Prime Minister on 2010-2011 drought on Agriculture in Uganda. It revealed losses of UGX 2.2 trillion (US$ 907.0 million), US$ 45.35 million of the total damage and losses for agriculture due to animal deaths. In addition, within the livestock sub-sector, 83% of the damage and losses for livestock was attributed to production losses, 9% was due to damage due to animal deaths, and the remaining 8% was due to higher production costs. Prolonged dry spells and drought in livestock grazing systems reduces the availability of water and pasture / fodder both directly and indirectly. Water deficits reduce access to water for production as well as grazing landscapes accounting for about 70% of value chain production costs.

Some districts such as Kitgum, Agago, Pader and Lamwo, experienced economic losses as a result of livestock disease outbreaks of foot and mouth disease, black quarter, tick borne diseases and lumpy, which are associated with weather changes.

The recommended adaptation options for Livestock Sub-Sector according to the Uganda National Climate Change Policy 2015 include the following:

a) Promote and encourage highly adaptive and productive livestock breeds
b) Promote technologies for improved livestock feeds/ feeding and sustainable management of rangelands and pastures through integrated rangeland management
c) Promote sustainable Animal health management systems
d) Promote and encourage diversification and improved livestock value chains

3.5.1.4 Vulnerability in the Fisheries Sub-sector

Ugandan fisheries Sub-Sector has been dependent on mainly natural water bodies, with lakes accounting for 90% of the total fish catch and aquaculture that comprises of fishponds and fish cages, contributes 10% of the total fish catch. The fisheries sector is a direct source of livelihood for more than 1.5 million Ugandans, and majority of those employed in the sub-sector are women and youth who comprise 70 – 87 percent. Fisheries activities are mainly carried out in open water sources comprising of five major lakes (Victoria, Albert, Kyoga, Edward and George), which are the main sources of fish in the country. Uganda is endowed with proportionately large open water resource accounting for almost 20% of the total surface area (241,550 sq.km). Lake Victoria continues to be the most important water body in Uganda, both in size and contribution to the fish catch; followed by Lake Albert, and then Lake Kyoga. In addition to the 5 major lakes, Uganda also has over 160 minor lakes and various rivers, flood plains and swamps that partly contribute to fish production (MAAIF, 2020a).

Climate change may affect the fisheries sub-sector through the following:

a) Increasing water temperatures
b) Extreme weather events which lead fluctuations in water levels (floods, droughts, storms) Changes in water quality parameters such as pH, conductivity and turbidity;
c) Decreasing pH
d) Changes in current open water productivity patterns

Increasing temperatures may lead to low oxygen levels in the water leading to the death of some plants that act as feeds to the fish and this may lead to death of fish and therefore reduced production. Small pelagic species (*Mukene, Enziri, and Agogi*) and large species (Nile perch, Tilapia) value chains differ significantly, but may be impacted by climate change and variability in similar ways related to production, processing and transport. Artisanal fish processing in which majority of women and youth are involved and is dependent on firewood and sunshine is highly vulnerable to climate change. Aquaculture value chain shows weaknesses in input supply and delivery, resulting in low productivity. A combination of climate-related threats may further weaken input supply and threaten pond productivity (MAAIF, 2018a).

The recommended adaptation options for Fisheries Sub-Sector according to the Uganda National Climate Change Policy 2015 are:

a) Promote and encourage climate change resilient fishing practices.
b) Promote sustainable fish farming as a means of economic diversification and enhancing the resilience of the fishing sector to the impacts of climate change.
c) Promote and encourage collaborative and participatory management of aquatic ecosystems.
d) Promote awareness of the climate change–related impacts on fisheries amongst the various stakeholders, such as local communities, resource managers and policy makers.
e) Provide economic incentives to diversify livelihood options in order to reduce dependence on climate-sensitive fisheries resources.
f) Promote biological engineering and restoration of stress-tolerant organisms.
g) Improve and strengthen trans-boundary cooperation regarding fisheries ecosystems.

3.5.2 Vulnerability in Forestry Sector

Forestry as a sector in Uganda, is under the Ministry of Water and Environment (MWE), and managed by three institutions namely: (i) Forestry Sector Support Department (FSSD). The FSSD under MWE, is responsible for overseeing the forestry sector as well as formulating and regulating policy; (ii) National Forestry Authority (NFA). This semi-autonomous agency managing the Central Forest Reserves, and (iii) District Forestry Services (DFS) responsible for forests on private land and local forest reserves. The private sector, academia, research institutions and the Civil Society Organizations (CSOs) such as Uganda Timber Growers Association (UTGA), Nyabyeya Forestry College, and other entities also play an important role in supporting the forestry sector to fulfil its commitments and obligations at national and international levels. The forestry sector contributes much on the Uganda's GDP through income generated from tourisms and forest products such as timber. For climate, forests are water catchments and GHG sinks. Therefore, forests play an important role in stabilizing Uganda's climate and supports communities in adapting to climate change as source of water and fresh cool air in drought.

While the development agenda for Uganda is committed to sustainable management of forest landscapes, Uganda continued to register a reduction in forest-land cover from 24% of the total land area in 1990 to 10% in 2017 in Figure 3.17 (MWE, 2020a).

The annual forest cover loss was 2.2% of the total forest cover over the period 1990 to 2020. Forests on private land reduced from 16% to 4% and protected forests reduced from 8% to 6% of the national land area. Annual forest cover loss was recorded highest on Private Forests (1.9%); 94,747.48ha) and 0.3%; -12,976.74ha) on protected forests. The data indicates that the forests outside protected areas (PAs) reduced from 67% of the total forest cover area in 1990 to 38% in 2017.

While tree plantations increased from 35,066ha in 1990 to 159,929ha in 2017, natural forests cover reduced from 4,898,680ha to 1,865,263ha during the same period. Government support to National Forestry Authority (NFA) during NDPII increased forest cover to 12.4% during 2019. Reversing deforestation rates in Uganda is expected to increase forest cover to 15% by 2025, 18% by 2030 and 24% by 2040. Although there is generally an increased rate of tree planting in the country, and increased tree cover, the survival of the trees beyond 3 years has remained low due to climate change impacts and social-economic factors (population growth and income generation).

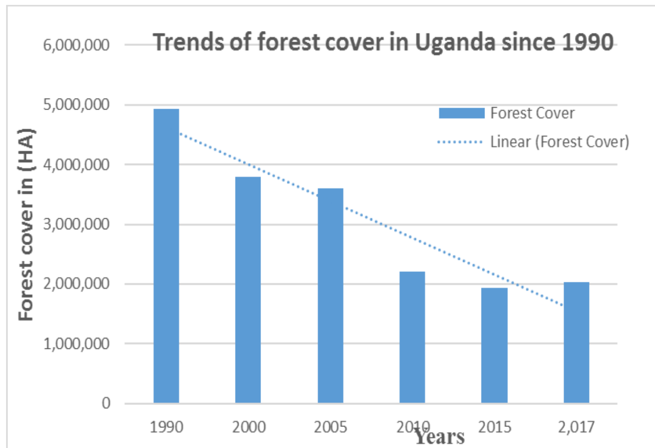

Figure 3.17: Trends of forest cover in Uganda during the period 1990 to 2017

(Source: MWE, 2020a)

Uganda's forests and woodlands provide many environmental services and direct benefits to the agriculture, water and fisheries sectors such as watershed and groundwater protection, erosion control and carbon sequestration (Obua *et al*., 2010). The loss of forests in many areas often results in serious environmental consequences in terms of soil erosion, flash floods and, not least, the depletion of a global carbon sink.

Climate change-induced changes are likely to affect forests and wildlife in various ways. For example, extreme weather and climatic events such as windstorms and flooding can destroy and kill trees on a massive scale, as observed in Bwindi Impenetrable National Park (BINP). The disappearance of medicinal plant species has been consistently reported (Bush *et al*., 2004). This is serious because a large proportion of the rural population depends on direct herbal medicine to treat a wide range of ailments. The disappearance is mainly related to changes in the ecosystems, land degradation and unsustainable use. The loss of herbal plants has been most prominent in highland ecosystems (Bush *et al*., 2004)

The recommended adaptation options for forestry sector are:

a) Promote intensified and sustained afforestation and reforestation programmes implemented by the government, institutions, households and individuals, the private sector, civil society and multilateral organisations.
b) Promote and encourage efficient biomass energy production and utilization technologies to reduce biomass consumption.
c) Encourage agro-forestry, which will enable poor rural households to meet their subsistence and energy needs.
d) Strengthen existing forestry research and encourage conservation and restoration of forest ecosystems critically threatened by climate change.

3.5.3 Vulnerability in the Tourism and Biodiversity Sectors

Tourism and biodiversity is one the key sectors in terms of contribution to Uganda's Gross Domestic Product (GDP). For example, in the year 2017, Tourism was the leading foreign exchange earner to the Ugandan economy by generating USD 1,453 million and contributing directly UGX 2,699.1bn which is 2.9% of total GDP and indirectly together with effects from investment, the supply chain the total contribution from the sector was UGX 6,888.5bn in 2017 representing 7.3% of the GDP (Uganda Government Budget Framework Paper FY 2019/20).

Climate affects a wide range of the environmental resources that are critical attractions for tourism, such as snow conditions, wildlife productivity and biodiversity, water levels and quality among others. Climate also has an important influence on environmental conditions that can deter tourists, including infectious disease, wildfires, insect or waterborne pests and extreme events such as floods or tropical cyclones.

Projected changes in climate such as heavy rainfall, increased temperatures and strong winds changes will affect the tourism industry through increased infrastructure damage, additional emergency preparedness requirements, higher operating expenses (e.g., insurance, backup water and power systems, and evacuations), as well as business interruptions when tourists are forced to cancel some of the planned trips because of those changes in climate. In Uganda, the Rwenzori Mountain in Western Uganda is a famous tourist attraction for mountain climbers mainly to view the snow topped peak of the mountain. With increased temperature, the snow topped peak is expected to melt leading to flooding in lower areas and also loss of revenue from tourists who come to see this snow. In addition, a lot of biodiversity including plants and animals that survive in very cool climates may also be lost due to temperature increases for example the mountain gorillas in the south western Uganda highlands. Climate change will lead to changes in biodiversity, affecting eco-tourism. Changes in biodiversity are expected especially in Albertine and Karamoja regions (USAID, 2014).

Uganda's biodiversity resources are distributed across the country with high concentrations in protected areas (forests, savanna grasslands) and aquatic habitats (lakes, rivers, and wetlands). According to Plumptre et al., (2003), the Albertine Rift region houses approximately 5,793 plant species, representing 14 percent of all mainland Africa's plant species and of these species, 551 are endemic, and 25 are threatened by climate change. The Albertine region also has a number of National parks that house a number of plant, animal and bird species among other bio diversities. An increase in temperature or changes in rainfall intensity, distribution, and patterns are likely to have a direct effect on ecosystem functions, services, and species distribution and survival throughout Uganda.

3.5.3.1 Impacts of Climate Change in the Tourism and Biodiversity Sectors

The report by USAID (2014) on climate impacts on biodiversity, highlighted the following:

a) Increase in temperatures may affect the hydrological cycle of forested water catchments through weakened water recharge or retention capacity for example Mt. Rwenzori, where snow cover has decreased by 40 percent between 1995 and 2011 due to an increase in temperatures will led to reduced year-round water flow in the rivers and streams draining from the mountain. This will affect biodiversity (e.g., aquatic biodiversity) and human activities that depend on water in the Rwenzori hydrological system, both upstream (e.g., hydropower generation along the Mubuku River) and downstream (e.g., fisheries, livestock, and water-based tourism activities).

b) Projected increases in temperatures will continue to trigger changes in flora and fauna through shifting of the various Afro-alpine vegetation zones progressively to higher altitudes, which are cooler. This shift will result in a decline in size of such afro-alpine vegetation zones which would inevitably stress associated flora and fauna

c) The shifting flora and fauna are likely to lead to decreased availability of ecosystem resources that provide livelihoods for people. For example, plant resources such as *Smilax anceps (enshuli)* from Bwindi National Park are extensively used for craft making and likely to be adversely affected by climate change.

d) Increases in temperature will create ecological conditions that favor colonization by invasive species such as *Lantana camara* that displaces pastures in grassland wildlife areas and is resilient to dry conditions. This will affect the animals that are habitat in these areas and therefore leading to reduced revenue from tourists that visit these national parks.

e) An increased temperature renders natural ecosystems vulnerable to disasters such as forest fires and more susceptible to pest and disease outbreaks.

3.5.3.2 The Recommended Adaptation Options for Tourism and Biodiversity Sectors

a) Promote measures that preserve the integrity of ecosystems that provide critical wildlife habitats and host endangered species.

b) Develop Park management practices that will enable wildlife to adapt to the changing climate.
c) Encourage mechanisms of improving local vulnerable population's livelihoods using revenues generated from the tourism industry.
d) Develop and diversify tourism products that are less sensitive to climate change, as an adaptation and substitute for the many natural attractions that are quickly disappearing.
e) Develop weather-resilient infrastructure to support tourism in the region while ensuring minimal damage to wildlife habitats.
f) Develop a national wildlife adaptation strategy that includes well-assessed climate change adaptation strategies

3.5.4 Vulnerability in the Water Sector

The economic study (MWE, 2016), exposed the dependency of Uganda's economy on water resources. The study revealed that: (i). The agriculture sector is, as expected, the main direct user of non-energy related water in the economy, (ii) The manufacturing sector depends on hydropower inputs more than any other sector of the economy, and (iii) education and public health are heavily reliant on hydro-power. Thus, water is a key resource in the development of the country. However, Uganda's water resources are faced with increased pressures from population growth, urbanization, and economic activity. In Uganda, there are competing and conflicting demands for water (e.g. domestic, energy, industrial, agriculture, and fishing). Conflicts over rights of access to water are not uncommon in Uganda, and many people still do not have equal access to water, which is a potential for a water crisis.

The impacts of climate change will affect water availability, quality as well as water resource management. Water resources are likely to be increasingly strained in Uganda's future climate. While it is projected that precipitation will increase in some parts of East Africa, warmer temperatures will accelerate evapotranspiration, reducing the benefits of increased rainfall. With more frequent and severe droughts, Uganda will likely experience negative impacts on water supply, biodiversity, and hydropower generation. A shift in rainfall patterns may decrease the recharge of rain water into the soil, which will have a negative impact on groundwater resources and water tables in wells.

Climate change will result in significant impacts on Uganda's water resources. Some the effects are already visible now, especially the increasing water stress in many parts of the country caused by prolonged droughts, and the deteriorating quality of water caused by floods and runoff and the future impacts will make the situation more severe. The impacts of climate change on water resources will have cascading effects various sectors that directly depend on water such as agriculture and food security, ecosystems and biodiversity, energy supply and electricity generation, navigation, health, hygiene and sanitation among others.

An assessment of water demand for households, industry, livestock and agriculture in Uganda's watersheds for the 1981-2010 period revealed that overall availability was sufficient in most months to meet supply. There were only a few isolated periods when unmet demand was as high as 5% of total demand. Projections paint a future with higher water demand across the country and cases of potential reductions in supply because the water resource base in Uganda is closely tied to prevailing climate since fresh water lakes are mainly fed by rivers, and rivers flow either from glaciers and ground water resources. Uganda is increasingly facing a major challenge of prolonged droughts and unexpected floods due to climatic change and variability and is predicted to be water stressed by 2025 (NPA, 2015).

3.5.4.1 Impacts of Climate Change in the Water Sector

Some of the impacts of climate change on water resources in Uganda include the following:

a) Climate change is projected to have significant impacts on the hydrology of basins characterized by glaciers, and the annual accumulation and melt of snowpack. Increased temperature leads to melting of glaciers and glacial retreats. For example, on Mt. Rwenzori, the glaciers cover less than 1 sq. km down from than 7.5sqkm that were recorded in 1906. The Rwenzori Mountains are a source of rivers and fresh water for communities in the lower slopes. The gradual melting of glaciers will result in reduced river flows and discharge of Nyamwamba, Rwimi, Nyamugasani and Mobuku rivers and affect energy generation, irrigation and communities that are dependent on them for livelihoods.
b) In the drier areas of Uganda, especially in the Cattle corridor, the combined effect of prolonged droughts, predicted reduction in rainfall, and increased temperature that will increase evapotranspiration has serious implications for rivers, even causing most of them to dry up. This in turn will affect the pasture and livestock in general which us a major source of livelihood of the people in the cattle corridor.
c) As higher temperatures increase evaporation rates including changes in annual rainfall, climate change will affect groundwater levels through its influence on the amount of water available to aquifer recharge. Reports of the drying up of boreholes and water dams in Greater Luwero region could be the resultant effect; thereby affecting the livestock industry, crop growing and domestic water supplies.
d) Droughts that result in reduced water levels in lakes and rivers will negatively affect hydroelectricity generation. Given that Uganda's major source of electricity is hydro, hydrological changes that affect lake and river volumes will directly affect the potential output of hydroelectric facilities. The project changes in climate, increased temperature and reduced rainfall are likely to undermine Uganda hydro-electricity potential and cause energy insecurity that will undermine overall development.
e) Reduced river flows due to less rainfall could have implications for drinking water quality and associated health impacts. Even where access is currently available, there is a risk of water quality degradation associated with increasing temperatures, low flows and increased contaminant inflow during more intense precipitation events. This will put stress on potable

water services and increase the urgency of developing effective storm and wastewater management systems.

3.5.4.2 The Recommended Adaptation Options for Water Sector

a) Ensure availability of water for production in water dependent sectors in order to increase their resilience to climate change impacts.
b) Promote and strengthen the conservation and protection against degradation of watersheds, water catchment areas, river banks and water bodies.
c) Promote Integrated Water Resources Management (including underground water resources), including contingency planning for extreme events such as floods and drought.
d) Ensure that all guidelines for infrastructure/hydraulic works (i.e., water for production, piped water supply schemes and conditional grants guidelines for support to point sources protection) mainstream climate change.
e) Improve and strengthen trans-boundary cooperation regarding water resources management.
f) Support institutional and human capacity building in water resource use, development and management.
g) Strengthen water resource monitoring networks and flood warning systems.
h) Promote and encourage water harvesting and efficient water utilisation among individuals, households, institutions and sectors.

3.5.5 Vulnerability in Wetlands Sector

The National Environment Act, Cap 153, defines wetlands (or swamp) "areas which are permanently or seasonally flooded and where plants and animals have become adapted. In general, a wetland can be defined as a shallow water body with teeming life of complex fauna and flora". Wetlands cover approximately 26,600 km2 of Uganda's total area of 241,500 km2, including water bodies. With a coverage of 11 percent of the total land area, wetland resources represent one of the country's vital ecological and economic natural resources. It is estimated that, approximately 5 million people depend directly on wetlands for their water supply needs, valued at US$25.0 million per year.

The importance of wetlands to water resources management is observed through groundwater recharging, water storage and water purification and serve as freshwater reservoirs that release water slowly to the major drainage basins. This slow release of water ensures continuous water availability, particularly during the dry season, to support the economy. Wetlands contribute to the economy of Uganda by purifying domestic and industrial wastes and effluents, thereby maintaining the quality of urban water supplies. For example, the Nakivubo Wetland in Kampala is recognized as important in the purification of water that drains into Lake Victoria. The wetland carries a big load of untreated sewerage, solid waste and effluents discharged from various sources, including industries and vehicle garages from the city. This wetland therefore acts as a retention basin for polluted surface run-off and as a natural purifier to improve the water quality, which can be observed from both its colour and turbidity.

Data from the National Biomass Study Unit of the NFA (2008) revealed that, in 2005, Uganda's wetlands cover as a proportion of the total land area had been reduced by an estimated 11percent. The underlying cause was largely attributed to the insatiable desire of both the rich and the poor to derive livelihoods from the wetlands. This was exacerbated by the high annual population growth rate of 3.7 percent and pressure for industrial expansion, especially in urban areas.

Wetland areas have rich biological diversity of birds, primates, and other flora and fauna. They have great value for eco-tourism development, and as livelihood sources for local communities. Wetlands also provide sources of food, and contribute to the socio-cultural importance of communities. For example, the Bigodi Wetland Sanctuary in Western Uganda is one of the most important ecosystems in Uganda, and home to approximately 200 bird species (NFA, 2008)

3.5.5.1 The Recommended Adaptation Options for Wetland Sector

a) Strengthen the existing national wetland policy to prevent wetland degradation and encroachment.
b) Promote and intensify wetland protection and restoration of degraded wetlands.
c) Strengthen collaborative and participatory management of wetland resources.
d) Strengthen existing wetland research and encourage conservation and restoration of ecosystems critically threatened by climate change.

3.5.6 Vulnerability in the Health Sector

Climate change has significant direct and indirect health implications for Ugandans. The predicted change in weather events especially heavier rainfall is expected to increase the frequency of extreme events such as floods and landslides. These are anticipated to exacerbate diseases and other health-related factors. Several diseases that are currently endemic in Uganda will likely increase in prevalence and distribution due to climate change. There is also potential for diseases that are not yet established in Uganda (in humans) to be introduced because of climate change. Climate change also threatens human health through its effects on food insecurity and malnutrition (USAID, 2014).

The study on the economic impacts of climate change, 2014, sampled costs of managing malaria in two regions of Uganda, and it found out that Tororo in Eastern Uganda, where malaria is endemic (widespread), the cost of malaria may rise from a range of US$8.7 - 221 million in 2010 to a range of US$20.1 - 560.5 million in 2050. In Kabale in South-western Uganda, where the disease is more epidemic (sporadic) in nature, malaria is expected to increase in cost from between US$0.7 - 15.8million in 2010 to between US$1.55 - 41.7million in 2050. The economic costs of these additional cases was estimated using data on the costs of treatment, loss of earnings and productivity, and the value attached to the loss of a life.

Studies have shown that, in Uganda, climate change is aggravating the occurrences of waterborne diseases such as dysentery, cholera, hepatitis E; vector-borne diseases especially malaria; respiratory diseases; and malnutrition-related illnesses (WHO, 2015). According to the MOH (2019) malaria accounted for 12.5% of all OPD attendances followed by No pneumonia (cough or cold) at 10.6%, urinary tract infections at 2.2% and gastro-intestinal disorders at 1.7%,.skin diseases 1.7%, intestinal worms 1.7%, diarrhoea 1.6% and pneumonia 1.2%.

Kigozi *et al*., (2020) using the national HMIS data studied the temporal and spatial patterns of malaria incidences from a number of health facilities in the different parts of the country. The relative risk of malaria at district and health facility catchment levels was derived as the respective predicted incidence rate divided by the overall predicted mean incidence rate at the national level per calendar month of the study duration. The total population identified within the health facility catchments, considered at risk of malaria infection and likely to seek care from the associated geo-located publicly reporting health facility, were considered the study population of interest.

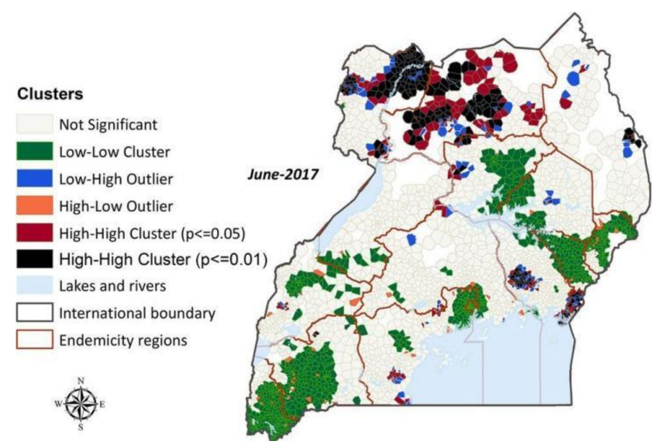

Figure 3.18: Malaria risk areas in Uganda

(Adopted from Kigozi *et al.,* 2020)

The HMIS data showed that on average between 62.2 and 88.7% of nationally reported cases of malaria annually were diagnostically confirmed cases in 2015 and 2019, respectively and these proportions increased across the 15 regions of the country over time with Kampala recorded marginal improvements. the majority of confirmed malaria cases in Kampala (ranging from 61.8 to 81.0% in 2015 and 2018, respectively) were unaccounted for due to exclusion of facilities, leaving only up to 38% of the burden in this metropolitan district estimated (Kigozi et al., 2020). Excluding Kampala, their results showed that estimates accounted for between 67 to 96% of the routine HMIS-based burden of malaria among the remaining 14 regions, over the same study period. The highest burden regions and districts also hosted health facilities with the highest number of confirmed malaria cases reported. For example, Bala health centre (HC) III in Kole district of the Lango region reported 3317 cases during November 2015, while Bira HCII in Adjumani district of the West Nile region reported 6697 cases during June 2016., Barakala HCIII in Yumbe district also from West Nile reported 9654 cases during October 2017 and 9246 cases during July 2018 while Matany hospital in Napak district of Karamoja region reported 8089 confirmed cases during September 2019.

Using the Bayesian space-time Poisson regression model and the HMIS data they developed a spatially significant clusters of malaria risk for the highest and lowest burden months between 2015 and 2019, across Uganda (Figure 3.18)

From the spatial map of malaria risk areas in Northern Uganda, Karamoja as well as West Nile were found to high risk as far as malaria prevalence in concerned compared to other areas. The highland areas of South Western Uganda and the Elgon region were found to be of low risk from malaria. The same partner is observed in another study on malaria prevalence that reports Karamoja region at 34% and West Nile region at 22% (Figure 3.19)

Cholera is mainly an epidemic disease in Uganda, with a yearly incidence of 250 to 5,000 cases, although it is endemic in certain parts of the country, such as the Kampala slums and along the south western border with the Democratic Republic of the Congo (DRC). The burden of typhoid in Uganda also remains unclear, although it has been associated with outbreaks and is endemic in certain regions as well due to contaminated water sources. Other waterborne bacteria and viruses that could contaminate drinking water include hepatitis (A and E) (USAID, 2014; Bwire, 2013).

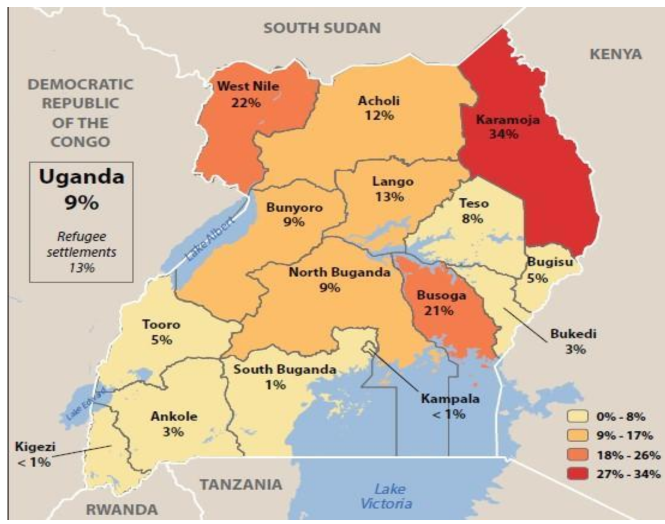

Figure 3.19: Malaria prevalence rates in the regions of Uganda

Malnutrition also has negative consequences on peoples' resilience to climate change and particularly to extreme events such as heavy rainfall and flooding that adversely affect agriculture. Climate change is bound to increase cases of malnutrition through impacts on food security, access to markets, and the increased prevalence of infectious disease. It has been well documented that projected climate changes will adversely impact agricultural production and various staples of the Ugandan diet, potentially leading to food security issues and consequently malnutrition.

Other potential impacts of climate change on health include;

- Potential change in distribution of vector- and water-borne diseases
- Expansion of malarial zone to highland areas that had traditionally been free from mosquitos
- Increased risk of respiratory diseases and infections due to prolonged dry spells
- Increased risk of food insecurity and malnutrition through decreased agricultural productivity

3.5.6.1 The recommended adaptation options for the Health Sector

a) Put in place contingency plans to develop climate change–resilient health systems.
b) Assess the impacts of climate change on human health and wellbeing.
c) Improve the capture, management, storage and dissemination of health information.
d) Heighten the surveillance of disease outbreaks and provide subsequent rapid responses to control epidemics.
e) Strengthen public health systems by building hospitals and supplying them with medicine, equipment and well-trained personnel.
f) Make provisions for a safe water chain and sanitation facilities to limit outbreaks of waterborne diseases, and implement strong public awareness programmes to promote better hygiene.
g) Increase the health workforce's awareness of the relationship between climate change and human health.

3.5.7 Vulnerability in the Transport sector

Some of Uganda's transport systems and infrastructures are built with inadequate consideration of changing climate. This results into climate-related damage on vital infrastructure such as roads, bridges, and rail networks. To address the challenges, Uganda's Updated NDC recommends the following adaptation strategies (MWE, 2022):

a) Build resilience of road and bridge infrastructure to climate change, through design codes and guidelines (climate proof standards for road designs construction and maintenance) and wh ere cost effective, future proof existing infrastructure
b) Promote thermally resilient road and rail infrastructure using heat resistant materials
c) Promote modes of transport that consider greenhouse gas emissions reduction such as use of non-motorized transport and increased access to high-volume public transport options to replace single-car commuter trips in cities and urban areas
d) Update transport codes and regulations and implementing measures to ensure compliance with them
e) Update transport risk assessment guidelines
f) Promote the development, approval, and effective implementation of a long-term national transport policy and plan that will take greenhouse gas mitigation concerns into account
g) Effect a gradual shift to the use of less carbon-intensive fuels (including compressed natural gas, ethanol, and liquefied petroleum gas) in vehicles, instead of relying heavily on gasoline and diesel fuels

3.5.8 Vulnerability in Cities and the Built Environment sector

Uganda is a fast-urbanizing country, and thus vulnerable to specific climate change risks associated with urban areas. These climate change risks include increasing temperatures due to the urban heat island effect, and urban flooding due to increasing rainfall intensities and insufficient capacity of existing urban drainage systems. To address such risks in urban areas, Uganda's Updated NDC outlines the following adaptation actions for the urban centers (MWE, 2022):

a) Develop standards and guidelines for climate proofing of urban built infrastructure, through revision of design codes and land use to embed resilience thinking in infrastructure design
b) Invest in making existing and new buildings more climate resilient and promoting climate resilient urban planning including Green Buildings standards and guidelines
c) Rehabilitate and expand urban drainage and flood management systems in flood prone cities including Water Sensitive Urban Design (WSUD) principles and guidelines
d) Benchmark Main Cities as Water Sensitive Cities and develop WSC Transition Plans
e) Develop, expand, and maintain greenbelts within cities

3.6 Implemented Adaptation Measures and Resilience Projects

This section gives the state of adaptation in sectors. It provides information on some of the adaptation interventions and measures implemented during the period 2015–2020. Furthermore, the section provides details of implemented adaptation and resilient projects, both ended and on-going during the period, and where applicable, a reflection of possible mitigation co-benefits of the project(s).

Studies have estimated that, in absence of implementation of adaptation actions, the cost of impacts of climate variability and change in Uganda would range between US$ 270 and US$ 332 billion over the 40-year period 2010- 2050, for the sectors of agriculture, water, infrastructure and energy. Annual costs could be in the range of US$ 3.2 billion to US$ 5.6 billion within a decade in these four sectors alone (MWE, 2015a, 2016; & UNDP, 2017). It is thus critical that Uganda responds to climate change.

Information on the state of adaptation in sectors was captured using a template (Figure 3.20), to ensure uniformity in information gathering across sectors. The template will be used by various stakeholders (MDAs, and focal points at the local government level) to report adaptation actions to the CCD, which is also the UNFCCC Focal institution.

It is proposed that, the template be digitalized and availed on the CCD website, to ease reporting of adaptation actions.

Ser. NO	Issue	Response
1	Name of Sector / organization	
2	Type of institution (State, Non-State)	
3	List the adaptation actions from the National Climate Change Policy, recommended for your sector	
4	List the adaptation actions implemented by your sector as recommended in the National Climate Change Policy	
5	Title of Adaptation activity	
6	Source of funds	
7	Implementing partner (if any)	
8	Implementation period	
9	Geographical scope of the activity (Districts covered)	
10	Objectives of the activity	
11	Components of the activity	
12	Achievement to-date on the adaptation activities. A description of best practices from the work would be of particular interest for the Adaptation Section of the Third National Communication. The description of best practice may be in form of pictures of technologies for resilience / livelihood improvement, income generating activities, or community engagement pictures. Each image should be accompanied with clear self-explanatory caption	
13	Mitigation co-benefit(s) (if any) of the adaptation action(s).	

Figure 3.20: Template for reporting ongoing adaptation and or resilience actions in sectors.

3.6.1 Implemented adaptation measures, results, and mitigation co-benefits, in the Sub-sectors of the Agriculture Sector

3.6.1.1 Crop Sub-sector

In the reporting period, the impacts of climate change in the Crop Sub-sector were addressed through implementation of the adaptation options recommended in the NCCP. The measures were at both policy-level and technical level.

(a) Policy level measures

The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), has undertaken various policy level measures to guide adaptation actions in the sector. Among these are the development of:

(i) National Development Plan for the Agriculture Sector 2018, (ii) Guidelines for Mainstreaming Climate Change Adaptation and Mitigation in Agricultural Sector Policies and Plans (MAAIF, 2018d), and (iii) National Adaptation Plan for the Agriculture Sector (MAAIF, 2018c).

(b) Technical level measures

Building resilience in the agriculture sector is of paramount importance as risks and vulnerabilities to agricultural and livelihood systems due to climate change are increasing. To address the current and future impacts of climate change in the Crop Sub-sector in Uganda, the adaptation measures were implemented to develop climate-resilient agricultural cropping systems and value chains as follows:

(i) ***Sustainable land management (SLM) approach***. The approach is essential for promoting healthy and resilient landscapes by combating land degradation and mitigating climate change effects while supporting sustainable human livelihoods. The SLM approaches are implemented in Karamoja Sub-region under the project: *Fostering Sustainability and Resilience for Food Security in Karamoja Sub-Region (SURE-FS)*. This project, funded by GCF to a tune of US$ 7 million, and operated by UNDP-FAO-MAAIF, focuses on various measures including: rehabilitating ecosystem services through restoration, agro-forestry, natural regeneration and sound pasture management (MAAIF, 2018). The SLM strategies and practices (Table 3.5) have enabled farmers and communities to adapt, as well as becoming more resilient, to climate change by increasing food production, conserving soil and water, enhancing food security and restoring productive natural resources.

Table 3.5: Common SLM practices in Uganda and their functions

SLM Practice	Function
Terraces, Contour bunds, Trenches ,Grass strips, Trash-lines, Stone-lines, Mulching, Tied ridges, Cut-off drains, Check dams, Micro basins, Conservation agriculture / farming, Water harvesting technologies, Irrigation	Conserve soil and water
Integrated nutrient management (INM): Agroforestry, Crop rotations, mixed cropping, Bush fallows, Improved fallows, Cover crop and green manures, Manure (compost, FYM, etc.), Mulching, Inorganic fertilizers, Bio-fertilizers [BNF, Mycorrhizea]	Enhance soil fertility
Crop rotations, Mixed cropping, integrated pest management, (Biological agents, inorganic and organic chemicals, physical control, etc.)	Manage pests and diseases

(Source: MAAIF 2020b)

(ii) Promotion of crop varieties which are highly adaptive and productive into systems that are prone to droughts and floods and are primarily rain-fed making cropping systems more resilient to the impacts of climate change. There are on-going initiatives to breed, promote and disseminate climate-resilient crop varieties that are resistant to drought, pests and diseases in different agro-ecological zones through initiatives such as the Support for Tea and Cocoa, Vegetable Oil Development, Agriculture Cluster Development, Commercialization of Agriculture in Northern Uganda and Agriculture Technology Transfer and Water Efficient Maize projects. Table 3.6 shows some of the improved crop varieties bred by research institutions in Uganda.

Table 3.6: Some of improved crop varieties and their attributes

Crop Variety	Attribute
Maize	
Longe 7H	Hybridity; resistant to MSV, GLS, the northern corn leaf blight (NLB) and Turcicum; drought tolerant; and maturity of 120 days
Longe 10H	Hybridity; resistant to MSV, GLS, NLB and Turcicum; drought tolerant; and maturity of 120 days
Beans	
NABE 16	Marketable, suitable for all regions, tasty and swell when cooked
NABE 19	Highly marketable, tasty and cooks well
NABE 20	Highly marketable, tasty and cooks well

(Source: MAAIF, 2020b)

(iii) Conducting demonstrations and trainings on: (a) water harvesting using water reservoirs, and (b) solar irrigation pumps and use of simple irrigation technologies. The MAAIF, and MWE, implemented a project titled "Irrigation Scheme Development in Central and Eastern Uganda: Volume-III Atari Irrigation Scheme Development Project (F/S)" funded by JAICA (MAAIF, 2017). A Technical Handbook Guideline for Small Gravity Irrigation Schemes in Uganda was developed by MAAIF (MAAIF, 2020b).

(iv) ***Conducting demonstrations and trainings on climate smart agriculture.*** The MAAIF published a program titled "Uganda Climate Smart-Agriculture Country Program 2015-2025" (MAAIF, 2015b), and held CSA capacity building of Nwoya District administration and technical agriculture staff (MAAIF, 2015b)

(v) ***Promotion of Uganda Agriculture Insurance***: The Government of Uganda established the Uganda Agriculture Insurance Scheme (UAIS) in Financial Year 2018 / 17, as a pilot with the objective of cushioning farmers from risks associated with losses arising from natural disasters; and also attracting financing to agriculture. The UAIS is implemented by the Agro Insurance Consortium (AIC), provided cover for 175, 000 farmers by the year 2020.

3.6.1.2 Detail of Some of the Resilient Projects implemented in the Crop Sub-sector

(a) The Banana Livelihood Diversification Project

The Banana Livelihood Diversification Project, funded by UNIDO through GEF, was locally implemented by MAAIF and MTIC (2015 to 2018) in the Districts of Mbarara, Isingiro, Bushenyi, Mitooma, Ntungamo, Sheema, Rubirizi, and Buhweju. The overall objective of the project was "to support vulnerable communities in Western Uganda to better adapt to the effects of climate change through banana value addition activities, to provide greater opportunities for income generation, poverty reduction and food security".

This project established the following:

(a) One juice processing facility in Bushenyi, 4 wineries, and 4 Banana Solar Drying Facilities, (Figure 3.21).

(b) A total of 68 entrepreneurs in agribusiness were supported to add value to Bananas, and process products like Wine, Banana Chips, and Flour, which are more profitable.

Figure 3.21: Solar drying of fresh bananas established during the Banana livelihood project in Mbarara, and Bushenyi Districts, is an improved postharvest handling technique offering mitigation co-benefits.

c) The facilities received standard equipment, enabling the processing of high quantity products as well as training. Two hundred bio-digesters were established to provide biogas and organic fertilizers (Figure 3.22).

Figure 3.22: Biogas for cooking at household level in Rubirizi District, and Bio-digester plus Bio-slurry in Mbarara District, both offering mitigation co-benefits.

(Source: www.agriculture.go.ug)

The Mitigation co-benefits from the Banana project

The bio-gas digesters (Figure 3.22) constructed within the project are sources of clean energy, substituting the traditional three-stone cooking. Firewood as a source of energy, emits relatively higher carbon dioxide than from the bio-digesters, and increases the rate of deforestation due to a high demand for firewood. Thus, the use of bio gas reduced, the amount of carbon dioxide emission into the atmosphere, and the cutting down of trees, which act as carbon dioxide sinks. (ii) Banana plantations are carbon-sinks. Therefore, enhanced banana growing through use of the bio-slurry in this project increased the amount of carbon sinks, hence a reduction in the rate of accumulation of carbon dioxide in the atmosphere.

3.6.1.3 Livestock Sub-sector

The MAAIF has continuously implemented the Sub-sector ‘s recommended adaptation measures through support from Government and Non-government Bodies. The implemented adaptation measures are the following:

(i) ***Provision of an enabling environment*: ** The Government of Uganda has developed a range of policies and strategies to ensure sustainable growth and transformation of the livestock sector. These are guided by the Agriculture Sector Strategic Plan (ASSP) 2015/16 – 2019/20, which prioritizes investments in beef, dairy cattle, poultry and goats as well as in other agricultural commodities. Others include: Policy on Marketing of Livestock and Livestock Products, Animal Health Policy, the Animal Breeding Policy, Public Health Act, Liberalisation, and the National Agricultural Advisory Services (NAADS) and the Meat Industry Development Act (2016). (ii) ***Undertaking control of vectors and diseases through vaccinations, disease surveillance and construction of infrastructure for disease control.*** Under various programs of MAAIF, in the year 2019, 700, 000 heads of cattle were vaccinated against FMD, CBPP, and anthrax; and 500,000 goats and sheep were vaccinated against PPR. (iii) ***Integrating crops with livestock*: ** In Uganda, this action was widely practiced within the agro-pastoral communities to increase the adaptive capacity of farmers. From the implementation of the adaptation actions in the livestock sub-sector, there was an increase in milk production from 2.2 billion litres in 2016 / 17 to 2.5 billion litres in 2017 / 18 (MAAIF, 2018a).

An example of the pojects in the sector is the RPLRP project funded by IDA World Bank (40 million dollars) together with the Government of Uganda (1.8 million dollars). The project was implemented by MAAIF (January 2014 to December 2019) in various districts in the north-eastern parts of the cattle corridor. The Project objective was "to reduce Uganda's agriculture sector's vulnerability to impacts of Climate Change by disseminating practical knowledge on climate-resilient agricultural practices at a community-level, through Farmer Field Schools".

The project achieved the following: (i) ne valley dam, 7 valley tanks, and 51 bore-holes, were constructed in northern Uganda (Figure 3.23), (ii) Pastoral and agro-pastoral land for sustainable management were identified, and arrangements established for production of hay. The project made various achievements including the following: (i) valley dam and valley tanks were constructed, (ii) district laboratories were provided with equipment, (iii) animals were vaccinated, and district staff were trained. (iv) Acaricides and veterinary dugs were provided, and (v) ear; warning systems and disaster risk management plans were established.

Figure 3.23: Animal watering point (trough) at Abim valley dam in the dry Cattle Corridor is a key drought adaptation measure.

(Source: MAAIF, 2018a)

3.6.1.4 Fisheries Sub-sector

The Sub-sector implemented its recommended adaptation options through interventions that promote aquaculture. The implemented adaptation measures included the following:

(i) Strengthening the monitoring of illegal fishing and gear use (MAAIF, 2020b), (ii) Improving post-harvest technology e.g. solar driers, (iii) Improving market information channels on consumer preferences, (iv) promoting and supporting of cooperative groups, and (v) Management of wetlands / lake shore area.

3.6.1.5 Conclusions and Recommendations on State of Adaptation in the Agriculture Sector

It was noted that the recommended options for fisheries (i.e. (a) Improve and strengthen trans-boundary cooperation regarding fisheries ecosystems resources, and (b) Provide economic incentives to diversify livelihood options in order to reduce dependence on climate-sensitive fisheries) were not addressed during the reporting period (2015/2020). The short-comings in the implementation of the recommended adaptation options by the Fisheries Sub-sector was attributed by the sector itself to various issues, including: (i) limited investment in fish farming, and (ii) overwhelming demand beyond budgetary allocations for inputs

3.6.2 The implemented adaptation measures, results, and mitigation co-benefits, in the Water Sector

The Water sector implemented adaptation measures through resilient projects and supporting individual initiatives towards adapting to climate change, with the aim of maintaining continuous supply of water, and environment management. The measures were implemented through projects in the water catchments, trans-boundaries, and dry lands.

3.6.2.1 Catchment-based Water Resources Management

The Ministry of Water and Environment (MWE) through the Directorate of Water Resources Management (DWRM) operationalized catchment-based Integrated Water Resource Management (IWRM) in the four Water Management Zones (WMZs) of: Lakes Kyoga, Victoria, and Albert; and the Upper Nile, through Catchment Management Plans (CMPs).

(i) Albert Water Management Zone**:** In the Albert Water Management Zone, the achievements from interventions in Semiliki and Kiiha catchments included: Solid waste management in Kabango Town Council to mitigate pollution of Kiiha reiver, and river bank stabilization and restoration of degraded watersheds in Karusandara, Mubuku-Nyamwambw sub-catchment. (ii) Victoria Water Management Zone: In the Victoria Water Management Zone the achievements from the interventions included: (a) training of 30 people in conservation and mitigation of the impacts of land and ecosystem degradation in Kakigani micro-catchment, and (b) assessment of areas affected by flooding and mudslides. (iii) Upper Nile Water Management Zone (UNWMZ): In the Upper Nile Water Management Zone, the interventions included: (a) Enhancing resilience of communities to climate change through catchment-based integrated management of water and related resources (EURECCCA) with Funding from Adaptation Fund, and (b) Eco-systems Disaster Risk Reduction, (ECO-DRR) project with funding from Wetland International., Care International and Cord Aid. The achievements from the interventions included: (a) Planting in Aswa catchment of 350,000 assorted tree seedlings supplied by local tree nurseries supported under EURECCCA, and (b) Development of Micro-catchment management plans of Ora in Zombo District, Yelulu in Arua and Nyarwodoin Nebbi districts. (iv) Kyoga Water Management Zone (KWMZ): In the Kyoga Water Management Zone interventions included: (a) enhancing of resilience of communities to climate change through catchment-based integrated management of water and related resources (EURECCCA project), with funding from adaptation fund; and (b) Strengthening climate resilience and operation and maintenance of water supply systems of selected health centres in Karamoja. The achievements from the interventions included (a) Planting for eco-restoration in about 140 hectares of degraded land a total of 155,435 assorted tree seedlings, and (b) demarcating of 25 km of Ongio-Aakum wetland system with 250 concrete pillars.

3.6.2.2 Details of Some of the Resilience Projects in the Water sector

(a) Enhancing Resilience of Communities to Climate Change through Catchment-based Integrated Management of Water and Related Resources in Uganda.

The EURECCCA project, funded by Adaptation Fund, and implemented together with Sahara and Sahel Observatory, for a total of USD 7,751,000, was implemented by: (i) MWE, and (ii) the Directorate of Water Resources Management (2017-2021), in 3 catchments (Awoja, Aswa, and Maziba). Its objective was "to increase the resilience of communities to the risk of floods and landslides through promoting catchment-based sustainable management resources".

The EURECCCA project made achievements including the following: (a) capacity building and awareness raising in the Catchments, and significant improvement of community perceptions towards restoration activities. The project set up three (3) demonstration centers to accelerate the adaptive capacity of communities, (b) management planning guidelines were revised to include aspects of climate change, and (c) Improved cooking stoves were promoted in the 3 catchments to reduce forest degradation.

b) Multinational Lakes Edward and Albert Integrated Fisheries and Water Resources Management (LEAF II) Project

The Multinational Lakes Edward and Albert Integrated Fisheries and Water Resources Management (LEAF II) Project was implemented nationally by Uganda and Democratic Republic of Congo (DR Congo), through financing from the African Development Bank/Fund, and regionally by the Nile Basin Initiative (NBI) / Nile Uganda Equatorial Lakes Subsidiary Action Program (NELSAP) on the other hand through financing from the Global Environment Facility.

The objectives of the LEAF II project were poverty reduction, and sustainable livelihoods of the basin community, through: (i) establishing legal, institutional and financing arrangements for trans-boundary management and development of the shared natural resources; (ii) promoting and enforcing sustainable fishing procedures; and (iii) reversal of catchment degradation, and enhance sustainable use of natural resources.

By the end of the year 2020, the following were achieved from the project activities: (a) Uganda and Democratic Republic (DR) Congo issued a *"notification of approval of the Bilateral Agreement on the Fisheries Management and Development"* thereby allowing its enforcement and implementation, and Joint Fisheries Management Information System was developed to cover various aspects including the following, (b) Aquaculture was prioritized as one of the potential alternative sources of livelihoods to address the deficit in fish supplies in view of the declining catches against increasing demand for fish both nationally, regionally and globally. The project conducted a comprehensive *"assessment of the potential for cage aquaculture development"*. The study identified 2 commercial aquaculture management areas on the Uganda side of Lake Edward with a carrying capacity of 2,270 tons of Nile tilapia while 6 areas were identified on the Uganda side of Lake Albert with a carrying capacity of 41,775 tons of Nile tilapia. (c)The Integrated Lake Management Plan (ILMP) by Uganda and DR Congo, was updated and adopted. (d) Water quality monitoring was enhanced to promote good health and provide adequate information on the physical, chemical, and biological characteristics of water, plus water resources development. Bathymetry/hydrographic survey of the lakes Edward and Albert were undertaken to provide a bathymetric map (Figure 3.24), guiding fisheries research, plus other benefits.

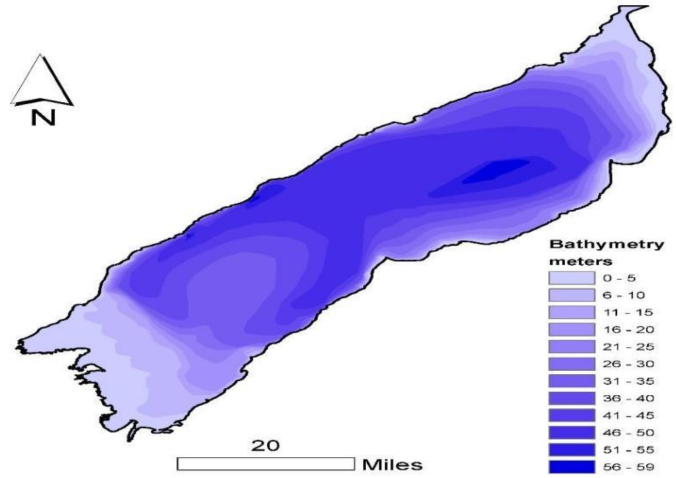

Figure 3.24: Analytical bathymetric map generated by the project to guide adaptation actions on Lake Albert

(Source: MWE, 2020)

Community-based integrated catchment management plans were developed for rivers; Nkusi, Muzizi, Semliki, river Mitano, and Nyamwamba, to strengthen local capacities on soil and water conservation. Catchment Management Organizations comprising of Catchment Management Committees, Catchment Technical Committees and Catchment Stakeholder Forums were established. e) River Catchment restoration interventions were implemented in the districts of Kasese, Bundibugyo and Ntoroko. f) In close collaboration with the Districts and beneficiary communities the project: (i) planted 207,400 trees as improvement to the basin vegetation cover; (ii) restored and protected 41km of river bank areas by fencing and planting bamboo; (iii) established 46km of soil and water conservation measures; (iv) setup 4 tree nursery beds with a total capacity of 61,580 trees; (iv) constructed 3 solar-powered mini water systems in Ntoroko District that incorporates public stand posts for domestic use and cattle watering troughs.

c) Irrigation for Climate Resilience Project

The "Irrigation for Climate Resilience Project (ICRP)", is on-going till the year 2025, supports a shift towards more resilient agriculture through irrigation services, and is funded by the: World Bank (US$ Million 169.2), Government Counterpart (US$ Million 2.4), and Local beneficiaries (US$ Million 18.5). It is implemented by MWE, with the MAAIF as technical implementation partner. The project is implemented in various districts of Western, Eastern, Nothern, and Central regions of Uganda.

Expected Mitigation co-benefits from the project activities are:

a) The proposed new irrigation schemes will be pressurized for higher transportation efficiency and flexibility, to allow higher distribution efficiency on-farm. At the same time, the schemes will be gravity-based, taking advantage of natural pressure without introducing pumps. Furthermore, the existing design of the Kabuyanda Irrigation Scheme envisaged inclusion of pumping stations, the ICRP project is looking forward to review the design to eliminate the pumping stations in favour of using natural pressure. Therefore, the use of natural pressure in water distribution will produce zero GHG emissions, and the improved efficiency in the transportation and distribution of water on the farm, will mitigate climate change through reducing the amount of GHG emissions.

b) Under farmer-led irrigation model, solar pumps are proposed to be used, and thus zero GHG emissions. In addition, by financing the planting of trees as part of the catchment management plan under the Environmental and Social Impact Assessment (ESIA), the project will contribute to net emission reduction. This is based on the theory that trees are Sinks for Green House Gases.

c) By supporting improved soil and water conservation measures, the project will contribute to net emission reduction by allowing for some stock of Carbon dioxide ($CO_{2)}$ in the soil.

3.6.3 Implemented adaptation measures, results, and mitigation co-benefits, in the Health Sector

To enhance the health system's ability to prepare for, and cope with rising needs for treating climate-sensitive diseases, Uganda approved a series of five-year national Health Sector Development Plans (HSDPs) and National Health Policies (NHPs) where climate change has been integrated in these health sector policy and planning documents (MOH, 2010a, MOH, 2010b).

At the national level, climate and health planning was linked to the Second National Development Plan (NDPII 2015/16-2019/20), the country's Vision 2040, and the Uganda National Climate Change Policy 2015, which identifies the health sector among the priority sectors and accordingly the policy aims to strengthen adaptive mechanisms and enhance early-warning systems and adequate preparedness for climate change-related diseases.

3.6.3.1 Progress and state of implementation of the recommended adaptation measures for Health Sector

(a) *Conduct vulnerability assessments of the health sector to climate change impacts:* A national vulnerability assessment of the health sector to climate change according to WHO guidelines has yet to be conducted as a key step in developing health national adaptation plan (H-NAP).

(b) Put in place contingency plans to develop climate change-resilient health systems: (i) The MoH developed an Emergency Medical Services (EMS) policy and strategic plan to advance timely pre-hospital and emergency care. These services were to cover other acute life-threatening conditions. (ii) The EMS provided emergency contingency plans to respond to various emergencies including climate related emergencies like flooding, landslides and associated disease outbreaks. In this regard the sector has endeavoured to acquire necessary equipment and ambulances to enhance response. (iii) The climate change health focus and mainstreaming in district plans has been emphasized every year in regional planning meetings in all 14-health regions of Uganda, and are grouped taking into account various aspects, e.g., geographic factors, to be able to cover climate-related concerns, such as poor rains and famine in Karamoja, heavy rains and landslides in

highland ecosystems. (iv) Promotion of solar energy and hydroelectric power in health facilities and hospitals across the country to reduce carbon footprint**.** According to a MoH (2020) Geo-mapping of Health Facilities study 45% of the facilities listed solar as their energy source. This mitigation approach contributes to reduction of carbon emissions and the overall carbon footprint and environmental degradation as a major co-benefit.

(c) Assess the impacts of climate change on human health and wellbeing: Building climate resilience calls for both basic and applied research so as to reduce uncertainty about how local conditions may be affected, gain insight into local solutions and capacities, and build evidence to strengthen decision-making (WHO 2015). In this regard, various research initiatives on climate change have been undertaken in Uganda and East Africa e.g., the East Africa Vulnerability, Impacts, and Adaptation assessment (VIA) undertaken by the East African Community (EAC). (EAC & USAID, 2018)

(d) Improve the capture, management, storage and dissemination of health information.

Over the period 2015/20, the health sector has rolled out Core hybrid (digital and paper) Health Managemnt Information Systems (HMIS) tools, including DHIS2.3, mTrac and Integrated Human Resource Information System (iHRIS). The DHIS2.3 has enabled improvement in the ability of early detection of disease outbreaks, including climate-sensitive diseases like malaria and cholera.

(e) Heighten surveillance of disease outbreaks and provide rapid responses to control epidemics: Uganda is prone to outbreaks of disease, such as yellow fever because it is located within geographic belts for Yellow fever and filoviruses as well as proximity to the Congo Basin, one of the world's 'hot spots' for zoonotic diseases. The disease outbreaks have been further heightened by climate change and variability.

(f) Strengthen public health systems by building hospitals and supplying them with medicine, equipment and well-trained personnel: Ministry of Health strengthened public health systems by building hospitals / health centres and redeveloping existing ones and supplying them with medicine, equipment and well-trained personnel. Examples of hospitals in this category include Kawolo, Kayunga, Yumbe, Kapchorwa and Mulago Super Specialized Hospital.

(g) Make provisions for a safe water chain and sanitation facilities to limit outbreaks of water-borne diseases and implement strong public awareness programmes to promote better hygiene: Implementation of the Uganda Sanitation Fund made provisions for a safe water chain and sanitation facilities to limit outbreaks of water- borne diseases and implement strong public awareness programmes to promote better hygiene. In Financial Year 2019 / 20 there was improved sanitation coverage except for Karamoja region. 78 % of the population in Uganda had access to sanitation including improved toilet, unimproved and shared.

(h) Increase health workers' awareness of the relationship between climate change and health: Ministry of Health created climate change readiness through sharing weather forecasts, with

UNMA, containing healthy advisories to heal districts to plan in advance for extreme weather events, such as heavy rains and drought.

(i) Develop further support action plans against HIV/AIDS to enhance the climate change resilience of HIV/AIDS affected persons and communities: The HIV/AIDS epidemic has had great impact on the population with an unacceptably high HIV prevalence among those aged 15 to 49 years of 7.3% (Uganda Aids Indicator Survey, 2011). Mortality has significantly reduced due to interventions to improve uptake and use of Anti-retroviral (ARVs). Coverage of Anti-Retroviral Therapy (ART) increased from 64% in 2015 / 16 Financial Year to 89% in 2019 / 20 Financial Year, although the incidence of new cases remains a challenge (MOH, 2015).

3.6.3.2 Details of Some of the Climate Change Resilience Projects Implemented in the Health Sector

Climate Change and Health in Sub-Saharan Africa: The Case of Uganda

The "*Climate Change and Health in Sub-Saharan Africa: The Case of Uganda* (CHASA) Project" aimed at fulfilling the gap of "luck of a system capable of predicting the anticipated occurrence of climate-sensitive diseases based on changes in weather conditions (such as temperature and rainfall)". The project objective was "to develop recommendations for enhancing Uganda's health system to support the health and wellbeing of the population in changing climate". The project was implemented in the districts of: Nakasongola, Nakaseke, Soroti, Gulu, Kitgum, Sembabule, Butambala, Kampala, and Wakiso.

Key findings from the CHASA project were:

(a) *Climate-sensitive Diseases:* Asthma, cholera, dysentery, fever, guinea worm, malaria, skin diseases, typhoid and yellow fever were identified as climate sensitive diseases; (b) *Pathways to Climate-induced Health Hazards:* The pathways to climate-induced diseases were identified as: drought that affect the availability of safe and adequate water supply for domestic consumption, as well as floods that contaminate water sources with disease-causing pollutants which result in water-related diseases such as typhoid and cholera. Also, heavy rainfall that results in the proliferation of stagnant water increases the breeding of vectors, such as mosquitoes, which increases the prevalence of vector-borne diseases, such as malaria. *Results from modelling* enabled prediction of the occurrence of climate-sensitive diseases based on weather and health data. This demonstrated the possibility of using historical and current weather and health data for the development of reasonably accurate prediction models for estimating future occurrences of climate-sensitive diseases (Kaddu *et al*. 2020).

3.6.4 Implemented adaptation measures, results, and mitigation co-benefits, in the Energy and Mineral Development Sector

The Energy and Mineral Development sector, one of the key sectors in Uganda's economy, is under the Ministry of Energy and Mineral Development (MEMD). MEMD was established, to "promote the Development, Strategically Manage and Safeguard the Rational and Sustainable

Exploitation and Utilization of Energy and Mineral Resources for Social and Economic Development". The sector is vulnerable to climate change like other sectors in Uganda. In this course, the sector has taken steps to implement the recommended adaptation actions as outlined for the energy sector in the NCCP.

In terms of diversification of energy sources, the sector has four sub-sectors each responsible for a particular energy source, namely, Power, Bio-mass management, Oil and Gas, and Mineral sub-sector. Biomass, as of the year 2020, contributes over 88.8% of total primary consumable energy in Uganda. It is the biggest source of heating and cooking energy in the country for households, institutions, and industries. In addition, biomass is a popular source of energy for value addition in the areas of: tea curing, ceramics, confectionery and other rural-based industries. This over dependency of several activities of Uganda's economy on biomass, has resulted into over exploitation and unsustainable utilization of forest cover and vegetation, and continued emissions of GHGs to the atmosphere. In the performance report of MEMD for the year 2020 / 2021, it was estimated that over 44 million tons of woody biomass are consumed annually against an estimated sustainable yield of 26 million tons (MEMD, 2020). This is owed to the traditional, inefficient technologies, and practices in the conversion of biomass to energy. The trend is set to continue, driven primarily by economic growth and rising population.

As recommended by the NCCP on adaptation, several modern technologies and fuels are being promoted and deployed by the ministry through projects and programmes to improve on the sustainable utilization of the biomass resource in the country, and to cut significant GHG emissions. These measures offer mitigation co-benefits of adaptation measures. The measures include: (a) Biofuels production, blending, and utilization, in the thermal and motive energy sector; (b) Waste to energy technologies: biogas, gasification, briquetting technology for household, institution and large scale for power generation; (c) Improved biomass cooking technologies and fuels at household, SMEs and institutional level; (d) Improved biomass-fuelled baking ovens and fish drying kilns; (e) Sustainable charcoal production technology; (f) Promotion of Soil stabilized blocks to reduce the firewood demand for brick making, and (g) Energy crop promotion for biofuels, firewood and charcoal feedstock.

In the power sub-sector, a number of electricity generation projects led by the public and the private sector have been completed and commissioned while others are under implementation. The country had a total energy consumption of approximately 4,080.81GWh in the year 2019 from power (MEMD, 2020). However, Climate change presents increasing challenges for energy production and transmission as a result of temperature increase, extreme weather events (e.g. flooding of power generating stations), and changing precipitation patterns. Therefore, the ministry has promoted adaptation actions to climate change, and diversification of energy to increase the proportion of renewable energy through projects on generating power from solar, wind and geothermal. Furthermore, the rotting of woody electric poles in flood prone geographical areas has been combatted through use of concrete poles as measure for resilience building of power lines.

3.6.4.1 Details of Some of the Resilience Projects Implemented in the Energy and Mineral Development Sector

(a) Climate Resilient power supply infrastructure, ERA project on the election of concrete electric poles.

The Rural Electrification Agency (REA) recently has started phasing out the rotting wooden electricity poles in favour of concrete ones, in the east, north-eastern, and northern parts of the country (Figure 3.25).

Figure 3.25: Pilot project. Concrete poles erected by REA on Serere Road in Soroti Municipality

3.6.5 Implemented adaptation measures, results, and mitigation co-benefits, in the Forestry Sector

The forestry sector is implementing adaptation measures by its various departments, and institutions such as National Forestry Resources Research Institute (NAFORRI). The interventions by its various institutions and departments are as follows:

3.6.5.1 National Forestry Resources Research Institute-NAFORRI

The NaFORRI is one of the 16 public agricultural research institutes of the National Agricultural Research Organisation (NARO). The NaFORRI is mandated to conduct research in all aspects of forestry in the country. Research in the NaFORRI aims at increasing the benefits derived from trees and forests through conservation and sustainable management of forests and tree resources. In line with the recommended adaptation actions for the Forestry Sector, NaFORRI made various achievements during the Financial Year 2019/20, including the following:

(i) Promoted intensified and sustained forest restoration efforts through biological control agents. In the year 2017, NAFORRI introduced *Psyllaephagus bliteus*, and Cleruchoidesi *nockae* in the year 2019, for control of Red gum lerp psyllid (order Hemiptera, family Psyllidae,) and Bronze bug, respectively. (ii) In collaboration with FAO's SPGS III Project, research and species trials were conducted to identify suitable species for commercial timber and bio-energy plantations in Uganda's drylands in Kasagala, Kazo, Mbarara and Nabilatuk districts. Early growth performance results indicated that Eucalyptus GC550, Melia volkensii, and Clonal Eucalyptus GC796 had good height growth, having attained greater than 1.9 m by 11 months. (iii) The NaFORRI updated the pests and diseases guideline developed under SPGS II and trained 80 key stakeholders in the forest sector in tree pests and diseases identification, recognition, and management. This was targeted to build the capacity of key stakeholders in pest and disease management. (iv) Production of 150,000 clonal eucalyptus seedlings (GC796, GC540, GC550, GC578, GU7, GU8) proceeded throughout the Financial Year 2019/2020, supplying tree growers across the country.

3.6.5.2 Some of the Resilient Projects Implemented in the Forestry Sector

(a) Farm Income Enhancement and Forestry Conservation Project II

The project was funded through Africa Development Bank loan for agricultural infrastructure development component, and part of the agribusiness development activities. The project, co-funded by the Nordic Development Funds (NDF) grant to the tune of USD 5.6 million had the objective "to improve household incomes, food security, and climate resilience through sustainable natural resources management and agricultural enterprise development", and was implemented in a total of 5 irrigation schemes, spread in five Districts, namely, Nebbi, Oyam, Butaleja, Kween, and Kasese.

Achievements from project activities in the forestry sector were:

(a) Awareness raising, and engagements at national level as well as at catchment level for Agroforestry and conservation farming, were conducted with 250 people engaged. (b) A total of 1,310,352 assorted tree seedlings were distributed to farmers in selected districts in the 4 catchment areas of Ngenge, Manafwa, Tochi and Mubuku-II covering approximately 1,310 hectares. (c) 107ha (45kms) of rivers in Mubuku catchment were restored.

The Mitigation co-benefits from the project activities in the forestry sector were:

(i)Enhanced afforestation and re-afforestation in this project increased the amount of vegetation cover which acts as carbon sinks, hence a reduction in the rate of accumulation of carbon dioxide in the atmosphere. (ii) The proposed new gravity-based irrigation schemes, taking advantage of natural pressure without introducing pumps in water distribution will produce zero GHG emissions. (iii) By supporting improved soil and water conservation measures, the project will contribute to net GHG emission reduction by allowing for some stock of carbon dioxide (CO_2) in the soil.

(b) Investing in Forests and Protected Areas for Climate-Smart Development (IFPA-CD)

The IFPA-CD project, was on-going since the year 2020 and expected to end in 2026. The project was funded by the World Bank / International Development Association {a combination of grants (US$70 million, through the Refugee Sub Window and IDA), loans (US$80 million)} and the Government of Uganda (US$ 30 million). It was expected that the project will attract an additional US$ 30 million from Global Climate Funds as co-financing to World Bank loan and grant. The project was implemented in the Albert Rift and West Nile, with focus on target protected areas as well as districts that host refugees or areas within 5 km of refugee settlement boundaries. The project objective was “to improve sustainable management of forests and protected areas and increase benefits to communities from forests in target landscapes”.

The project implementation was led by FSSD that provides technical and coordination responsibility on behalf of the MWE. National Forestry Authority (NFA) leads activities within CFRs and also supports forest monitoring. Activities in and around NPs and wildlife reserves are implemented by UWA (under MTWA). District Local Governments are supported through FSSD to implement activities supporting Local Forest Reserves, forests outside protected areas, erosion control measures and household energy interventions.

By the end of the year 2020, there was no physical contributions of the project to the communities as the project was at its early stage. The expected Mitigation co-benefits from the project activities is N et GHG emission reduction from the planted trees; and improved soil and water conservation measures, that allows for some stock of Carbon dioxide (CO_2) in the soil.

3.6.6 Implemented adaptation measures, results, and mitigation co-benefits, in the Wetlands Sector

During the Financial Year 2019 / 20, adaptation measures were implemented to mitigate wetland degradation as well as promoting adaptation to impacts of climate change in the wetland sub-sector. These adaptation measures are as follows:

3.6.6.1 Restoration of Degraded Wetlands

Restoration of degraded sections of wetland has been ongoing since Financial Year 2012 to 2020, making the cumulative area of wetlands restored at 16,906.5ha (1.9%) of the 865,700ha of degraded section of wetland countrywide. As indicated in Figure 3.26, there is increment in wetland restoration, due mainly to establishment of the Regional Technical Support Unit which works with DLG to undertake wetland restoration as well as direct release of fund to the regions and LGs to undertake the tasks. However, this needs to be strengthened furthermore to realize more outputs.

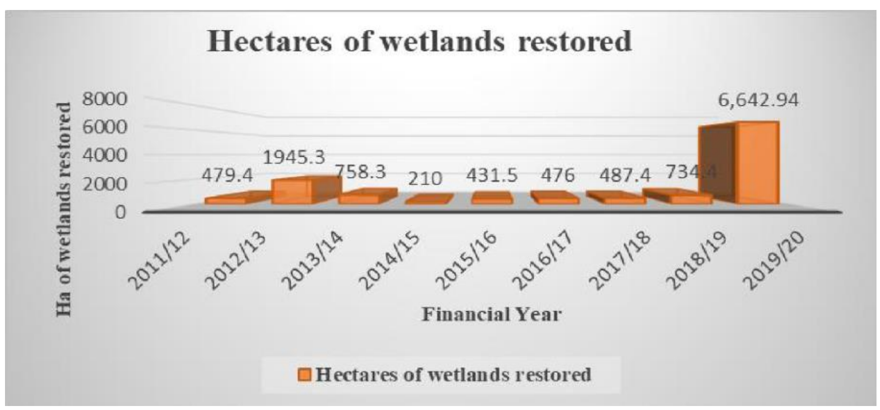

Figure 3.26: Trends in wetland restoration in Uganda during the period 2011 to 2020

3.6.6.2 Promotion of knowledge of environment and natural resources

The Wetland Management Department (WMD), continued to raise public awareness on wetland values, Policy, Laws and Regulations. This was achieved through different communication media such as; commemoration of the World Wetlands Day in Bushenyi, radio talk shows and TV talk shows on topical subjects and distribution of printed and electronic materials (Wet-news, Spot messages).

3.6.6.3 Demarcation of Wetlands

During the Financial Year 2019/2020 over 5,000 pillars were procured and delivered across the country to the various DLGs, and this enabled demarcation of a total of 480.39 km boundary, representing 96.1 % of the targeted 500 km.

As indicated in Figure 3.27, there is tremendous increment in boundary of wetland demarcated countrywide mainly attributed to close involvement of the RTSU and DLG to undertake demarcation process as well as direct release of fund to the regions and LGs to undertake the tasks.

3.6.6.4 Development of wetland wise-use demonstration sites

To support livelihoods income generation of the community dependent on wetland resources from wetland function and services, the GCF project constructed 2 water retention facilities at Nyaruzinga wetland in Bushenyi district and Kandekye-Ruhorobero wetland in Sheema district with a capacity of 20 and 15 million liters of water respectively. The facilities aimed at enhancing wetland recovery while supplying clean and safe water for mini-irrigation of the communities' crop adjacent to the wetland covering an area of 40acres. This new approach to wise-use of wetland was intended to demonstrate how wetland user's communities can be compensated from evacuating wetland ecosystem.

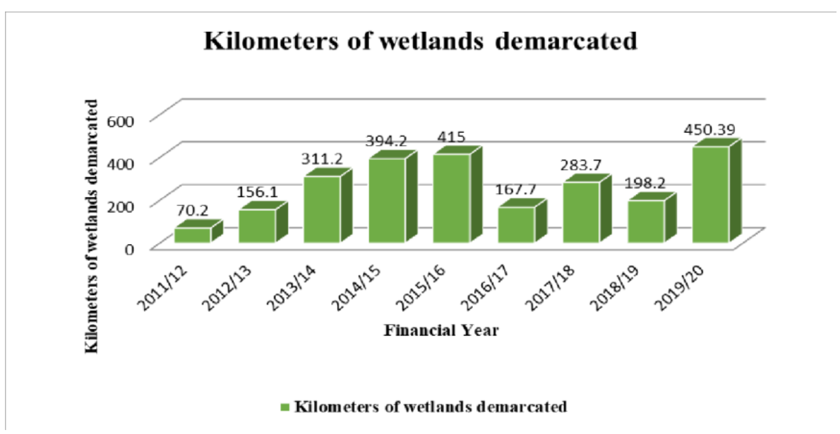

Figure 3.27: Trends in wetland demarcation in Uganda during the period 2011 to 2020.

(Source: MWE, 2020a)

3.6.6.5 Capacity Building and Technical Support

Training was conducted in various fields including the following: (i) Data generation and management (45 district officers) (ii) Application of open data kit for capturing wetland data using smart phones (74 LGs from various regions of Uganda, and (iii) Advanced GIS and remote sensing25officers from MDAs)

3.6.6.6 Some of the Climate-resilience Projects Implemented in the Wetlands Sector.

(a) Building resilient communities, wetland ecosystems and associated catchments in Uganda

The Project was jointly funded to a total grant of US$45 million, by GCF (US$24.9 million), and Government of Uganda and UNDP (US$20.1 million), was on-going since 2017, and expected to end in 2025. It was locally implemented by the MWE in collaboration with the MAAIF, and UNMA. As of 2021, targeting 20 districts in South Western, and Eastern Uganda, with a total population of 3,946,366 and land area of 13,000 Km^2. The Objective of the project was "to restore and sustainably manage wetlands and support target communities in wetland areas of Uganda to reduce the risks of climate change posed to agricultural-based livelihoods."

The achievements from the project activities were: (i) Restoration of degraded wetlands, and improvement of ecosystem services of wetlands and their associated catchments, being achieved through improving the livelihoods of those who live close to wetlands, providing vital skills for alternative livelihoods particularly education on crop diversification and conservative agriculture techniques. and (ii) Participatory management of wetlands as a key factor in successful wetland conservation and wise use.

The project reached approximately 1,095 homes (580 Female headed, and 515 males headed) and the beneficiaries have begun adopting alternative livelihood methods, through e.g., farming cooperatives, thereby reducing the exploitation of the wetlands and associated catchments (Figure 3.28).

The project theory of change envisages the co-benefits of restoration of wetlands, as the climate continues to change, the project is

"My family's life was particularly difficult as my father died from an illness, leaving behind my mother and four brothers and sisters. The family situation worsened when people started to drain the wetlands to plant crops and raise cattle, which was then followed by a severe drought in 2010. When this wetland was drained, we faced shortages of food and water, and mothers had to fetch water from far away on hot sunny days. Children were no longer going to school, and were forced to go and fetch water. From the project, I now know that I am not supposed to be destroying the wetlands because when I destroy them it will affect me in the future. I thank this project for transforming my family life", said a beekeeper who lives in Western Uganda, Sheema district.

Figure 3.28: Testimony of a farmer who switched from growing rice to beekeeping in order to protect wetlands and at same time provide family livelihood

(Source MWE, 2020a).

supporting the beneficiaries to adapt by putting in place a range of responses such as the wise use of wetlands and the restoration of degraded wetlands. Harnessing the natural capacity of wetlands to buffer communities against the adverse effects of climate change is increasing their ability to attain climate resilience. Through the project, wetland conservation and restoration is protecting communities against the effects of a changing climate, alongside other ecological, cultural and socio-economic benefits that wetlands provide that contribute to human wellbeing, such as the provision of food, energy and clean water, support to livelihoods and biodiversity, and sites of spiritual and cultural importance. Identifying and valuing the full suite of wetland ecosystem services provide a strong rationale for restoration.

Project Mitigation co-benefit: By supporting improved soil and water conservation measures, the project will contribute to net emission reduction by allowing for some stock of Carbon dioxide ($CO_{2)}$ in the soil.

3.6.7 Implemented Adaptation Measures, and Results, in the Disaster Risk Management Sector

Uganda, in the past decades, has been experiencing widespread occurrence of both natural and human-induced hazards including droughts, floods, earthquake, hailstorm, windstorms, lightening, landslides, fires, conflicts, disease outbreaks (human, crop and livestock). Though their magnitude and coverage vary, these are a common phenomenon in several districts of Uganda. On the other hand, the country is undergoing increased exposure and vulnerability of population, livelihoods, critical infrastructures and environment to prevailing hazards that have resulted in frequent economic loss and human mortality due to extreme weather conditions. Although a number of climate change and disaster risk reduction policies are in place, implementation is still a challenge. Despite past and ongoing efforts, Uganda has not yet reached the threshold for climate change resilience and disaster risk reduction. The remaining bottlenecks to reaching a minimum threshold are: (a) Policy gaps related to integration and provision of funding for climate change response and disaster risk reduction policies and legal frameworks, (b) Gaps in policy implementation capacity i.e. planning, mainstreaming, coordination, monitoring and evaluation, (c) Weak capacities for adoption and adaptation of emerging technologies and methods for low carbon emission and climate change resilience, and (d) Weak public response to climate change and disasters.

3.6.7.1 Some of the Resilient Projects Implemented in the Disaster Risk Management Sector

(a) Strengthening community resilience to climate change and disaster risks in Uganda (SCORE project).

The SCORE project was funded by the United Nations Development Programme (UNDP), and locally implemented by Office of the Prime Minister (OPM) in the period April 2016 to December 2020. Other responsible Parties included: Ministry of Water and Environment (MWE), Ministry of Finance, Planning & Economic Development (MFPED), Ministry of Lands, Housing & Urban

Development (MLHUD), Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Uganda National Meteorological Authority (UNMA), National Planning Authority (NPA).

The main objective of the SCORE project was "to ensure that natural resources management and energy access is gender-responsive, effective and efficient, reducing emissions, negating the impact of climate-induced disasters and environmental degradation on livelihoods and production systems, and strengthening community resilience".

The achievements from the SCORE project were: (i)Together with OPM, the SCORE project enhanced Disaster risk governance through improved coordination, information sharing and inclusive participation, achieved through the National Disaster Risk Reduction Platform (DRR). The Platform plays a critical role as a multi-stakeholder mechanism in supporting the Government of Uganda in making the strategic shift from reactive disaster response to a proactive DRM approach. In 2018 for example, the platform was instrumental for the rapid assessments following the Bududa landslide. (ii) The SCORE established a strengthened and integrated functional climate information, early warning and response system. Uganda Inter-Ministerial / Agencies Monthly National Integrated Multi-Hazard Early Warning (U-NIEWS) bulletins are developed and disseminated monthly. The monthly bulletins are disseminated using various platforms including the District Disaster Management Committees, and online http://www.necoc-opm.go.ug/bulletins.php . (iii) Together with UNMA, historical data was digitized to reduce data gaps and improve forecasting. (iv) In line with disseminating and promoting use of climate information, UNMA has documented the indigenous forecasting indicators used by different communities in Uganda so that they can be researched on and integrated in modern science to come up with a hybrid forecast for planning and decision making in agricultural and other social-economic activities. In addition, 110 (36 Female and 74 Male) weather information champions were trained so as to strengthen the dissemination and application of weather and climate information in various districts in Central region. (v) The SCORE facilitated mainstreaming of climate change and disaster risk reduction into district development plans through a number of ways, such as, developing the "*lands, housing and urban sector climate change mainstreaming guidelines*" (arising out of the recommendations of the *National Urban Climate Change Profile*). (vi) *Hazard, Risk and Vulnerability (HRV)* profiles of over 112 districts have been developed. The HRV profiles have now informed the development of *National Risk Atlas* which guides and supports decision makers to make evidence-based, risk-informed investment and planning. (vii) The National Urban Climate Change Profile and Guidelines to mainstream climate change in the Lands, Housing and Urban Sector were disseminated in various regions. (viii) Supported the launch of the National Adaptation Planning (NAP) Process, a means of identifying medium and long-term adaptation needs and developing and implementing strategies and programs to address those needs.

3.6.8 Implemented adaptation measures, results, and mitigation co-benefits, in the Transport Sector

The transport sector has implemented adaptation actions that enhance resilience to the impact of climate change through policies, strategies, plans, guidelines and physical level investments.

The following are the policies, strategies, plans, and guidelines-level actions (MOWT, 2021);

a) Through the MoWT, a program called "The Integrated Transport Infrastructure and Services Program" was developed and is under implementation (GoU, 2022). As of 2020, the program had established a number of policies, including (i) the National Transport and Logistics Policy; and (ii) Transport and Road Safety Regulation 2021. The program was implemented by MoWT (lead), Uganda National Roads Authority (UNRA), Uganda Civil Aviation Authority (UCAA), Uganda Roads Commission (URC), and Uganda Roads Fund (URF).

b) Establishment of a Master Plan to Shape a More Sustainable Transport Sector in Uganda, 2021–2024, which outlines where and how Uganda's transportation infrastructure and services, including roads, railways, inland waterways, and air transportation, should develop over the next five years. The National Monitoring and Evaluation Policy, which aims to improve transportation sector monitoring; the Northern Corridor Infrastructure Master Plan (2011–2030), which aims to define transportation infrastructure development needs in the northern corridor area through 2030; and the Traffic and Road Safety Regulation (TRSR) 2021, which aims to ensure road safety.

c) In line with updating risk assessment guidelines, the Ministry of Works and Transport conducted four road safety inspections along major national road corridors and further conducted six road safety awareness campaigns (MoWT, 2022).

The following are the physical- level investments implemented;

a) In line with building resilient roads and bridge infrastructure to climate change, the Ministry of Wonks and Transport (MoWT) implemented projects which contributed to the following:

b) In the financial year 2019/2020, twenty-four (24) roads were upgraded to paved bituminous standards, covering a total length of 1,692km. The routine maintenance of paved roads of about 5,117 km was conducted by the URA (MoWT,2021) as a factor of promoting resilience. Kampala-Entebbe expressway is Uganda's first road to be suspended over wetlands and is has become a blueprint of how concrete infrastructure can be integrated with the natural environment for promoting resilience amidst the changing climate.

Figure 3.29: A climate resilient infrastructure design Kampala-Entebbe Express at Nambigirwa Swamp

c) Fourteen (14) bridges were worked upon, of which five (5) bridges were completed with responsive resilience mechanisms.

Figure 3.30: Climate proofing road infrastructure: construction of Moyo Nyawa Bridge

d) Though funding from GoU, 10.05 km of roads was paved KCCA (MoWT ,2021).

e) Kampala City Council Authority (KCCA) drafted a program entitled "Second Kampala Institutional and Infrastructure Development Program". The program is funded by a loan from the International Development Association (IDA). The overall objective of the program is to enhance the infrastructure and institutional capacity of KCCA to improve urban mobility for inclusive economic growth. One of the program components is "city-wide road infrastructure and associated investments." This project component is aimed at enhancing the quality of road infrastructure and associated investments in Kampala City for increased mobility and drainage. Through this program, KCCA undertook a detailed design for the rehabilitation and expansion of the Nakivubo Drainage System as a mechanism for managing flood risk damage to city roads.

3.6.9 Implemented Adaptation Measures, Results, and Mitigation Co-benefits in the Cities and Build Environment Sector

The NCCP seeks to promote urban planning and the development of resilient humans that are robust enough to withstand climate change related risks and hazards. In view of the changing climate and its likely adverse impacts on urban systems, robust responses that address both the current and future climate change challenges and opportunities, enhance urban economic growth and alleviate urban poverty are necessary. With this background, the Ministry of Lands, Housing, and Urban Development, working in close relationship with urban authorities, has developed and implemented a number of policies, strategies, and actions geared to increasing resilience to climate change, namely;

a) The Ministry of Lands, Housing, and Urban Development developed the Uganda National Urban Climate Change Profile (2018) for the regional cities of Arua, Fortportal, Gulu, Jinja, Lira, Masaka, Mbale, Mbarara, and Kampala, the capital city. The profiles were disseminated to urban local governments to support the technical capacity of urban planners and other decision-makers on climate change-resilient urban development management.

b) Established the UGCities4Resilience Network in partnership with Kampala Capacity Authority (KCCA). UGCities4Resilience is set up in the ten (10) regional and strategic cities of Arua, Gulu, Lira, Soroti, Mbale, Jinja, Masaka, Mbarara, Hoima, and Fort portal, and the aim is to adapt cities to climate resilience.

c) Developed guidelines for mainstreaming climate change into the land, housing, and urban development sector and local government plans. The objective of the guidelines is to demonstrate how to mainstream climate change into the LHUD sector and urban local government planning processes to ensure that climate change response, adaptation, and mitigation are appropriately given due consideration in the respective development plan processes.

d) Establishment of and maintenance of green spaces in urban areas as part of resilience building in cities like Kampala, Arua, and Fortportal among others (Figure 3.31).

Kampala city greening Arua City Greening

Figure 3.31: Established green spaces in urban centres as part of the resilience project

e) The Kampala Drainage Infrastructure Upgrade program is aimed at improving the resilience of road infrastructure, businesses, and communities to flood risks. The objective of this project is to improve drainage infrastructure in order to reduce flooding, prevent water pollution, improve traffic flow, and contribute to the socio-economic development of Kampala, Uganda's capital city (Figure 3.32).

Figure 3.32: KCCA expansion works of Lubigi, Nakamiro drainage channels

3.7 The National Technical Working Group

The National Adaptation Technical Working Group (NATWG) was established to provide technical assistance to the Climate Change Department (CCD) in undertaking climate change adaptation actions. The NATWG is coordinated by the Climate Change Department.

The NATWG performs a number of roles including the following: (a) Providing information on adaptation; (b) Undertaking adaptation assessment; (c) Conducting stocktaking activities which include: (i) stocktaking of on-going and past adaptation activities, and (ii) Synthesizing of available analysis of current and future climate at the broad national / regional level; (d) Addressing capacity gaps and weaknesses in undertaking the NAP process; (e) Mainstreaming Gender into climate change actions; (f) Designing coherent implementation strategies including synergy; and (g) Implementing and managing actions through policies, programme, projects and other activities.

The Terms of Reference for the production of the Third National Communication called for a review of the composition of the existing NATWG, and identifying and mobilizing additional stakeholders, to support and participate in the NATWG. The identification and mobilization of additional stakeholders was done through analysis of the existing NATWG. From the analysis the following were noted: (a) some of the members of the NATWG had retired, while others had moved away from their original institutions of affiliation, and these called for replacements; and (b) in some sectors there were needs for additional representation to cover the many sub-sectors.

In identifying additional stakeholders for sectoral representation to the NATWG, a range of criteria including the following were followed: (a) Sectoral institutional representation in line with NCCP Adaptation Thematic Areas, (b) Technical Knowledge / expertise, (c) Gender, (d) Public sector, (e)

Private sector, (f) MBOs (CSOs, FBOs, NGOs), (g) Cultural institutions, (f) Academia, (g) Political institutions, and (h) Relevance.

The membership of the NATWG was updated and consists of members from the following "institutions": (i) Climate change Department, Ministry of Water and Environment (3 members), (ii) Directorate of Water Resources Management, Ministry of Water and Environment, (iii) Ecological Christian Organization (ECO), Uganda, (iv) EMLI, (v) Environmental Alert, (v) FAO, (vi) FSSD/MWE, (vii) Ministry of Health, (viii) MAAIF (3 members), (ix) Makerere University (6 members), Ministry of Energy and Mineral Development, (x) Ministry of Gender labour and social development , (xi) Ministry of Lands, Housing and Urban Development, (xii) Ministry of Local Government, (xiii) Ministry of Finance, Planning and Economic Development, (xiii) MoSTI, (xiv) Ministry of Works and Transport, (xv) National Environment Management Authority , (xvi) National Forestry Authority, (xvii) National Planning Authority, (xviii) Office of Prime Minister - Disaster Preparedness, (xix) Red Cross Red Crescent Climate Centre, (xx) Uganda National Council Of Science and Technology, (xxi) Uganda National Metrological Authority (2 members), and (xxii) Wetlands Department. Figure 3.31 shows a sample database for the NATWG.

Experts of the National Adapatation Technical Working Group (Last Updated 2022)			
Name	**Institution**	**Email**	**Telephone**
Callist Tindimugaya	Directorate of Water Resources Mgt	Callist.Tindimugaya@mwe.go.ug	0772-521413
Anthony Wolimbwa	ECO Uganda	anthony.wolimbwa@ecouganda.org	774492372
Robbert Bakiika	EMLI	bakiika@gmail.com	782643315
John Diisi (Sector Lead)	National Forestry Authority	johnd@nfa.org.ug johndiisi@gmail.com	772410523
Emmanuel Zziwa	FAO		
Kanzomba Imelda	MAAIF	ikanzomba@gmail.com	704577312

Figure 3.33: Sample of NATWG database

NB: Details of the members of the NATWG (names, contact, and expertise), and their roles, can be found from CCD which is the focal institution for climate change actions in Uganda.

3.8 National Adaptation Plan (NAP) for Uganda

3.8.1 National arrangements for the Formulation, Registration and Implementation of NAPs.

3.8.1.1 Background

The foundation of NAP activities at the global, regional and national levels is embedded in articles 3 and 4, of the Convention on Climate Change. Article 3 (on Principles of the Convention) alerts Parties to formulate policies and measures to include adaptation, comprising all economic sectors. Article 4 of the Convention commits Parties to cooperate in preparing for adaptation to the impacts of climate change.

The Paris Agreement in its Article 7 paragraph 9(b) commits Parties to engage in adaptation planning processes and the implementation of actions, including the development or enhancement of relevant plans, policies and / or contributions, which may include the process of

NAPs formulation and implementation. For the Least Developed Countries (LDCs) actions on NAPs emerged from National Adaptation Programmes of Action (NAPA), to which Uganda responded (MWE, 2007). The NAPA was a special programme to communicate adaptation needs and actions of immediate and short-term nature, and had a time frame (decision 5/CP.7). The NAPA gave rise to the "medium to long-term" plan of action, recognized as the National Adaptation Plan (NAP) under the Cancun Agreement (decision 1/CP.16).

As a way of establishing national arrangements for climate change action, in particular adaptation, Uganda, a Party to the UNFCCC, and a signatory to instruments under the Convention (the Kyoto Protocol and the Paris Agreement) has put in place policies and instruments to fulfil her commitments under the UNFCCC. While the Constitution of Uganda and various sectoral policies allude to climate change action, Uganda launched a Climate Change Policy (MWE, 2015b) specifically to address issues of climate change.

3.8.1.2 Entry points for Uganda's NAPs

The Constitution of Uganda in its article 237(1, 2b), the National Environment Act (Cap153), the National Forestry and Tree Planting Act (Act 8 of 2003), and various sectoral policies {e.g. the National Environment Management Policy (1994), Uganda Forestry Policy (2010), and the Energy Policy for Uganda (2002)} allude to climate change actions.

The above identified entry points for formulation of Uganda's NAPs, and those in table 3.7, will provide landing zones for Uganda's NAP processes, and thus are key qualifiers for Uganda to start her NAPs processes.

Table 3.7: Identified entry points for formulation of Uganda's NAPs

Entry points	Climate action aspects
Vision 2040	Section 5.9 of Uganda Vision 2040 (paragraph 309) provides that Government will put in place enabling legal instruments to facilitate an effective national response to climate change. The same section provides that Government will develop policies and organizational structures to address climate change with emphasis on strengthening coordination systems at both national and local levels and building the capacity of local governance and decision making bodies.
National Development Plan (NDP I) {NDP II (2015/16 – 2019/20)}, and {NDP III (2020/21 – 2024/25)}	NDP is a series of six instruments intended to guide the nation in delivering the aspirations articulated in Uganda Vision 2040. The National Development Plan II (2015/2016 – 2019/2020) identifies one of the country's strategies as integrating Key Cross-Cutting Issues into Programmes and Projects (Gender, HIV/AIDS, environment, nutrition, climate change, human rights, social protection, child welfare among others). These will be mainstreamed in government programmes and projects during the implementation, monitoring and evaluation through alignment of sector priorities to ensure coordinated, effective and efficient service delivery at all levels. Within the Environment and Natural Resources sector,

	climate change subsector, the plan has the objective of increasing the country's resilience to the impacts of climate change through the following interventions: (i). Integrate and implement the Uganda National Climate Change Policy (UNCCP) including awareness creation in all MDAs, LGs as well as CSOs and the private sector; and (ii) Strengthen national coordination, monitoring and reporting on the implementation of regional, international standards and commitments. Section 9.2 Objective 7 of the NDP II allows formulation of an appropriate legal framework for climate change policy implementation and compliance. The same section calls for establishment of an appropriate institution for coordinating national climate change response. The NDP III (NPA, 2020), is anchored on the progress made from previous planning and implementation experiences of NDPI and NDPII. The NDP III defines the broad direction for the country and sets key objectives and targets for the sustainable socioeconomic transformation of Uganda. On climate change adaptation, NDP III focuses on a range of actions more specifically, reducing climate change vulnerability and carbon footprints through:- (i) Building capacity for climate change adaptation including disaster risk reduction; (ii) Mainstreaming climate change resilience in programmes and budgets with clear budget lines and performance indicators; and (iii) Implementation of 18 programmes that include "Community Mobilization and Mind-set", all designed to deliver the required results.
The National Climate Change Policy (2015)	The policy specifies its goal as to ensure a harmonized and coordinated approach towards a climate-resilient and low-carbon development path for sustainable development in Uganda. The overarching objective of the policy is to ensure that all stakeholders address climate change impacts and their causes through appropriate measures while promoting sustainable development and a green economy. One of the specific objectives of the policy is to support the integration of climate change issues into planning, decision making and investments in all sectors and trans-sectoral themes through appropriate institutional arrangements.
Uganda Green Growth Development Strategy (UGGDS 2017/18 – 2029/30)	The Uganda Green Growth Development Strategy (UGGDS 2017/18 – 2029/30) aims to ensure that the goals of the Uganda Vision 2040 and the NDPII are attained in a sustainable manner. The general objective of the strategy is 'to provide guidance on priorities and strategies and governance frameworks for implementing the green growth principles within the existing development frameworks towards the sustainable development of the country.

National Climate Change Act, 2021	The Act give the force of Law to the UNFCCC, Kyoto Protocol and Paris Agreement and to the implementation of the NCCP. The Act gives legal authority to an institution to coordinate, supervise, regulate and manage all activities related to climate change while requiring all government ministries, departments, and agencies, local governments, private sector and individuals to undertake their own respective roles in climate change response measures and actions and also provide for climate change financing.
Uganda National Climate Change Communication Strategy (UNCCC) (2017-2021)	The UNCCCS 2017-2021 derives its mandate from and is intended to communicate the objectives of the National Climate Change Policy (NCCP) framework. Due to the growing realization by the Government of Uganda (GOU) and other stakeholders of the existing gap in communication, coordination, and dissemination of climate change adaptation and mitigation information, there is critical need to change communities' attitudes and behaviors towards climate change to enhance sustainable development. However, there are several challenges in achieving effective communication of climate change issues to all target audiences. As such, the strategy is intended place greater urgency on climate change impacts and responses to motivate desired behavior changes

3.8.1.3 The Institutional Arrangement in the National Climate Change Policy

The National Climate Change Policy constitutes the institutional arrangement (Figure 3.34) to support the integration of climate change issues into planning, budgeting, decision making and investments in all sectors through appropriate institutional arrangements and legal framework.

The various levels of the institutional arrangement in the NCCP, namely, Implementation, Coordination, and their respective components were examined to identify (and where necessary propose new) levels/components, that could fulfil the requirements for formulation, registration and implementation of NAPs. Subsequently, two additional levels were identified and their relevancy to the NAP process considered. These are the: (i) "**Strategic Level**", which re-echoes Uganda's Vision 2040 of meeting Uganda's long-term development goal of becoming a middle-income country by the year 2030, while "taking measures to protect the environment and natural resources and ensure their future sustainability", plus consideration of green economy in the context of sustainable development and poverty eradication; and

(ii) "**Enforcement level",** which brings the legal aspects into the institutional arrangement through "The National Climate Change Act, 2021".

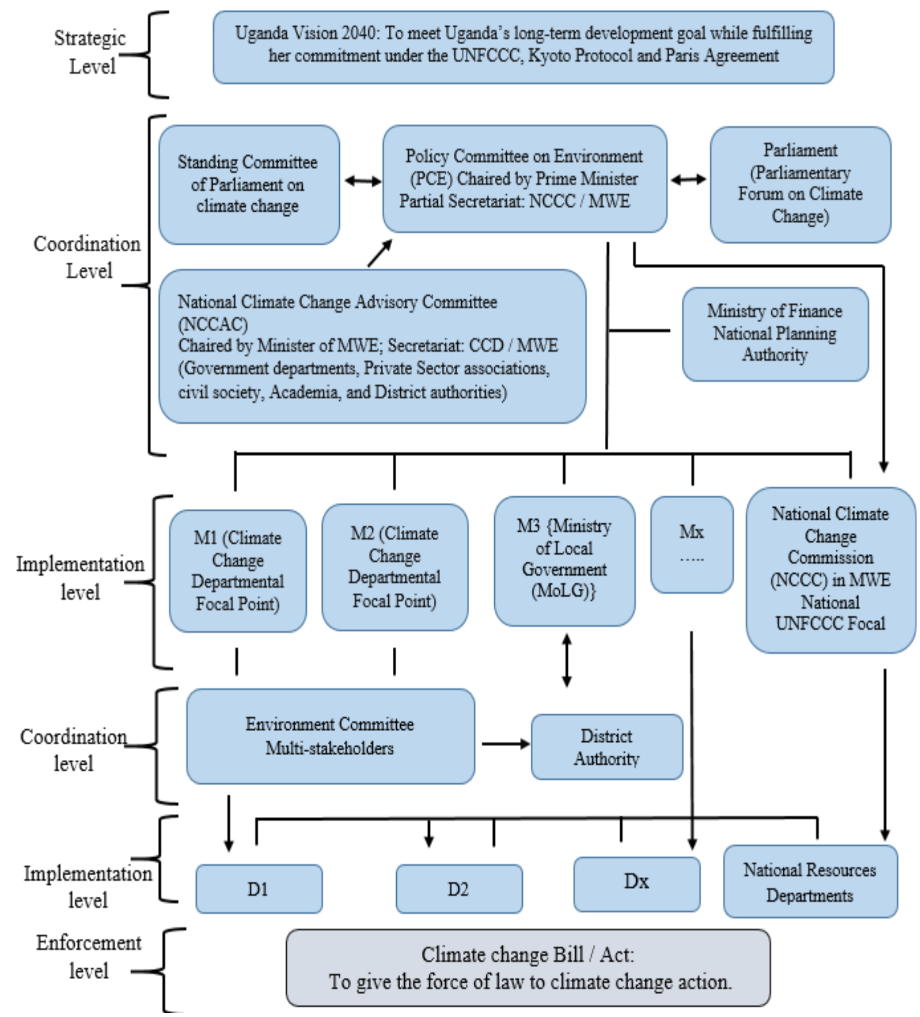

Figure 3.34: Institutional arrangement for climate change action in Uganda as at 2020

(Modified from MWE, 2015b,)

Details of the roles of the main entities (e.g. Ministries and Authorities) are provided in the Uganda's National Climate Change Policy 2015.

3.8.1.4 Conclusion

The Instruments: Laws, Policies, Initiatives and the Coordination strategies within the entities under the various levels of Uganda's institutional arrangement for addressing climate change, at the National level, fulfil the global requirements for NAP processes and reflect the readiness of Uganda for preparing her NAPs. The "National Climate Change Act, 2021", the National Climate Change Policies, and Strategies {e.g. Uganda's Long-term Low Emission Development Strategy

(LTS) on climate change}, provide landing zones for Uganda's NAP processes and as well as the country NDC (2016) currently ongoing its update process.

3.8.2 The National Governance Structure for the Establishment and Maintenance of NAPs

3.8.2.1 Background

The establishment of a country's first National Adaptation Plan (NAP 1) goes through various stages, outlined in the Technical Guidelines for the National Adaptation Plans process {(LEG, 2012), decision 5/CP.17}. These stages are as follows: Stage one: laying the ground and addressing gaps, Stage two: preparatory elements, Stage three: Implementation strategies, and Stage four: Reporting, Monitoring and Review (RM & R).

Uganda has initiated the process to formulate a National-level NAP, through various stages, including submission of funding proposal to the Green Climate Fund (GCF), which is the entity mandated by the Paris Agreement to support the development phase of a country's NAP process through its Readiness and Preparatory Support Programme. The Proposed governance structure of Uganda's NAP (figure 3.33) is envisaged to consist of: a high-level policymaking body, and technical working groups tasked with supporting, coordination and providing technical inputs for the high-level body.

3.8.2.2 Proposed National Governance Structure for Uganda's NAPs

The governance structure for Uganda's NAPs in Figure 3.35, was proposed in consideration of the National Climate Change Act, 2021. The governance structure will allow transparent and effective coordination, flow of information, knowledge and financial resources. The activities under various stages in the operationalization of the NAP establishment and maintenance will be facilitated under the various bodies in the proposed governance structure, with overall coordination by the Climate Change Department (CCD) which is also the National Climate Change Focal Point (NCCFP) in the Ministry of Water and Environment and the Focal Point for UNFCCC.

Roles of various bodies in the proposed governance structure for the establishment and maintenance of Uganda's NAPs.

1. Minister for Water and Environment: The minister will head all activities

2. Climate Change Department (CCD): The Act Mandates the CCD to coordinate, monitor and evaluate Government programmes and actions of Government on Climate Change. Therefore, the CCD will carry out the coordination, monitoring and evaluation roles in the NAP process. Furthermore, the Act mandates the CCD to implement policies and decisions on Climate Change. The CCD therefore will implement the NAPs. Other roles for the CCD will include: (i) provision of technical assistance to the NCCAC regarding the NAP; provision of technical assistance and information to Districts in support of District CC Adaptation Plans; and compiling reports on the NAP implementation and report to the Policy Committee on Environment.

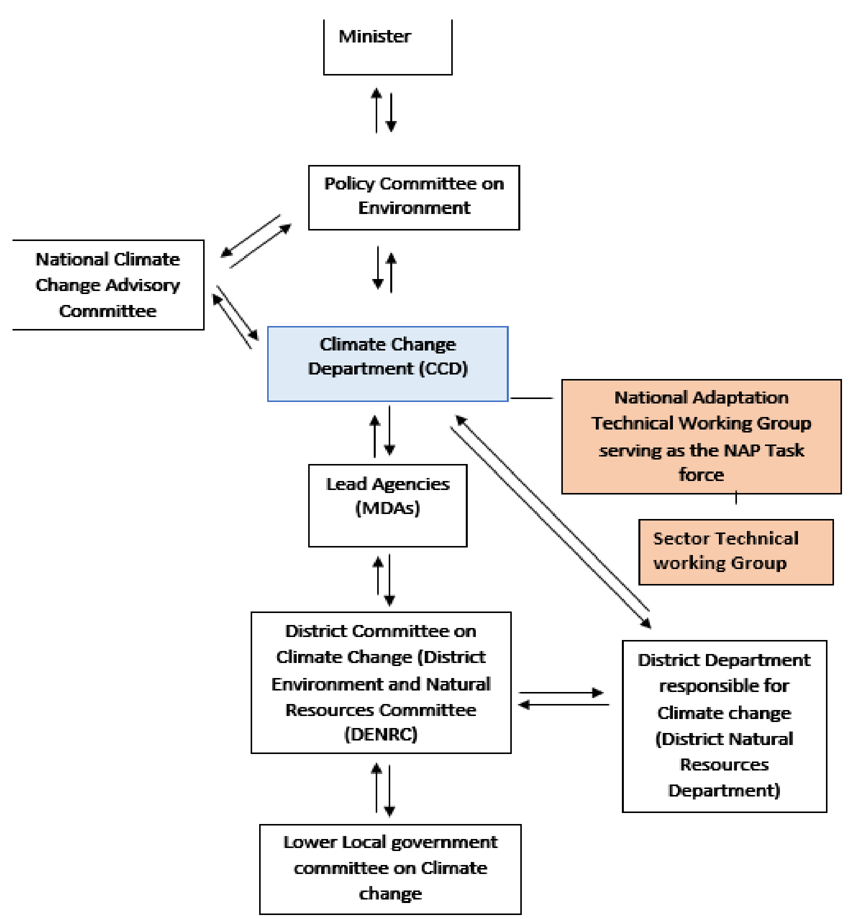

Figure 3.35: Proposed National Governance Structure for Uganda's NAPs

3. Policy Committee on Environment (PCE): The Act mandates the PCE to make policies and decisions for implementation, as well as receiving and reviewing reports from CCD. Thus, the PCE will make policies and decisions (mandate) for implementing the NAPs. Furthermore, the PCE will review reports from the CCD on the Implementation of NAPs for recommendations.

4. National Climate Change Advisory Committee (NCCAC): The NCCAC will be under the administrative office of the CCD. The NCCAC is mandated to provide technical advice on climate change-related issues to PCE. Therefore, the NCCAC, together with the CCD will develop the NAP, and forward it to the PCE for review and mandating.

5. Lead Agencies (MDAs): The Act mandates the Lead Agencies to "establish adaptation and compatibility standards, measures and performance levels for responding to CC matters". As stated in article 7 paragraph 3 of the Act, Lead Agencies will develop Adaption action Plans for the Agency in line with the National Adaptation Plan. This will be done in groups within the Agency. These groups will have a focal person who will be a member of the NATWG. This focal person will provide technical advice to the Groups in line with Adaptation actions, and will report to the CCD.

6. District Department responsible for Climate change -District Natural Resources Department (NRD): The NRD is mandated to "Provide technical assistance (and act as a secretariat) to District Environment and Natural Resources Committee (DENRC), and local government" in developing District Climate Change Action Plan. Thus, regarding NAP process, the NRD will provide technical assistance to the DENRC and local government in developing District Adaptation Plans in line with the NAPs. The NRD, will have a focal person to the NATWG of the CCD who will provide assistance to the NRD as well as reporting adaptation actions to the CCD. The NRD is mandated to "Prepare and submit annual report on DCCAP" in article 8 paragraph 5 of the Act.

7. District Committee on Climate Change -District Environment and Natural Resources Committee (DENRC): The DENRC is mandated to integrate climate matters into district plans, and to coordinate activities of lower local government committees. The DENRC therefore, will integrate NAPs into the District Plans to develop District Adaptation Plans (DAPs). Other activities by the DENRC in the NAP process will include: (a) coordinating the activities of local government committees in implementation of District Adaptation Plans; and (b) reporting to the implementation of Adaptation actions to the Natural Resources Department of district as well as to the Lead Agency were appropriate.

8. Lower Local government committee on Climate change: The local government is mandated by the Act to coordinate actions at local level jurisdiction. Therefore, the role of Local government in the NAP process will be to: (a) Coordinate the implementation of District Adaptation Plans (DAPs), and (ii) Report to the DENRC on state of implementation of DAPs.

9. National Adaptation Technical Working Group (NATWG): The NATWG is a technical working group under the CCD, to provide technical assistance on Climate Change variability and Vulnerability assessments, and Adaptation measures. The group is comprised of focal persons from different levels of the institutional arrangement for climate change actions in Uganda reflected in the National Climate Change Act. The focal persons will report adaptation actions in sectors to the CDD, as well as providing technical guidance to respective sectors in the development of Sectoral plans and implementation. The NATWG will serve as a NAP Task Team. It will work together with the CCD, and the Sectoral NAP teams. The NATWG, together with the CCD will carry out technical activities at all stages of developing the NAP, which will be sent to the

Policy Committee on Environment for inputs/endorsement. The PCE will be assisted by the NCCAC in analyzing the Adaptation actions in the NAP

10. Sector Technical working: Sectoral Technical Working Groups (STWG) will be established with 15 people each to mirror the sector working groups that have quarterly standing meetings at the senior, principal, commissioner, and director levels. Sector working groups (SWGs) will be responsible for the economic appraisals for their sectors through standing SWG meetings throughout the entire NAP process.

3.8.3 System for Updating Uganda's NAPs.

3.8.3.1 Introduction

A system for updating NAPs calls for identification of: (a) trigger for action, and (b) inputs to the system. The trigger for action comes from the global level (i.e., UNFCCC processes).

The process for updating Uganda's NAPs will entail financial support from both domestic (e.g., Domestic government revenues) and international sources. The Paris agreement in its article 7.13 alludes to availability of international support. The international financial support sources are, Multilateral providers under the United Nations Framework Convention on Climate Change (UNFCCC) {e.g., Green Climate Fund (GCF), and Least Developed Countries Fund (LDCF)}, and Multilateral funds established outside of the UNFCCC (e.g., Pilot Program for Climate Resilience, Adaptation for Smallholder Agriculture Programme, and multilateral development banks). At COP 18, the COP requested the Global Environment Facility (GEF), to provide support to LDCs through the LDCF in the NAPs formulation and implementation activities, and also the GEF to explore ways of supporting non-LDCs through the SCCF (Decision 12/CP.18, paragraphs 1 and 4). At COP 21, the Green Climate Fund was requested by the COP to expedite support for the formulation of NAPs and subsequent implementation of policies, projects and programmes identified in them (Decision 1/CP.21, paragraph 46). As of 2020, LDCs and other developing countries are accessing the USD 3 million for the formulation of NAPs under the GCF Readiness and Preparatory Support Programme. Some LDCs have successfully applied for funding on specific activities relevant to NAPs under the LDCF. Accredited delivery partners, such as UNDP, UNEP and FAO are assisting countries in accessing these funds. The system for updating Uganda's NAPs should take advantage of this.

3.8.3.2 Triggers for updating NAPs

a) Actions emanate from the Paris Agreement article 7, paragraphs 10 and 11 which reflect periodic updating of adaptation communication and other communication frameworks, including the NAP.
b) The UNFCCC indicative sequencing of activities at the national level, for implementation of the Convention and Paris agreement, indicates that the period for updating climate change

instruments, namely, NDC, “Adaptation Communication”, and NAPs, is 5 years, and thus the system for updating Uganda’s NAPs will be 5 years.

c) The recommended timeframe of Uganda’s National Climate Change Action Plan referred to in article 6 paragraph 3 of the National Climate Change Act, 2021, is five years. Thus, Uganda’s NAPs will be updated every after five years in coherence with the Act. The Adaptation plans of the Lead Agencies, and Districts, will as well be updated a year after the update of the NAP.

NB: The NAP could be one of the Key inputs to the National Climate Change Action Plan for Uganda, referred to in Article 2 of the Climate Change Act.

3.8.3.3 Sources of inputs for Uganda’s NAPs-updating system

Sources of inputs to the NAPs-Updating system will be the following: (i) Annual reports from sectors on implementation of adaptation actions; (b) Monitoring and review report from the Climate Change Department for the five years of the previous NAP; (c) Research in various dynamics such as weather, climate and climate change, vulnerabilities at regional, sectoral and ecosystems consideration as well as any other relevant aspects; and (d) The National MRV under development will provide substantial information requirement on progress of NAP implementation. This will be hosted at CCD.

3.8.3.4 Stages in the Uganda’s NAPs-updating system

Having established the NAP, updating Uganda’s NAPs will call for Climate Change Department’s reviewing of the annual sectoral reports on adaptation, to monitor the annual progress of implementation of the NAP for the five years. With this information, the CCD will be able to produce an overall progress report or country’s status report on adaptation which will provide input for the NAP-updating system. Each institution and organization will have to take on the duties or roles assigned to them in the proposed NAP governance structure at various stages in the NAP process.

The designed system for updating Uganda’s NAPs will majorly involve the elements in the preparatory stage as well as preparation and updating of implementation strategies. The stage of reporting, monitoring and reviewing, will also be continuously undertaken in the period of implementation of updated NAP to produce a status report (i.e., progress report) to serve as input to the incoming NAP.

Activities that will be involved in each stage, are outlined in the Technical Guidelines for the National Adaptation Plans process {(LEG, 2012), decision 5/CP.17}.

3.9 General Recommendations and Conclusions

a) Co-benefits of adaptation actions:

- Across the various sectors the concept of mitigation co-benefit of adaptation actions was found to be down-played, although the agriculture NAP alludes to it. Adaptation measures that have or show potential for mitigation co-benefits should be prioritized across sectors, for example the use of solar driers in the drying of especially small fish, such as "Mukene", and crops, in post-harvest handling. This prioritization will avail a range of benefits. It will:
    i. Enhance generation of projects with multiple benefits
    ii. Avail opportunities for joint / sectoral climate action by sectors, e.g., energy - agriculture- disaster risk reduction-and others, and
    iii. Enhance contribution to the shift from project-based to programme-based climate actions.

b) Focus on adaptation measure recommended in the "National Climate Change Policy, 2015".

- In the adaptation actions reported from sectors there was no evidence that the sectors made deliberate efforts to implement adaptation measures in line with those recommended in the "Uganda national climate change policy". This shortcoming needs to be addressed in the continuing adaptation actions across sectors.

c) Disaster Risk Reduction platforms and weather information

- Disaster Risk Reduction Platforms should be inclusive of climate change practitioners or vice versa. Furthermore, there is need for more weather information champions across geographical regions to ensure that communities can access and utilize timely and accurate weather information. With new cities on board, there is need for more support to cities to develop Climate and disaster risk inclusive and resilient urban physical development plans. At local level, there is need to support more communities to develop community-based disaster resilience and emergency response plans.

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CHAPTER 4

PROGRAMMES CONTAINING MEASURES TO MITIGATE CLIMATE CHANGE

4.1 Introduction

Uganda has made efforts to comply with UNFCCC requirements by implementing some mitigation actions. These have included hosting and implementing several Clean Development Mechanism projects, developing and implementing policies that have a strong mitigation component and conducting mitigation assessment as part of the reporting to the UNFCCC. This chapter provides a description of the process and results of the mitigation assessment undertaken as part of the TNC project. It also presents selected on-going mitigation projects, actions and policies.

The chapter describes the systematic process that was followed in conducting the mitigation analysis and presents the results of the mitigation assessment. Overall, the assessment focused on providing an update on the socio-economic scenarios (i.e., demographic growth, GDP growth, welfare of the population, etc.) available for use in mitigation assessments in the view of sustainable development and low emission development trajectory. The assessment updated the Business as Usual (BAU) scenarios for selected sectors such as energy, transport, industry, agriculture, water, LULUCF and waste management. Analysis (qualitatively) of the development and climate impacts of considered mitigation options is also presented in the assessment.

4.2 Process of Mitigation Assessment

Mitigation assessment takes into account information of the national level framework of climate change as well as efforts underway to mitigate GHG emissions within the broader national development context. The mitigation interventions must be aligned to main national mitigation policies, strategies and development plans. The mitigation assessment therefore was conducted based on the context, data and information that was collected and analysis was conducted using the Greenhouse Gas Abatement Cost Model (GACMO) and the Low Emissions Analysis Platform (LEAP) tools.

4.2.1 Basis of the Assessment

Uganda's mitigation actions are premised on the existing as well as the projected legal and institutional framework for implementation of the mitigation measures. The main framework at the time of the assessment was the National Climate Change Policy (MWE 2015a). In addition, the National Climate Change Bill was being processed through the Parliament. This law provides an enforceable framework to enable the implementation of the National Climate Change Policy MWE 2015a) the National Determined Contributions (NDC) (MWE, 2015b), and other relevant policies that are intended to combat climate change including mitigation. The law sets the institutional arrangement for addressing Climate Change and identifies the following as major sources of financing:

a) National and Sectoral Development Plans and Budgets.
b) Private sector investments in energy, industrial developments and technology transfer.
c) Multilateral and bilateral development partner support and support from international climate change funds.
d) Market-based mechanisms for climate-related actions and payment for ecosystem services schemes.

Under the NDC it is anticipated that cumulative implementation of a series of policies and measures in the energy supply, forestry and wetland sectors are projected to result in approximately 22% emission reduction of national greenhouse gas emissions by 2030 compared to business-as-usual (MWE, 2015b). To cater for shortcomings in the NDC such as lack of detail on interventions, timelines and targets per sector and subsector, the Government of Uganda through its Climate Change Department was in the process of revising her NDC during the process of implementation of the TNC project, in line with the UNFCCC decisions, as well as developing a Long-Term Strategy (LTS) on climate change, in line with the provisions of the Paris Agreement. The LTS is expected to be a long-term low greenhouse gas emission development strategy, putting into consideration the national circumstances.

In addition to the above, the mitigation assessment builds on Uganda's third National Development Plan (NDPIII) (NPA, 2020) which recognizes climate change mitigation and adaptation as being critical to the achievement of increased household incomes and improvement of quality of life of the population. Uganda's NDPIII considers continuous integration of climate change, gender considerations and disaster risk reduction, planning, budgeting and reporting including the development of a national Green House Gas Inventory and its Monitoring, Reporting and Verification system.

4.2.2 Assessment Process

The current assessment of mitigation actions does not include prioritization but rather evaluates the full spectrum of activities that are possible within the country in order to demonstrate maximize opportunities for the country. The mitigation assessment process involved a literature review, data and information collection, GHG inventory referencing and application of contemporary tools. The assessment team conducted a review of documents obtained from different sector Ministries, Departments and Agencies (MDAs) NGOs, development partners and CBOs. The documents reviewed were identified after an investigation of the highlights of the key areas of focus as guided by the NIR and the simultaneous GHG inventory work under the TNC project. The main objective of document review was to identify data and generate information for ascertaining the national trends and on-going mitigation actions in the country. The documents included policies, strategies and associated action plans, reports, programme documents, periodic publications of authentic bodies as well as previous reports of the CCD/MWE, national appropriate mitigation actions (NAMAs) and Uganda's Nationally Determined Contributions (NDCs).

The NAMA database and other related databases for Uganda were reviewed with a view of providing update where necessary. In addition, the qualitative methodology that was utilized to analyse mitigation options during the FBUR was taken into account.

Participatory and consultative approaches were used by involving different stakeholders responsible for designing and implementing mitigation measures in the different sectors of the economy. Specific focus was put on the institutions and offices that are handling climate change and disaster risk reduction management in the country. Specifically, the IPCC and mitigation NDC prioritized sectors were carefully studied and analysed: These include energy, agriculture, forestry, and other land uses (AFOLU), waste, works and transport, industry processes and product use (IPPU).

Consultations were carried out with MDAs, the development partners and the academia with a view to identifying the known mitigation measures undertaken, the BAU scenarios in the selected sectors of the economy and the impacts of considered mitigation scenarios, and implied costs and benefits. Through these consultations on-going interventions and progress towards achievement of national and sector mitigation actions was reported.

Mitigation goals should be underpinned with measures i.e., policies, instruments or projects that meet the strategic objective to reduce emissions. At this stage, Uganda has not yet carried out a clear cause and effect relationship between steps taken or envisaged, reported and expected results. Broad mitigation strategies and policies that may help achieve the strategies are presented in Table 4.1.

Table 4.1. Measures (policies, projects) that are anticipated to meet the sectoral mitigation strategies

Sector	Mitigation Strategy	Actions
Energy (stationary fuel combustion)	Development and utilization of renewable and new energy resources	1. Construct enabling infrastructure for electricity sector development, including power lines, substations and transmission facilities 2. Achieve at least 3,200 MW renewable electricity generation capacity by 2030, from 729 MW in 2013 3. Sustainable energy solutions in public buildings & Energy efficiency in hospitals 4. Integrated energy solutions for schools in off grid areas-NAMA 5. Promotion and wider uptake of energy efficient cooking stoves or induction cookers 6. Promotion and wider solar uptake of solar energy systems 7. Development and enforcement of building codes for energy efficient construction and renovation
Transport	Modernization and improvement of the transport sector	Under the Climate Change Policy and NDC: 1. Develop and ensure integrated planning and management of transport and other physical infrastructure that build on insights from climate predictions 2. Promote the development, approval, and effective implementation of a long-term national transport policy and plan that will take greenhouse gas mitigation concerns into account 3. Effect a gradual shift to the use of less carbon-intensive fuels (including compressed natural gas, ethanol, and liquefied petroleum gas) in vehicles, instead of relying heavily on gasoline and diesel fuels 4. Promote modes of transport that take into account greenhouse gas emissions reduction. Under the National Transport Master Plan (NTMP): 1. Serve as a long-term reference framework for developing plans for individual transport modes 2. Provide key input to the overall national planning process 3. Provide key input to the regional transport planning 4. Create a framework for investment decisions for both the private and public sectors 5. Create a high-quality transport planning capability within the Ministry of Works and Transport.

		Others: 1. Implement tax regimes that discourage use of personal vehicles in favour public transport 2. introduce electrified buses and buses that use Natural Gas in urban centres 3. Implement tax regimes that discourage importation of used vehicle 4. Implement tax regimes that promote fuel efficient vehicles (motor cycles, cars) 5. Improve of transport organisation and vehicles 6. Fuel Efficiency Initiative NAMA 7. Development and implementation of a long-term transport policy accounting for climate change mitigation concerns 8. Bus Rapid transit and shifting freight transport from road to rail.
Waste	Improved municipal waste management that takes advantage of waste to energy technologies	1. Harness energy from landfills (gas flaring) 2. Composting of Municipal Solid Waste 3. Harness energy from waste water 4. Harness energy from farm waste (cattle and big farms biogas digesters)
Land use	Support and promote a wide range of Forest Landscape Restoration initiatives that includes forests, wetlands and agroslivopastoral systems	1. Reverse deforestation trend to increase forest cover to 21% in 2030, from approximately 14% in 2013 through Forest Landscape Restoration initiatives and creation of instruments that will attract investment in REDD+ mechanisms 2. Develop enabling environment for wetlands management 3. Develop an enabling environment for forestry management 4. Increase wetland coverage to 12% by 2030, from approximately 10.9% in 2014, through demarcation, gazettement and restoration of degraded wetlands 5. Support livestock breeding research and manure management practices 6. Climate Smart Agriculture techniques for cropping

4.2.3 Tools for assessing mitigation effects

The two key tools used is assessing effects of mitigation interventions were the Greenhouse Gas Abatement Cost Model (GACMO) and The Low Emissions Analysis Platform (LEAP) (SEI, 2017). The GACMO tool was used for economy-wide assessment covering all the mitigation sectors. The LEAP model was used to conduct a specific assessment for the transport sector.

4.4 Mitigation Assessment in the Transport Sector

The transport subsector accounts for close to 66% of the emissions of Uganda's energy sector. Emissions from the transport sub sector were estimated at 2,500 Gg and was ranked as the fifth key category source in absolute values and as the eighth key category in terms of trends according the First Biennial Update Report (MWE, 2019). Most of the interventions in the energy sector are thus targeted towards the transport sub sector. Unlike the other sectors where assessment is grouped under sector wide assessment, the transport sector is given a stand-alone assessment using the LEAP model.

4.4.1 Passenger Transport Sub-sector

The major challenge facing Uganda's transport sector is the prevalence of high fuel intensity vehicles with low passenger kilometer. Figure 4.1 shows that in terms of number, motorcycles account for 50% of motorized road vehicles while buses, minibuses and cars combined take only 30%.

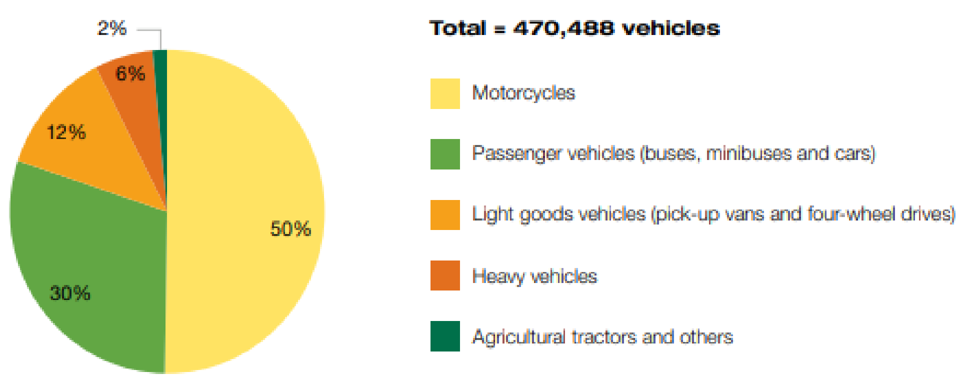

Figure 4.1: Share of Motorized Vehicles in Uganda

(Source: LEDS, 2018)

In terms of passenger kilometer, buses take the highest share estimated at estimated at 21 Billion or 70% of motorized passenger road transport. This is because buses relatively carry many people (about 50 people for long distances, estimated at 400 km per day or 12,000 per bus per year). Omini buses and bodas take the lowest at 1.8 Billion Passenger km (Table 4.2).

Table 4.2: Share of road transport by Vehicle type. Computed based on number of vehicles, passenger KM, load factor and fuel consumption per km

Passenger Vehicle Type	Load Factor	Numbers	Km/Day	Passenger Km	Per PASS KM
Buses	50	3,500	400	21,000,000,000	70%
Mini Buses	14	4,500	100	1,890,000,000	6%
Bodas	1.5	200,000	20	1,800,000,000	6%
Cars	4	87,500	50	5,250,000,000	18%
Total				29,940,000,000	100%

In terms of fuel intensity, the buses have got the lowest fuel intensity at 0.0067 while Bodas have the highest estimated at 0.0267 followed by cars at 0.0227. Ominbuses are in between at 0.01 (Table 4.3).

Development of interventions and mitigation options in the passenger transport system factored in the issues of absolute vehicle type numbers, passenger kilometre and fuel intensity.

4.4.2 Development of interventions in the Road Transport

The National Transport Master Plan (NTMP) together with other transport policies and strategies are aligned with the overall national development framework of supporting and nation's development targets. The National Transport Master Plan's primary objectives are to: (1) serve as a long-term reference framework for developing plans for individual transport modes; (2) provide key input to the overall national planning process; (3) provide key input to the regional transport planning; (4) create a framework for investment decisions for both the private and public sectors; and (5) create a high-quality transport planning capability within the Ministry of Works and

Table 4.3: Fuel Intensity by vehicle type

Passenger Vehicle Type	Load Factor	Fuel (Lts) /Km	Fuel Intensity
Buses	50	3	0.0067
Mini Buses	14	7	0.0102
Bodas	1.5	25	0.0267
Cars	4	11	0.0227

Transport (MOWT, 2009).

4.4.3 Selected Interventions in Transport Sub-sector

In line with National Climate Change Policy, the NDC and other development plans, the following interventions were considered for the Transport Sub-sector.

a) Halt the growth rate of boda-boda from the current 2% per annum so that Boda-boda Passenger Km share declines from the current 19% to 10% instead of projected 24% share of road transport by 2050.
b) Support investment into public transport system so that that bus Passenger Km increases from the current 59% share of passenger road transport to close to 70% by 2050
c) Within urban centres introduce electrified buses and buses that use Natural Gas by year 2040 or before.
d) Support use of more efficient motor cycles to replace 2% of the less efficient boda- boda fleet by 2025, 10% around year 2030 and 25% by 2050.
e) Invest in electrified rail system that electrified passenger train services accounts replaces 5% and 10% of the old system by 2040 and 2050 respectively.

4.4.4 Transport Sector Mitigation effects

Compared to the BAU, the aforementioned proposed interventions in the motorized road transport and rail would result in net avoided emissions, starting in 2022 and progressively increasing until 2050 as most of the proposed investment become operational. By year 2050, annual net mitigation effects are estimated at 2,999 Gg or kilotonnes per year (Figure 4.2).

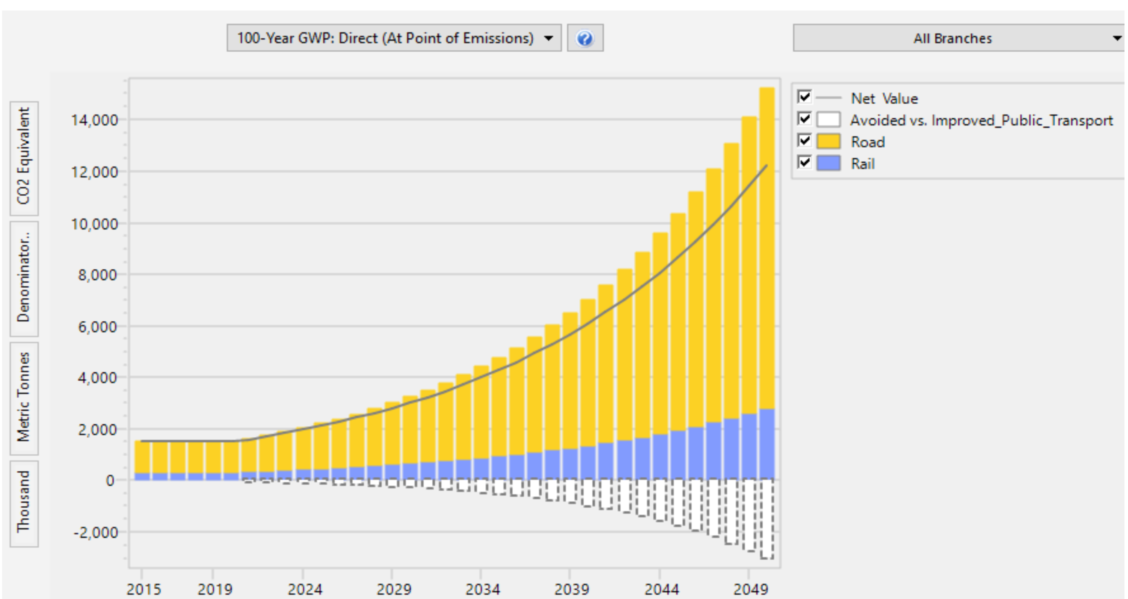

Figure 4.2: Envisaged mitigation effects as result of the proposed interventions; LEAP output

The cumulative mitigation effects of interventions in the motorized road and rail transport sub sectors are estimated to rise from 1,108.6 Gg in 25,772.9 Gg by 2050 (Table 4.4)

Table 4.4: Projected Mitigation effects in the transport sector Gg CO2e

Year	2025	2030	2035	2040	2045	2050
Annual Avoided	79.7	236.8	494.8	946.0	1,713.4	2,999.2
Cumulative Avoided	279.3	1,108.6	3,007.6	6,737.1	13,609.1	25,772.90

4.5 Sector Wide Mitigation Assessment

4.5.1 Non-Transport Energy Sub-sector

The energy sector in Uganda comprises of both traditional and conventional energy sources, including petroleum and renewable energy sources. All petroleum is imported into the country, with major ones being gasoline (diesel), petrol and aviation fuel. Between 2005 and 2015, diesel usage more than doubled from 319,574 m^3 to 718,831 m^3. In the same period petrol usage increased by almost fourfold form 174,054 m^3 to 663,649 m^3.

4.5.2 Non- transport Energy Mitigation Assessment

A substantial portion of Uganda's electricity generation is from Hydro Electricity Power (HEP). Interventions thus focus on end use efficiency such as efficient lighting systems and increased investment renewable energy sources and use. These include increased HEP production, increased connection to HEP main grid and promotion of Solar house PVs especially in rural areas where electricity connectivity is very low.

4.5.3 The AFOLU sector

Emissions from degradation of forests (forest land remaining forest), conversion of (mainly forests) to cropland, and CH_4 emissions from enteric fermentation of ruminant animals were identified as key emitting categories both in absolute terms and trend. From 2005 to 2015 emissions from AFOLU increased from 59,735Gg to 66,829 Gg representing 93% and 86% of national emissions, respectively.

To affirm its commitment to global climate goals, the NDC seeks to reduce Uganda's vulnerability to climate change sectors as well as reduce greenhouse gas (GHG) emissions reductions in forestry and wetlands, energy, transport and agriculture sectors. Uganda committed to reduce its emissions by 22% by 2030 compared to the business-as-usual projections, contingent upon receipt of ongoing and planned international support to complement domestic efforts (MWE, 2015a). In 2019, Uganda becomes the first African country to submit REDD+ results to the UNFCCC, paving the way to potential results-based payments.

4.5.4 AFOLU Mitigation Assessment

Policy measures and actions in the agriculture sector are focused on sustainable development as the main objective. Mitigation of climate change impacts such as soil carbon enhancement as a result of Climate SMART agriculture practices or reduced methane emission (CH_4) from livestock due to improved feeds are seen as co benefits.

Commitment to the implementation of mitigation actions in the forestry sector is exemplified by a number of policy decisions and actions.

The National Forestry and Tree planting Act 2013 (NFA, 2013) and the National Climate Change Policy 2015 (MWE, 2015b) provides the foundation for investment in the forest sector while REDD+ National Strategy 2017 (MWE, 2017) and the National Climate Change Bill 2020 (MWE, 2020) are intended provide an enforceable framework to enable the implementation of mitigation actions; provide for institutional arrangements for coordinating and implementing climate change response measures; provide for financing for climate change; and other related matters in addressing climate change. These polices and measure address institutional or political barriers that may prevent effective implementation or make the sector less attractive to private sector investment and technology transfer.

Key interventions are reduced deforestation (also known as avoided deforestation) and forest restoration. Due to complications of the former, mitigation effects assessment only focused on restoration.

4.6 Waste Sector

Solid waste management and disposal is mainly a problem in urban areas. In Uganda the responsibilities framework for waste disposal management are mainly enshrined in the laws that govern municipalities and urban authorities. Kampala city has been documented to produce the largest volume of waste in Uganda. There are three types of wastes generated in Kampala and other major cities namely; domestic wastewater, industrial waste water and solid waste.

Kitezi, the largest solid waste disposal site managed by Kampala Capital City Authority (KCCA) is estimated to handle 755,084 metric tons of waste per annum. Mainly attributable rapid urbanization and changing levels of income, the composition solid waste in the capital city is changing with the share of biodegradable materials declining from 88.5% in 1990s to about 77% in 2014.

Wastewater treatment is also a big challenge because of limited sewerage systems and connections. The National Water and Sewerage Corporation (NWSC) is estimated to serve approximately only 6% of the households in Kampala and is projected to increase its services to 30% of the by year 2030. The majority of the urban population will most likely continue to rely on onsite sanitation which calls for innovative solutions to deal with wastewater and sludge disposal.

Assessment of actions under the waste sector focused on both on-going and planned projects in the management of solid waste and waste water disposal. By nature of the sector, these interventions are mainly urban or peri-urban based. Almost all the projects in the waste sector follow CDM carbon accounting procedures. Waste sector assessment include; waste to energy for small scale and large-scale farms, waste to energy from industrial waste water and household waste water.

4.7 Economy wide approach of assessing mitigation effects

GACMO allows selection and assessment of economy wide mitigation actions. Interventions in terms of emission reduction options covering several sectors were developed and mitigation effect (in terms of tCO_2) of each unit computed. These were spread at periodic intervals of; (2015 to 2020, as baseline and future as 1), 2020 to 2025 2), 2025 to 2030 and 3) 2030 to 2050. The three intervals represented are denoted as 2025, 2030, and 2050, in Table 4.5.

4.7.1 Mitigation Effects in the Energy (non- transport)

The energy (non-transport) subsector includes efficient lighting with LED, increased Hydro power connected to the main Grid, replacement of kerosene for biogas in rural areas. These interventions are anticipated to have a combined mitigation effect of 4,281Gg, 4,282 Gg and 6,165 Gg tCO_2e/year in the 2025, 2030 and 2050 period respectively.

4.7.2 Mitigation Effects in Land Use Sector

Under the land use change and forestry, the interventions assessed are reforestation and restoration of 500 units of 1,000 hectares each in for every 5 years. This is anticipated to sequester 5,500 Gg CO_2 or 1,833 Gg of CO_2 e every five-year intervention period (Table 4.5).

4.7.3 Mitigation Effects in the Waste Sector

Under the Waste Sector, mitigation effects were assessed for one ongoing project, one project that is about to be commissioned, and one planned for 2030. The on-going project is a CDM Programe of activities known as the Uganda Municipal Waste Compost Programme (PoA). It is managed by NEMA in collaboration with a number of municipalities. It is anticipated to offset about 115 Gg tCO_2e / year. The Nakivubo Wastewater Treatment Plant Methane Capture and Utilization Project is about to be commissioned and it will be implemented by National Water and Sewerage Corporation (NWSC). It is designed to capture methane and generate electricity from waste water. It is also designed to produce compost manure. The anticipated mitigation effect is in the range of 27 Gg tCO_2e/ yr.

The Mpererwe Landfill Gas Project is anticipated to capture and flare and also produce electricity from the KCCA managed landfill at Mpererwe, a Kampala suburb. The mitigation effect is estimated at 182 Gg tCO_2e/year.

All waste to energy interventions are anticipated to have a mitigation effect of 6,395 Gg CO_2e by 2050.

Table 4.5: Economy wide periodic Interventions (reduction options)

Intervention	Period	2025		2030		2050		Cumulative
Reduction option	Sub-type unit	Units	kt/year	Units	kt/year	Units	kt/year	
Efficient lighting with LEDs	1000 Bulps	5000	389	5000	389	5000	389	
Efficient office lighting with LEDs	1000 lights	1000	44	1000	44	1000	44	
Hydro power connected to main grid	1 MW	2000	3846	2000	3846	2000	3846	
Solar house PVs	500 W	5000	2	5000	2	20000	8	
Solar LED lamps	1000 lamps					20000	1878	
Sub Total Energy			**4,281**		**4,281**		**6,165**	**14,727**
Reforestation (Land use)	Reforestation of 1000 ha	500	1833	500	1833	500	1,833	5,500
Composting of Municipal Solid Waste	1000 t/day plant					1	4,137	
Biogas at rural farms using kerosene	1000 units					1000	1,228	
Biogas at big farms	84000 pigs					1	281	
Biogas from industrial waste water	1 plant					10	258	
Composting of Municipal Solid Waste	1000 t/day plant	PAO	106		106		105.90	
Biogas from Municipal Solid Waste	2000 t/year plant				24		24.37	
Landfill gas flaring	1 t/day plant						124.42	
Sub Total Waste			**106**		**130**		**6159**	**6,395**
Overall total			**6,220**		**6,245**		**14,157**	**26,622**

Cumulative mitigation effects (including transport) are estimated at 52,434 Gg CO_2e by 2050. This however does not include potential from investment in REDD+ avoided deforestation projects which are not part of this assessment.

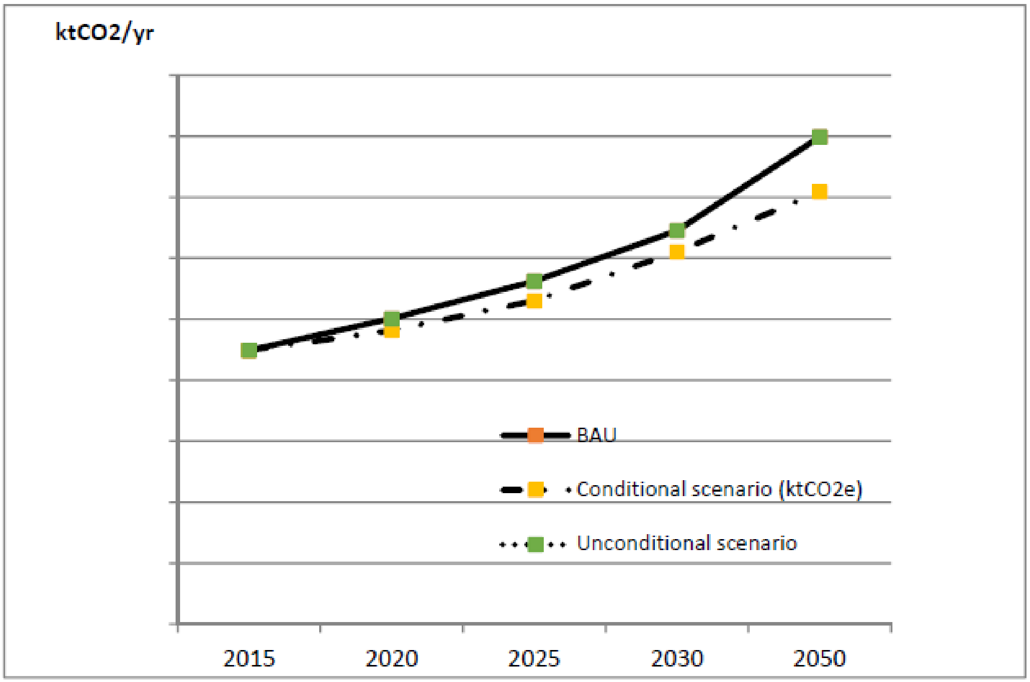

Figure 4.3: Conditional Scenario (kt CO_2e) vs baseline emissions for period 2020 to 2050

4.8 Goal, Progress Indicators and Monitoring

This assessment is based emission reductions relative to a projected emissions baseline scenario or the 'business as usual'. All these estimates are ex ante. Uganda is yet to put into mechanism of collecting data on the parameters needed to estimate ex-post policy scenario emissions. This will enable the country to estimate GHG effects ex-post, and understand whether the policy or actions are delivering the expected results.

4.9 Ongoing Mitigation Actions

In line with the commitments under UNFCCC, Uganda has made efforts to develop and implement mitigation actions. These have included projects where funds have been sourced through bilateral and multilateral channels. In addition, a number of policy measures that have actions resulting in reduction of GHG emissions have been enacted. The National Climate Change Policy and its costed implementation strategy specifically outlined a number of mitigation actions.

Table 4.6: Mitigation actions from selected sectors

Name of the mitigation action(s)/Title of the project activity	Sector	Objective	Methodology	Description of the mitigation action(s)	Technology	GHG Gas	Estimated emissions reduction	National implementing entity
Restoration of the river Enyau micro-catchment (Arua, Uganda)	AFOLU	Changing the poor land use practices to better catchment management practices		Restoration of the river Enyau micro-catchment; afforestation in areas degraded by communities living within the Enyau micro-catchment, restoration of about 41 square kilometres to improve water quality, quantity and livelihood of the beneficial communities.	Afforestation of degraded areas	CO_2	Not estimated	NWSC
Restoration of the river kitagata micro-catchment	AFOLU	Changing the poor land use practices to better catchment management practices hence improved water quality, quantity and livelihood of the beneficial communities.		Restoration of the river kitagata micro-catchment; afforestation in areas degraded by communities living within the Kitagata micro-catchment, restoration of about 5 square kilometers	Afforestation of degraded areas	CO_2	Not estimated	NWSC
Briquette making; Lubigi waste water treatment plant; sludge re-use	Energy	Environmental protection and putting resources to use.		Briquette making; Lubigi waste water treatment plant; sludge re-use; resource recovery through utilization of sludge to make briquettes for cooking	Efficient energy production	CO_2	Not estimated	NWSC
Sludge re-use for fertilizer making	Waste	Protection of the environment and reduction in greenhouse gas emissions		Sludge re-use for fertilizer making; utilization of sludge generated from waste water treatment for fertilizer making; usage for agricultural practices. Less mining for calcium carbonate (cobalt), phosphates.		CH_4	Not estimated	NWSC
Cable Car Transportation in Kampala	Energy	improved efficiency of transporting passengers with the Cable Cars reducing GHG emission in Kampala City	The impact of the cable car system on emissions reduction is determined by comparing and monitoring the emissions levels. Levels to be considered would include a baseline scenario (do nothing/as is basis) and another in which the cable car is operative.	From the available data, there are 10,184 taxis registered in the city covering an average of 22.25km in every trip and making an average of 4 trips a day. This generates a CO_2 emission of 461.03tons daily. On the other hand, the Kampala Kable Kar integrated system would generate only 120.45 tCO_2 emissions every day reducing the overall daily emissions by 340.58 tCO_2.	Cable Car System	CO_2	124.312 tCO_2e	KCCA

Name of the mitigation action(s)/Title of the project activity	Sector	Objective	Methodology	Description of the mitigation action(s)	Technology	GHG Gas	Estimated emissions reduction	National implementing entity
Demand Side Management of Energy Use in MSMEs of the manufacturing sector - Switch Africa Green Project (NOVEMBER 2015- JUNE 2018)	Industry	To improve energy productivity and reduce adverse environmental impacts through adoption and implementation of energy efficient techniques and practices in MSMEs in the manufacturing sector	Awareness and Regional training workshops, Rapid and detailed energy audits for 20 MSMEs, in-house trainings on key energy efficient areas, Monitoring and technical evaluation	In collaboration with Uganda Cleaner Production Centre (UCPC) has been implementing the sub-project Demand Side Management of Energy Use in MSMEs of the manufacturing sector (Energy Efficiency) under the Switch Africa Green two years Project that commenced in November 2015 and later extended for one year to end in June 2018. The project was implemented in tea plantations in Uganda. i) Kayonza ii) Kazire Health Products iii) Mpanga iv) Southern v) RECO Industries limited.	Preventative Maintenance, Energy efficiency techniques and Use of Resource Efficiency and Cleaner Production (RECP) tool kits	CO_2	i) Kayonza tea factory - 4737 tons CO_2eq ii) Kazire Health Products - 93.6 tons CO_2eq iii) Mpanga Tea Growers - carbon emissions reduced from 2.11kgCO_2eq/kg of made tea to 2.06 kgCO_2eq/kg of made tea iv) Southern range Nyanza Teextiles - reduction in Carbon emissions from 18.25 kgCo_2.eq per kg produced to 16.74kg CO_2.eq per kg produced v) RECO Industries – reduction in greenhouse gas emissions by 0.158 kgCO_2eq per kg produced	Ministry of Trade, Industry and Cooperatives in collaboration with Uganda Cleaner Production Center (UCPC)
Renewable Energy Strategy	Energy	The overall objective of the 2007 Renewable Energy Policy was to diversify the energy supply sources and technologies in the country.	Create more favourable business environment with appropriately refreshed policies, regulations and energy plans;	In particular, the policy goal was set to increase the use of modern renewable energy from 4% to 61% of the total energy consumption by the year 2017, with special focus on following areas. Since the inception of this strategy, Uganda accomplished the following: • Standardized PPA and Implementation Agreement for hydro, bagasse, biomass and solar PV have been developed or are being finalized; • RE-FIT and GET-FIT, implementation of a very successful Feed-In-Tariff Program which is expected to drive additional small renewable generation between 2014 and 2023;	Promote the sustainable production and utilization of biofuels; • Promote the conversion of municipal and industrial waste to energy.	CO_2 CH_4	Not estimated	Ministry of Energy and Mineral Development
Biomass Energy Strategy (BEST) 2013		improve the enabling environment of the biomass sector	collaboration with GIZ formed the Uganda Biomass Energy	Specially targeted Awareness Creation • Creation of a Biomass Resource Information System • Enhanced Institutional Capacity to implement BEST	Dissemination of improved Biomass Energy Technologies (BETs	N/A	Not estimated	Ministry of Energy and Mineral Development

Name of the mitigation action(s)/Title of the project activity	Sector	Objective	Methodology	Description of the mitigation action(s)	Technology	GHG Gas	Estimated emissions reduction	National implementing entity
			Efficient Technologies Association (BEETA), as an umbrella body to enhance technology diffusion.	• Biomass demand Interventions • Biomass Supply Interventions • Cross cutting Issues such as innovative funding mechanisms to support disseminating improved biomass technologies.				
Adoption of Improved Charcoal Production Technologies and Sustainable Land Management Practices	AFOLU	"Addressing Barriers to Adoption of Improved Charcoal Production Technologies and Sustainable Land Management Practices" through an Integrated Approach project (2014 – 2018), looks to overcome the main barriers to transforming the current charcoal production practices into a sustainable one	Dissemination of appropriate technologies for sustainable charcoal production in 4 selected charcoal-producing districts (Mubende, Kiboga, Nakaseke and Kiryandongo).	The UNDP/GEF funded looks to overcome the main barriers to transforming the current charcoal production practices into a sustainable one	Energy Efficient Improved Kilns	N/A	Not estimated	Ministry of Energy and Mineral Development
The GIZ-MEMD Energy efficiency and management program	Energy/ Industry	for high 100 most energy intensive industries, aiming at supporting them reduce their energy consumption	15 audits took place in the second half of 2015.	Large and medium industries' power consumption totalled 1450 GWh out of 2,276 GWh, sold by UMEME in 2014. This is almost 64%.	energy audits program targeting 50 energy intensive industries (2015-2017) which are part of the top 100 electrical energy consumers.	N/A	Savings in electricity consumption are expected between 15% and 25%. Approximately 200 – 400 GWh electricity/ year	Ministry of Energy and Mineral Development
Dissemination of 3,000,000 LED and efficient appliances	Energy	reducing evening peak power by 35 to 60 MW, and energy consumption by 1,000 to 1,500 GWh	1 million urban households	ARE allowed UMEME to procure and distribute 1,000,000 LED lamps as a way of reducing energy demand by replacing CFLs and incandescent lamps.	Other appliances like refrigerators, freezers may reduce another 100 GWh per annum	N/A	1000 - 1600 GWh electricity/year	Ministry of Energy and Mineral Development
Dissemination of improved kilns	Industry/ Energy	Addressing Barriers to Adoption of Improved Charcoal Production Technologies	Energy Efficient Improved Kilns	Bricks making, Small scale lime production Fish smoking		N/A	2400 ktons wood/year	Ministry of Energy and Mineral Development

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CHAPTER 5

CONSTRAINTS, GAPS AND RELATED FINANCIAL, TECHNICAL, AND CAPACITY NEEDS AND SUPPORT NEEDED, AND PROPOSED INTERVENTIONS

5.1 Overview of National Achievemnets, Constraints and Gaps

Uganda's capacity to meet its reporting obligations to the United Nations Framework Convention on Climate Change has gradually improved since its first national communication in 2002. Currently, the compilation process is led by national experts who work with sector working groups that are drawn from various Ministries, Departments, and Agencies (MDAs). However, a number of contrainsts and gaps remain. These are outlined in this section.

5.1.1 Achievements

Uganda has received support in training of experts in the area of GHG inventory compilation. More than 60 personnel from mandated MDAs have received training in data handling, archiving and the compilation process. Over 20 of these have, in addition, received training in the UNFCCC guidelines for the preparation of national communications. Overall, over 100 stakeholders from NGOs, academia, CSOs and youth organizations are engaged in various climate change activities such as advocacy and negotiations at both national and international levels. This has raised the level of awareness and visibility of key climate change issues. The status of the national communication report has been elevated such that it has to be approved by the National Climate Change Advisory Committee (NCCAC).

5.1.2 Financial Constraints, Gaps, and Needs

Financial contraints and gaps that the country faces were presented in the FBUR in 2019. Many of them are still relevant. The majorone are:

a) Difficulty in tracking climate finance inflows: _Various organisations in the country receive climate funding from multiple sources that do not pass through the central government authority, the Ministry of Finance, Planning and Economic Development. In addition, most of the programmes take place at different levels and unless is the funding for these programmes are held at the national level, it is difficult to track.

b) Inadequate financial allocation in the national budget; Domestic financing of climate change activities is very limited including allocations of funds for the national communication and other national and international reporting arrangements. The lead government entity, the CCD, is insufficiently funded like many other MDAs. As such it is inadequately staffed. The

COVID-19 pandemic has constrained the situation further and widened the financing gap in almost all sectors and government institutions.

c) Weak institutional coordination; Weak institutional coordination within government and among donors makes it difficult to estimate expenditure on climate change activities and in many ways leads to duplication of climate change interventions. In addition, lack of a streamlined system and failure of information sharing may lead to duplication of activities. Funding and resources that are sent to NGOs, academia, etc. may not be applied to where they are needed most.

d) Lack of capacity at the local level: Uganda's two tier government structure where the central government deals mainly on policy and technical guidance while implementation is expected at local government is constrained by lack of structures for the implementation of climate change activities in the local governments.

5.2 Constraints, Gaps, Opportunities and Needs in the Preparation of GHG Inventory

Despite recent enhanced capacity development, Uganda still faces technical and financial difficulties in preparing its GHG inventory. With support from the Global Environment Facility (GEF) under the Capacity-building Initiative for Transparency (CBIT), a training and capacity needs assessment in 2019 revealed a wide range of issues in areas of data collection, data collation and archiving, data processing, and compilation of GHG plus reporting mechanisms. The assessment informed follow-up through training in data analysis and compilation of GHG. This exercise helped elevate the level of understanding of the data requirements at the technical level. However, decision makers at the senior management level are yet to be engaged so as to provide adequate support.

Climate change capacity needs in GHGI compilation range from coordination at high levels of government to short-comings in data collection and inadequate skills in implementation of climate change activities at lower levels. Overarching issues and needs include streamlining GHG data management and institutional arrangements, strengthening national GHG inventory system, training on 2006 IPCC software (including guidelines) and training in software that can enable the country to use the Tier 2 approach in GHG compilation for Agriculture, Forestry and other land use (AFOLU).

As stated earlier, CCD has facilitated addressing these gaps with support from RCMRD, UNEP, GEF and the Rainforest Coalition. At sector level, the major gaps are presented in Table 5.1.

Table 5.1: Technical and Capacity needs and those received

Level	Activity	Capacity Needed	Capacity received	Source of Support
Overarching	GHG National System improvement	GHG Data management and institutional arrangement.	Development of MRV & Mitigation Tool	UNDP
	Improved coordination strategies	Strengthening national system for GHG	Establishment of online GHG database	UNDP
	Use of 2006 IPCC guidelines software	Training on 2006 IPCC Guidelines and software	Training on GHG Inventory all GHG compiling MDAs done three times	RCMRD, Rainforest Coalition and GEF CBIT
	Improved coordination AFOLU sector working group & Tier 2 approach	Tier 2 AFOLU compilation	Hands on -training on the use of ALU software	GGGI /Rainforest Coalition
Energy sector	Improved data collection, collation, archiving and analysis	Mechanism for monitoring vehicle fleet by major types	Action needed	
	-do-	Mechanisms for regularly updating fuel imports / exports and reconciling with end use data	Action needed	
IPPU	-do-	Mechanisms for documenting data imports and use of lubricant and HFC-134a	Action needed	
Waste sector	-do-	Solid waste characterization	Done only for KCCA	UBOS, NEMA
	-do-	Establish per capita solid waste generation	Done only for KCCA	UBOS, NEMA
	-do-	Establish Degradable Organic Carbon (DOC)	Done for major industrial effluents in Kampala	NEMA
	-do-	Waste water generated (m3) per (t) of industrial products	Action needed	
Agriculture sector	-do-	Livestock characterization	Work in progress	UBOS, NEMA, SIRGE
	-do-	Document manure management systems	Work in progress	RUFORUM[2]
	-do-	Establish wood extraction	Initiated but stalled	FAO FLEGET

[2] RUFORUM; The Regional Universities Forum for Capacity Building in Agriculture

Land and land use	-do-	Improve updating of LUC maps from every 5 years to 2 years	NFA trained and given access to freely available remote sensed imagery and cloud platform such as Google Erath Engine (GGE) and SEPAL	FAO, RCRMD-NASA
	-do-	Mechanism for improved estimation of burnt area and fraction of biomass burnt	Action needed	

5.3 Constraints, Gaps, and Opportunities in implementation of adaptation measures

5.3.1 Constraints and Gaps

Efforts to undertake adaptation measures face various constraints and gaps / barriers, although in some instances there are opportunities. The constraints, gaps and barriers in the implementation of adaptation actions are as follows:

Accessing finance and other support: (i) Capacity to write fundable proposals for climate finance from the various funding windows, such as, the GCF, GEF is still inadequateand (ii) Awareness of the changes in the requirements for funding is often not uptodate.

Climate scenarios, and translation to local context: (i) Most of the existing climate scenarios are of low resolution and not readily usable for precise decision-making; (ii) Intra-sectoral assessibility of avail climate data has yet to be streamlined to ease the underpinning of effective adaptation assessment, planning and implementation, taking into account specific needs at the national, sub-national and sectoral levels ; and (iii) Methods and tools for translating climate data and climate change scenarios to the local context have yet to be institutionalized

Risk and vulnerability assessment and risk management: Sector-specific risk and vulnerability assessments and management have yet to be institutionalized to enhance understanding of not only beslines but also progression of vulnerabilities and risks. The absence of area specific local vulnerabilities affects local adaptation planning which are important aspects of measuring and assessing progress in reducing vulnerability Institutionalization of risk and vulnerability assessment and risk management at all levels of governance and in key sectors will enhance the building of evidence for adaptation additional arguments in funding proposals to the GCF.

Access to and use of technology: Access to and use of technology calls for prior technology needs assessment (TNA). Whereas TNAs have been undertaken for the Water, Agriculture and Forestry sectors, the bulk of the sectors have yet to undergo technology needs assessment, Furthermore, for the sectors where TNAs have been undertaken there are barriers to access and use of the identified technologies which include finance and the know-how.

Linkage with the development agenda: Linking climate change adaption with development agendas is essential. as reflected in the Paris Agreement articles 2 and 7. However, Uganda is still facing barriers emanating from gaps in understanding of the concept of integrating adaptation into development planning; and low capacity to integrate international processes that are relevant to adaptation planning using the appropriate frameworks.

5.3.2 Constraints Pertinent to Agriculture Sector in the Implementation of Adaptation Actions

Logistical and infrastructural risks: The lack of sufficient storage capacity both at farm level and agricultural produce trading system levels, coupled with inability to construct durable and weather tight stores, leads to high losses due mainly to damage by pests and poor handling prior to storage. There is an estimated 550,000 MT storage capacity but the estimated demand for storage facilities is estimated at 2.3 million MT and yet up to 20% of what is harvested is lost during storage. There are also inadequate cooling facilities for fish and milk, leading to substantial losses.

Weak enabling environment: The legal environment for the agricultural sector is conducive but implementation of many initiatives has been poor in the past due to inadequate institutional arrangements and financial resources to invest in enforcing the policies.

Gender constraints: The differentiated impacts of climate change and differentiated access to production resources and inputs by men and women, including extension, information, and climate finance, results in gender-related productivity gaps in agriculture. In most cases external resources and technical assistance is directed towards men, even though women are responsible for the bulk of agricultural work. Women are also accorded minimal rights compared to men especially when it comes to land access, tenure rights and security. This has been noted a barrier to adoption of sustainable agricultural practices, hence the need to review customary and statutory provisions governing the rights and security of tenure using a gender lens.

5.3.3 Proposed Interventions and Opportunities

Various interventions and possible opportunities were proposed including the following:

a) *Accessing financial and other support*
   (i) Capacity building enhancement in proposal writing to develop human capacity to prepare concept notes and funding proposals. This should include support on awareness arising on the latest information required to be included in GCF funding proposals.
   (ii) Mechanism to channel climate finance to local government authorities.

b) *Climate scenarios, science and translation to local context*
   (i) Capacity building in generating, accessing and using climate data to develop climate scenarios.
   (ii) Provision of support for climate information services and early warning systems projects, and capacity development for risk-informed planning.
   (iii) Capacity building in accessing and using climate change scenarios at the ground level.

c) *Risk and vulnerability assessment and risk management*
   (i) Capacity building in risk and vulnerability screening in development projects, programs and activities. *Access to and use of technology*
   (ii) Support to projects in developing platforms for sharing and accessing information on climate change adaptations. Some progresses have already been made on the use of technology to collect and share climate change related information, in the health sector (Kaddu *et al*., 2020).

d) *Promoting commercialization of agriculture, and private sector-led value addition and trade.*
   (i) Smallholder farmers need to be assisted to invest in agriculture as a business, meaning producing surplus for the markets, to improve their incomes and livelihoods. To achieve this, access to markets and agro-processing facilities is key through their farmer or producer organizations.

e) *Building resilience to agriculture production systems and managing related risks: – climate change, disease and pests*
   (i) Investing in irrigation and water harvesting technologies to combat climate variability and climate change is critical; as well as putting in place early warning systems (EWS) and emergency response mechanisms (ERM) for managing disasters, such as droughts, floods, and outbreak of pests and diseases.

f) *Improving policy and regulatory environment and strengthening institutions.*
   (i) To attract private investments in the agriculture sector, the government needs to create an enabling business environment. This includes addressing institutional capacity gaps at the national and district level, so that they are able to provide advisory and regulatory services; and adopting policies that will enhance competitions in the input (particularly seeds and fertilizers) and output markets, as well as value addition or agro-processing.

5.4 Barriers and Opportunities in Implementation of Mitigation Measures

Uganda, like many LDCs, experiences a lot of gaps and barriers in the area of data for undertaking GHG inventory and consequently mitigation assessment. In order to reduce on these, Uganda received support and made efforts to address gaps and barriers in several applicable sectors. The major achievement has been to ease data sharing among government institutions. This was achieved through a formal mechanism through memoranda of understanding (MoUs) between the coordination entity (CCD) and institutions/sectors that generate data. During the development of the TNC, some further constraints and gaps have been identified. These are outlined in Table 5.2.

Table 5.2: Constraints and gaps in the different sectors with respect to mitigation assessment

Sector/ Activity	Gaps and needs identified
Setting of baselines	Need to support sectors to improve baseline setting and make baseline transparent
Climate Change Scenarios	Data has been collected by sectors but collocating data is still limited to data collectors. Development of mitigation scenarios for non-energy sector, require training on marginal abatements curves
Use of software for mitigation assessment	Sectors need to be trained on how to use the software for mitigation assessment
GHG Inventory	Absence of arrangements for data sharing with the private sector especially for the mitigation actions and disclosure of their emission reductions
Climate Impacts assessment	Development of mitigation scenarios for non-energy sector, require training on marginal abatements curves
Energy	Inadequate and sometimes un-availability of reliable data and their appropriate coefficients
Transport	Constrained by paucity of data on fleet of vehicles
IPPU	Limited data collection and structures for sustainable data management
Forest	Limited operationalisation of the national forest management information system
Waste	Absence of a legal standard for clasifying and quantifying of the solid waste Profiling and structuring of solid waste management at national level
Agriculture	Climate modelling to understand and predict the impact of climate change on agricultural sector Mitigation analysis and scenarios building for agricultural sector
Gender	Lack of disaggregated activity data on gender
Financial assessments	Limited mechanisms for the collection of reliable data, archiving and updating in a manner that meets the minimum IPCC requirements

5.5 Efforts, Constraints and Gaps in Technology Transfer

5.5.1 Efforts in Technology Transfer

Elements of Uganda's efforts in the enabling environment for transfer of environmentally sound technologies can be found in various sectors of the economy. These elements include, policies and instruments (including Legislations, and Plans). In terms of policies, there is the Uganda National Climate Change Policy (MWE, 2015), and its costed implementation, and also Sector-specific Policies such as The Energy Policy of Uganda (MEMD, 2002); The National Agriculture Policy (MAAIF, 2013); and The National Renewable Energy Policy (MEMD, 2007). In terms of Climate Change-related Plans, Uganda is in the process of producing her National Adaptation Plan (NAP), having produced the National Adaptation Plan for the Agricultural Sector (MAAIF, 2018c). Regarding Legislative instruments, Uganda's Climate Change Act 2021 was put in place to guide the National climate change response, setting the legal basis for mainstreaming climate change considerations and actions into sector activities, and providing the legal foundation for public and private actors in climate change actions. The Act gives the force of Law to the UNFCCC, Kyoto Protocol and the Paris Agreement and to the implementation of the NCCP (The Republic of Uganda, 2021), and also the National Environment Act, 2019 (MWE, 2019). For the purpose of the TNC activity, two key sectors were efforts in transferring environmentally sound Technologies can be found are agriculture and energy sectors. In agriculture, these are in form of Climate Smart Agriculture (CSA) Technologies while in energy they take the form of Clean Energy Technologies (CET). Table 5.3 provides a summary of the efforts in promoting environmentally sound technologies.

Activities in CSA encompass a set of technologies and practices used to improve agricultural production, productivity and profitability right from pre-production, production, harvesting, post-harvest handling to value addition and processing, while minimizing greenhouse gas (GHG) emissions. CSA is one of the areas through which Uganda will meet her adaptation and mitigation contributions to global goals, as reflected in Uganda's Nationally Determined Contribution (NDC). The GHG emission reduction potential of CSA is estimated at 2.7 million tons of carbon dioxide equivalent per year in 2030 (MWE, 2016). Climate Smart Agriculture Technologies include the following:

a) ***Agro-forestry:*** the intentional integration of woody vegetation such as trees and shrubs, with crops and / or livestock simultaneously or sequentially on a unit of land.
b) ***Solar irrigation:*** Use of solar pumps which is free from greenhouse emissions and replaces conventional electricity and diesel-based pumping systems.
c) ***Solar drying***: Support value addition in agriculture as an energy-efficient drying technology that does not negatively impact the product quality.

The efforts are embodied in the following programmes:

a) Climate Smart Agriculture (CSA) Program, 2019-2030): The program was developed jointly by MAAIF and MWE to contribute to reduction of emissions intensity by reducing conversion of forest into cropland ***(MAAIF, 2019a)***. Priority areas in the CSA Program include: improved productivity of crops, livestock and fisheries; irrigation and water management; improved food storage, distribution and human nutrition; and increased incomes.
b) Solar-powered irrigation projects: This covers Bugomola village, Lwabenge sub-county in Kalungu District as well Gomba, Kiboga, Luwero, Mubende, Nakaseke, Nakasongola, Rakai and Sembabule districts. The project funded by FAO, is part of the multi-million-dollar Global Climate Change Alliance (GCCA) Project that aims to strengthen the resilience of rural populations and agricultural production systems through provision of water for irrigation in 33 districts of Uganda's Cattle Corridor.
c) Solar powered irrigation systems in Moyo District: This is a solar powered irrigation scheme developed by FAO with support from the government of Japan, and serves a purpose of addressing water scarcity in the community where villagers are known to travel for long distances in search of water.
d) Electric powered buses (Kayoola EVS bus): Uganda has already piloted the establishment of assembling center of Kayoola EVS Bus in Uganda. The Kayoola EVS Bus is innovatively designed to facilitate a total sustainable mass mobility solution for urban centers in Sub-Saharan Africa.

5.5.2 Constraints and Gaps in Technology

Uganda's capacity in the development and transfer of environmentally sound technologies has many gaps and contraints. The major gap is lack of an overall policy and legal framework.

Uganda currently does not have a comprehensive and overarching national policy or legal framework that addresses the transfer of environmentally sound technologies. The actions in this area are currently managed through a constellation of sectoral policies and guidelines. While the policy relevant to the development and transfer of environmentally sound technologies is the overall national science, technology and innovation (STI) policy which sets out the vision of the sector and highlights strategic frameworks for its attainment, there is no specific mention of environmentally sound and climate technologies.

As outlined above, current technology transfer efforts in Uganda are wide spread in various sectors of the economy. Many technology transfer elements are captured in the various sector policies. These include: the Uganda National Climate Change Policy (MWE, 2015), and its costed implementation, the Energy Policy of Uganda (MEMD, 2002); the National Agriculture Policy (MAAIF, 2013); and The National Renewable Energy Policy (MEMD, 2007).

5.5.3 Technology Needs Assessment

Uganda joined the Technology Needs Assessment (TNA) Phase III project which was launched in 2016 with other 23 countries. The TNA project implementation in Uganda effectively commenced in February 2019 and was completed in 2021. The TNA project, was funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UN Environment) and the UNEP DTU Partnership in close collaboration with the UNFCCC Technology Mechanism, being the Technology Executive Committee and the Climate Technology Centre and Network and the University of Cape Town, which is the Regional Centre in Africa.

The TNA is a set of country-driven activities leading to the identification, prioritisation and diffusion of environmentally sound technologies for mitigation and adaptation to climate change. Technology Needs Assessments are designed to do precisely this type of in-depth analysis using national sustainable development plans as a starting point, Technology Needs Assessments strengthen the country's ability to analyse and prioritize climate technologies, guiding them towards implementation of the UNFCCC Paris Agreement.

The TNA in Uganda is hosted by the Uganda National Council for Science and Technology (UNCST) and is the National Designated Entity. The institutional set up is made up of the Steering Committee, National Coordinator, Sectoral Working Groups and the mitigation and adaptation National Consultants. The UNCST houses the TNA National Coordinator who is the focal point, and supports management of the overall TNA process. Other institutions involved as Steering Committee members include Ministry of Finance, Planning and Economic Development (MoFPED), Ministry of Water and Environment (MWE), Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Ministry of Gender, Labour and Social Development (MoGLSD), Ministry of Science, Technology and Innovation (MOSTI), and Office of the Prime Minister (OPM). The role of the steering committee is to provide high-level guidance to the national TNA team, and to secure political acceptance for the Technology Action Plan (TAP).

The Uganda Technology Needs Assessments Project followed a country-driven approach and stakeholders were engaged in the TNA process from the public, private sector, civil society organizations, and academia. Gender aspects were also considered in the whole TNA process starting with selection of the TNA teams, National Consultants/experts and 50% of the members of the sector working group are female. Views of both men and women were valued equally during the technology prioritization process. In addition, gender considerations were analysed in all technology factsheets.

Uganda, through the Technology Needs Assessments Project, determined her technology priorities for mitigating and adapting to climate change. The key technology priorities for each sector for mitigating and adapting to climate change are presented in Table 5.3.

Table 5.3: Key technologies prioritized for adaptation and mitigation

	Sectors	Priority Technologies
Adaption	Agriculture	a. Responsive agricultural extension b. Community irrigation systems c. Crop breeding for climate change adaptation
	Water	d. Deep well extraction e. Rainwater harvesting f. Surface runoff harvesting
	LULUCF and Forestry	a Promotion of Farmer Managed Natural Regeneration (FMNR) for forest landscape restoration b Integrated pest management in forest plantations through promoting mixed-species plantations c Promoting Forest based enterprises e.g. bee keeping/apiary; butterfly farming, fruit trees production; ecotourism
Mitigation	Energy	a Solar rooftop systems b Efficient institutional cook stoves c Bio-latrines for institutions (using biogas technology)

5.6 Financial Resources and Technical Support for the Preparartion of National Communications

As a signatory to the United Nations Convention on Climate Change (UNFCCC), having signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. Uganda has made efforts to fullfill the obligation to prepare and submit periodic reports under Article 12, paragraph 1 of UNFCCC, Uganda has received support from the Global Environment Facility (GEF) to prepare her National Communications to the UNFCCC. These have included the Initial National Communication (INC) submitted to the UNFCCC Secretariat in 2002 and the Second National Communication (SNC) submitted in 2014. Uganda also prepared and submitted the first Biennial Update Report (FBUR) in 2019.

With respect to this current Third National Communication, Uganda received financial support from the GEF through the United Nations Environment Programme (UN Environment) amounting to US$ 480,000 to undertake the TNC project. Uganda as a party contributed co-financing estimated at US$10,000.

In addition to the financial support from GEF, Uganda received technical support from the United National Environment Programme (UNEP) to prepare the INC, SNC and FBUR as well as this Third National Communication. The support has included detailed capacity building provided to the national technical experts undertaking the studies and preparation of the reports.

5.7 Financial Resources and Technical Support from National and Bilateral/Multilateral Agencies for Actities Related to Climate Change

The Government of Uganda and many donors have committed resources and offered technical support for Uganda to meet the cost of various activities addressing climate change. Most of the support Uganda received came through several development aid channels. Data on financial contributions from GEF, Annex II Parties and multilateral/bilateral agencies and Government of Uganda were obtained from the Ugandan Ministry of Finance. Table 5.4 shows details.

Table 5.4: Projects on Climate Action in Uganda - 2013-2020

Project Name	Description	Implement. Agency	Sector	Climate Objective	Amount	Duration
Strengthening the Adaptive Capacity and Resilience of Communities in Uganda's watersheds	The project aims to build adaptive capacity of rural communities and reduce their vulnerability to climate change and variability through integrated watershed management, climate-resilient infrastructure and sustainable agriculture. The project will be implemented in Bukedea district, within the Awoja catchment downstream of the sub catchments of Sironko, Simu-sisi, Muyembe and Sipi	AfDB	Multi-sector	Adaptation	USD 9,781,415	2019-2022
Climate Resilient Livelihood Opportunities for Women Economic Empowerment (CRWEE) in Karamoja and West Nile Regions of Uganda	The project focuses on advancing economic empowerment of the rural women as a means of addressing gender inequalities, female subordination, discrimination and poverty in households. The project will target beneficiaries from 8 districts in West Nile: Arua, Adjumani, Zombo, Yumbe, Koboko, Nebbi, Maracha, and Moyo; and 4 districts in Karamoja: Moroto, Abim and Nakapiripirit and Napak. Over 52,500 people to benefit	FAO	Social Development, Agricultur, Water and Environment	Adaptation	USD 8,968,448	2018-2023
Global Climate Change Alliance Plus (GCCA+): Scaling up Agriculture Adaptation to Climate Change in Uganda	The project aims to strengthen inclusive, gender responsive and climate smart resilience of rural populations depending on agricultural production systems in the cattle corridor. Over 9 districts; Nakasongola, Luwero, Nakaseke, Mubende, Kiboga and Sembabule, Kalungu, Gomba and Lyantonde to benefit.	FAO	Agriculture	Adaptation and Mitigation	USD 9,197,600	2018-2023
Strengthening the Capacity of Institutions in Uganda to Comply with the Transparency Requirements of the Paris Agreement.	The project aims to establish institutional arrangements (government, CSOs, private sector etc.) for a robust national system for GHG emission inventories and MRV systems, build capacity of key stakeholders to collect, process and feed data into the GHG emissions inventory system and support testing and piloting the GHG emission inventory and MRV system.	CI/AFRII	Multi-sector	Cross-cutting: capacity building	USD 1,100,000	2017-2020
Energy for Rural Transformation Project (Phase III)	The project aims to increase access to electricity in rural areas of Uganda and reduce greenhouse gas emissions. The project will support access to electricity for public institutions (100 post-primary schools, 276 health clinics, and 15 water pumping stations) in rural areas; and reduced Co2 emissions due to reduction/avoidance of diesel-based electricity. About 850,000 persons expected to benefit generation	World Bank	Energy	Mitigation	USD 8,200,000	2016-2020
NAMA on Integrated Waste Management and Biogas in Uganda	The project aims to provide environmental benefits and reduce greenhouse gas emissions from improper and inadequate management and treatment of wastewater and organic waste in towns, municipalities and agro-processing industry in Uganda. The project will support the establishment of enabling market conditions, institutional strengthening and capacity building for improved waste management and promotion of MSW-based biogas systems, support demonstration and investment in integrated wastewater treatment and biogas plants and scale up the use of biogas technologies in other municipalities	UNDP	Multi-sector	Mitigation	USD 2,170,030	2016-2020
Food-IAP: Fostering Sustainability and Resilience for Food Security in Karamoja Sub Region	The project aims to contribute to enhancing long-term environmental sustainability and resilience of food production systems in the Karamoja Sub-Region (Kaabong, Kotido, Moroto, and Nakapiriprit Districts)	UNDP/FAO	Agriculture	Adaptation	USD 7,139,450	2017-2020

Integrated Landscape Management for Improved Livelihoods and Ecosystem Resilience in Mount Elgon	The project aims to empower communities in Mount Elgon to Manage their Production landscapes in an Integrated Manner for Improved Livelihoods and Ecosystem Resilience	UNDP	Multi-sector	Adaptation	USD 1,620,320	2015-2019
Reducing Vulnerability of Banana Producing Communities to Climate Change Through Banana Value Added Activities – Enhancing Food Security And Employment Generation	The project aims to support vulnerable communities in Western Uganda to better adapt to the effects of climate change (CC) by providing greater opportunities for income generation, poverty reduction and food security, through banana value addition activities	UNIDO	Agriculture and Trade	Adaptation	USD 2,820,000	2014-2017
Building Resilience to Climate Change in the Water and Sanitation Sector	The project aims to reduce the vulnerability of both flood- and drought-prone areas in Uganda, ensure access to water for production and climate resilient sanitation in flood-prone peri-urban areas	AfDB	Water and sanitation	Adaptation	USD 8,370,000	2013-2018
Building Resilient Communities, Wetlands Ecosystems and Associated Catchments in Uganda	The project aims to restore and sustainably manage wetlands and support target communities in wetland areas of Uganda to reduce the risks of climate change posed to agricultural-based livelihoods, enhance the skills of people to diversify their livelihoods and become more resilient to climate shocks and strengthen agricultural practices and identify alternative livelihood options for those living in the wetland catchment areas.	UNDP	Wetlands Ecosystem, Agriculture	Adaptation	USD 24,140,000	2017-2025
Enhancing resilience of communities to climate change through catchment-based integrated management of water and related resources in Uganda	The project aims to increase increase the resilience of communities to the risk of floods and landslides in Awoja, Maziba and Aswa catchments through promoting catchment based integrated, equitable and sustainable management of water and related resources	OSS	Water	Adaptation	USD 7,751,000	2017-2020
Provision of Improved Water Source for Resettled Internally Displaced Persons in Acholi Sub-Region	The project facilitated the return and resettlement of internally displaced persons (IDPs) through improved water provision in Amuru, Nwoya, Gulu, Lamwo, Kitgum, Pader and Agago district: drilled approximately 110 boreholes and establishing 6 piped water systems. Over 30,000 IDPs benefited from the project.	JICA	Water	Adaptation	USD 9,730,000	2013-2017
Recovery and Development in Northern Uganda	The project aims to Increase resilience and equitable participation of Northern Uganda in the economic development of the country	Danida	Agriculture	Adaptation and Mitigation	USD 9,608, 000	2014-2018
Project for the Restoration of Livelihoods in the Northern Region (PRELNOR)	The project will increase sustainable production, productivity and climate resilience of smallholder farmers and provide increased and profitable access to domestic and export markets. Envisaged to benefit 140,000 rural households, including young people and will be implemented in the9 districts: Adjumani, Agago, Amuru, Gulu, Kitgum, Lamwo, Nwoya, Omoro and Pader	IFAD	Agriculture	Adaptation	USD 60,200,000	2014-2022
The Farm Income Enhancement and Forest Conservation Programme – Project 2 (FIEFOC-2)	The project is contributing to improvement of farm incomes, rural livelihoods, food security and climate resilience, sustainable natural resources management and agricultural enterprise development. The project is to benefit 386,543.8 households in the districts; Nebbi, Oyam, Butaleja, Kween, and Kasese. Project will also assist in the formulation and implementation of REDD+ measures that reduce deforestation and promote agro-forestry.	AfDB	Multi-sector	Adaptation and Mitigation	USD 82,300,000	2015-2020

Development Initiative for Northern Uganda (DINU)	The objective of the programme is to reduce the development gap between Northern Uganda and the rest of the country by focusing on three areas: Nutrition and Food Security, Road Infrastructure, and Good Governance. Programme intends to benefit 33 districts of Acholi, Karamoja, Lango, Teso and West Nile with a total population of over 7 million people	DFID/TMEA, GIZ, UNCDF, UNCIEF and GoU	Multi-sector	Adaptation and Mitigation	USD 150,630,000	2017-2022
Climate Smart Agriculture in Northern Uganda	The 4-year project aims at enhancing the resilience of rural farming communities in northern Uganda against negative effects of climate change. The project intends to achieve this through implementation of Climate Smart Agriculture practices and techniques, strengthening the capacity of local governments to mainstream climate smart agriculture in local planning processes, and supporting improving agricultural productivity of farmers. Over 25,000 small holder farmers from Lira, Kitgum, Agago, Dokolo, Amolatar, Oyam and Napak in northern Uganda are excpected to have benefited from the project.	GIZ	Agriculture	Mitigation and Adaptation	USD 5,671,000	2018-2022
Joint Partnership Fund (JPF) – Basket	The JPF supported capacity development across the MWE structures in addition to studies, piloting of new approaches and oversight of climate change and sector performance. It was ring-fenced for water supply, water resources and climate change activities	Danida	Water and Environment	Adaptation and Mitigation	USD 24,280,000	2013-2018
Sector Budget Support for Rural Water Supply	The support has ensured effective, efficient and equitable means of delivering water supply nationwide to all 112 districts	Danida	Water and Environment	Adaptation	USD 51,298,000	2013-2018
Climate Resilient Agribusinness for Tomorrow (CRAFT)	The project aims for improved food security by working towards climate resilient farming systems. The project will increase productivity of 300,000 smallholder farmers, climate proof value chains and practice climate resilient sustainable food production on 600,000hac. The project has established the Climate Innovation and Investment Facility (CIIF) to identify and support inclusive climate smart innovative business models	SNV	Agriculture	Adaptation and Mitigation	USD 14,600,000	2018-2022
Enhancing adoption of Climate Smart Agriculture (CSA) practices in Uganda's farming systems	The project aims to enhance productivity of land through sustainable land management of soil and water resources, particularly integrating CSA as a climate change adaptation strategy to build climate change resilient societies. The project will put in place measures/ systems to improve input supply, develop produce markets for economic sustainability for CSA enterprises; and supporting research activities to generate baselines, monitoring and evaluation guidelines and national recommendations on CSA technologies and practices. The project is implemented in 5 districts; Bugiri, Busia, Budaka, Namutumba and Buyende.	UNDP	Agriculture	Adaptation	USD 1,240,000	2014-2015
Enhancing resilience of agricultural landscapes and value chains in eastern Uganda – scaling up Climate Smart Agriculture (CSA) practices	The project aims to mainstream climate change in national policies, strategies and development plans of member States; and promoting, supporting, and piloting appropriate adaptation and mitigation projects. The project will benefit districts; Budaka, Namutumba, Bugiri, Busia, Kaliro, Kamuli, and Buyende	UNDP	Agrculture	Adaptation and Mitigation	USD 1,123,080	2019-2021
Climate Change Resilience and Disaster Risk Reduction for National Transformation.	The project aims to to strengthen; policy response on integration, provision of incentives & deterrents measures; national policy implementation capacities; LGs to build a strong community resilient to climate change and other disasters	UNDP	Multi-sector	Adaptation	USD 1,952,087	2016-2020
Promotion of Renewable Energy and Energy Efficiency	The programme aims to improve access to clean energy in rural and urban areas.	GIZ	Energy	Mitigation and Adaptation	USD 7,525,000	2019-2023

Reform of the urban water and sanitation sector	The programme aims to strengthen capacities of the Ugandan water sector institutions with regards to adaptation to climate change and provision of water and sanitation services at broad scale	GIZ	Water	Adaptation	USD 13,899,000	2017-2020
Promotion of mini-grids for rural electrification	The programme aims to improve conditions for the distribution of decentralized mini grids in villages based on renewable energy and with the participation of the private sector	GIZ	Energy	Mitigation	USD 9,546,000	2016-2020
Support to rural development Uganda	The programme aims to improve climate smart agriculture based development of the rural economy in selected regions of Northern Uganda.	GIZ	Agriculture	Adaptation	USD 10,669,000	2017-2022
NDC Support Programme	The programme aims to enhance integrated governance for delivery of NDC, enhancing private sector engagement and strengthening platforms for evidence based learning	UNDP	Multi-sector	Mitigation and Adaptation	USD 802,500	2018-2020
NDA Strengthening & Country Programming	The readiness support aims to: 1) strengthen country capacity by enhancing coordination mechanisms, 2) support the NDA to establish a broad-based multi-stakeholder engagement process and update of the GCF Country Programme, 3) Support the Kampala Capital City Authority (KCCA) to build capacity to meet GCF accreditation requirements, including support for the development of their pipeline of climate change and develop 3 concept notes, 4) support to establish the accreditation application status of NEMA and build capacity to meet GCF accreditation requirements, 5) support to establish the accreditation application status of Uganda Development Bank (UDB) and build capacity to meet GCF accreditation requirements, 6) develop 5 concept notes for climate change mitigation and adaptation projects in priority sectors till submission to the GCF, 7) engage the private sector to improve the availability of finance for climate change projects and help overcome the dependence on international development partners and government for climate finance.	GGGI	Multi-sector	Mitigation and Adaptation	USD 700,593	2019-2020
Northern Uganda: Transforming the Economy through Climate Smart Agribusiness (NU-TEC)	The project aims to increase the resilience to climate change of poor farmers in Northern Uganda, and to increase their incomes. This will be achieved by working with agricultural businesses to supply farmers with cheaper, better and more varied agricultural inputs and services, and to create stronger markets for farmer produce. This will benefit 250,000 households in Northern Uganda. The support is Support is targeted at agribusinesses, rather than farmers directly, although smallholder households are the ultimate beneficiaries of better agricultural input supply, and greater demand for their produce.	DFID through Palladium, Mercy Corps, AgDevCo	Agriculture	Adaptation	USD 25,055,600	2018-2022
Promotion of Drought Resilience and Food Security in Karamoja Region	The project aims to improve resilience of the population of Karamoja to drought events and climate change impacts through investment in water storage facilities, improved livestock production services and water catchment area management. The project envisages to support the construction of 3 dams and a network of smaller troughs and boreholes are to be built in the region and enhance access to veterinary care	KfW	Water and Agriculture	Adaptation	USD 21,600,000	2020-2025

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Kaddu JB, Berhane G, Kibaya P, and Munabi I.G, 2020. *Climate Change and Health in Sub-Saharan Africa: The Case of Uganda.* Climate Investment Fund. 30pp. Accessed from: https://www.climateinvestmentfunds.org/sites/cif_enc/files/knowledgedocuments/final_chasa_report_19may2020.pdf.

CHAPTER 6

GENDER EQUALITY AND WOMEN'S EMPOWERMENT; EQUITY AND INCLUSION IN CLIMATE CHANGE ADAPTATION AND MITIGATION

Government of the Republic of Uganda recognizes that gender equality, women's empowerment and equity are essential to the success of every development program. To this end therefore, gender mainstreaming was adopted as a key strategy to achieve this, spearheaded by the national machinery for gender equality and women's empowerment. In preparing this national communication, a gender analysis was conducted, focusing on the stakeholders in the climate change sub-sector, especially the agencies represented in the climate change working groups. The goal of the gender analysis was to inform the development of a cross-cutting gender strategy to address the root causes of gender inequality and support equity and empowerment for maximizing the impact of adaptation and mitigation interventions.

This chapter presents the status of gender equality and women's empowerment, equity and inclusion in climate change adaptation and mitigation efforts in Uganda. The chapter is structured into five major sections. Section 1 presents the introduction and background to the gender analysis, including the legal and policy framework. Section 2 presents the methodology used in conducting the analysis. Section 3 provides the findings while sections 4 and 5 give the conclusions and recommendations, respectively.

The status of gender equality and women's empowerment was highlighted briefly in the second national communication but more changes have happened in the legal and policy arenas, the programming as well as institutional frameworks at both national and sub national levels.

6.1 National Institutional Arrangements and Management for Gender Equality, Women's Empowerment, Equity and Inclusion

At the time of compiling the Third National Communication, Uganda had a conducive legal and policy framework for addressing gender and equity concerns, and institutional mechanisms including sector-specific arrangements to attain it. The conducive environment underpins national priorities for accelerating Gender Equality and Women's Empowerment. Gender Equality and the Empowerment of Women (GEWE) draws legitimacy from the Constitution of the Republic of Uganda which mandates the State to ensure gender balance and representation of marginalized groups on all constitutional and other bodies, guarantees women equal rights with men and affirmative action to address imbalances emanating from history, traditions and customs, among other factors.

The Government of Uganda is committed to the promotion of gender equality and women's empowerment. In this regard, Government adopted comprehensive measures to address gender equality and women's empowerment as a socioeconomic, development and human rights concern. At international level, Uganda is a signatory to various international instruments that promote gender equality and women's empowerment. These include the Convention on Elimination of all forms of discrimination Against Women (CEDAW), The International Conference on Population and Development (ICPD, 1994), and the Beijing Declaration and Platform for Action (1995). These instruments have been domesticated through existing laws, policies and programmes. As a party obligation, Uganda submits periodic reports on progress of the implementation of these instruments.

Uganda is also a signatory to regional commitments and instruments which include protocols, declarations, treaties and conventions that commit government to address gender equality and women's empowerment. These include; The African Union Gender Policy and Strategy (July, 2004), The AU Solemn Declaration on Gender Equality in Africa (2004), and The Maputo Protocol. Similarly, Uganda submits periodic reports on implementing the women's agenda in Uganda.

At the national level, the Constitution Articles 21 (equality and freedoms from discrimination) and 24 (respect for human dignity and protection from inhuman treatment) articulate gender considerations. The constitution specifically provides for gender balance and fair representation of marginalised groups (Objective VI); and recognises the role of women in society (Objective XV).

Uganda's vision 2040 is "a transformed society from a peasant to a modern and prosperous country". Ugandans aspire for a future in which men and women are accorded opportunity to participate as equal partners in development. Vision 2040 targets elimination of gender based violence to give opportunity to every Ugandan to live a life of dignity. Chapter 5, Section 5.7 recognizes that it will be paramount in the next 30 years to reduce gender inequalities as a pre-requisite for accelerating and sustaining socio-economic transformation. Women and men of Uganda will thus be treated as equal partners in development right from household to the country level. Therefore, efforts will be made to ensure gender responsive policies, programmes and actions are in place.

The aspirations of Vision 2040 are pursued through five (5) year National Development Plans (NDPs) which are aligned to the 2030 Agenda for Sustainable Development. The NDPIII requires all Sectors and Local Governments to abide by equality and equity principles through adoption of the human rights-based approach to design and implementation of policies, regulations, programmes and plans. NDP III targets elimination of barriers to women's advancement and gender equality as a path to national economic growth targets.

The NDP was developed in a gender responsive manner with full participation of the Ministry of Gender, Labour and Social Development. Sectors received technical support in developing issues papers. It was also subjected to a gender audit before finalization. It recognizes the importance of addressing gender as a pre-requisite for sustainable development in all spheres. The plan further recognizes that economic empowerment of women as a catalyst and game changer for attaining gender equality and women's empowerment. The above national commitments and principles are integrated into the five-year Sectoral Development Plans (SDPs) and District Development Plans (DDPs). Annually, the sectoral and district interventions are translated into budget framework papers for execution. The Social Development Sector Strategic Plan emphasizes upscaling of the strategy of mainstreaming gender in critical emerging sectors of climate change, energy, oil and gas, trade and tourism as well as public procurement. The Uganda Gender Policy (UGP) 2007 provides the overall framework for gender mainstreaming in all government sectors, and provides the focus areas of intervention. The gender policy is under review, with proposed priority areas on environment and climate change.

The gender policy recognizes that degradation of the environment and climate change threatens livelihoods of people and further increases gender inequality. Government shall ensure proper management of natural resources so as to mitigate climate change and environmental degradation whose effects threaten to erode human freedoms and limit choices. Gender considerations in natural resource management in general and climate change mitigation measures in particular shall be given priority.

In line with SDG7 on affordable and clean energy for all, SDG 9 on industry, innovation and infrastructure, and SDG6 on clean water and sanitation, government has developed gender-responsive laws, policies and strategies for oil and gas, climate change, environment and natural resources as well as water and sanitation namely: The National Climate Change Policy (NCCP) and its costed implementation strategy (2015), The Uganda National Irrigation Policy (2018) that promotes balanced growth across regions, Water and Sanitation Gender Strategies of (2010 – 2015) & (2018 – 2022), The Environment and Natural Resources Sub Sector Gender Mainstreaming Strategy (2016 – 2021), The National Strategy and Action Plan for Gender Mainstreaming in the Oil and Gas Sector 2016; and The Roads sub-sector Gender Policy 2019, which guides the mainstreaming of gender in the Sub-sector.

6.2 Methodology of Conducting the Gender Analysis

The process of compiling this chapter was informed by a gender analysis of climate change stakeholders. The purpose of the gender analysis was to obtain information and data on the situation of gender equality among the climate change stakeholders in regard to the situation of female staff and the gender responsiveness of institutions within which they work. The analysis further sought to gather practical recommendations to inform implementation of climate change interventions.

6.2.1 Core Objectives of the Gender Analysis

The core objectives of the gender analysis were to:

a) analyse the root causes of gender inequality in the context of climate change interventions at individual and institutional levels.
b) identify programming opportunities, strengths, gaps, lessons learned, and recommend strategies for designing a gender responsive strategy geared to the needs and interests of women and men to enhance the effectiveness of adaptation and mitigation interventions.

The gender analysis answered the following key questions with respect to gender dynamics at institutional level:

a) What are the differing needs, roles, interests, opportunities, barriers and experiences of female staff?
b) What is the percentage of female staff in the institutions?
c) What categories of occupations do they occupy?
d) What institutional mechanisms are in place for addressing gender equality and women's empowerment?
e) Do the organizations have a written Policy on gender equality and equity, including mechanisms of delivering services in an equitable and gender responsive manner?
f) Do the organizations have specific interventions for addressing marginalised groups?
g) Are there institutional mechanisms for supporting and facilitating female staff in the organization?
h) What are the most important gender gaps to address and what opportunities are there to support gender equality for maximizing achievement of Climate change interventions?
i) What is the gender responsiveness of the planning and budgeting processes?
j) What current gender mainstreaming strategies and provisions have been the most effective or least effective in contributing to positive and negative changes to gender equality so far?
k) How could the organizations' proposed activities be improved to reduce gender gaps and promote equality without negatively affecting gender dynamics?

6.2.2 Key Gender Concepts

The gender analysis was informed by the Uganda Gender Policy, the National guidelines for gender mainstreaming, the ENR gender strategy, the definitions, approaches and programming priorities for gender equality. These conceptual underpinnings aim to help the Climate Change Department and its stakeholders to formulate a strategy and common vision of becoming more gender responsive.

The MWE/CCD and its stakeholders will utilize the **gender analysis** to consider the existing systems and structures within the institutions, as well as their organizational cultures and practices that affect the welfare and performance of female and women beneficiaries of climate change interventions.

Drawing from the Uganda Gender Policy (2007), **gender equality** is understood as "working with women and men, boys and girls to bring about changes in attitudes, behaviors, roles and responsibilities at home, in the community and in broader institutional structures". Genuine equality means more than parity in numbers or laws in the books; it means expanding freedoms and improving overall quality of life so that equality is achieved without sacrificing gains for males or females. For MWE/CCD and all other development interventions in Uganda, **empowerment** is a process of awareness and capacity building leading to greater participation and decision-making power. It involves the ability to make choices as well as to define what choices are offered. Though empowerment often comes from within, and individuals empower themselves, institutions can (and have the responsibility to) support processes that avail space for women and men, girls and boys to develop their skills, self-confidence and self-reliance. This is particularly important in the science–based fields where women and girls have been a minority.

The MWE/CCD appreciates that a number of methodologies may not fully empower female staff and women beneficiaries but can support in building their capacity, self-confidence toward self-efficacy for their empowerment. **Self-efficacy** is defined as a sense of personal agency and ability to mobilize the motivation, cognitive resources, and courses of action needed to exercise general control over events in one's life. It is linked to personal and collective goal-setting and perseverance in the face of difficult situations.

6.2.3 A framework for Analysis: MWE/CCD Core Objectives

The core objective of strengthening the capacity of climate change stakeholders in gender and equity responsiveness enables them to design interventions in holistic and people-centered ways to build resilient individuals and systems. It helps staff, partners and beneficiaries to develop more rapid, effective, and acceptable pathways out of inequality and into empowered and healthy productive lives supported by more just systems and structures.

In order to support holistic development for women and girls in the climate change sub-sector and overall gender responsive development among climate change stakeholders, it is imperative that participatory gender assessments are conducted at institutional level in which people operate. This assessment involves looking at differences based on gender and other social factors, identifying shocks, cycles, and trends (vulnerability) which will enable them (institutions) to design mitigation, preparedness, and preventive activities that decrease vulnerability and increase resilience.

6.3 The Gender Analysis

All the respondents that participated in the analysis were selected from various sector stakeholders where implementation of climate change interventions takes place and these provided primary data. These organizations are characterized by employing a big number of scientists and the study used a questionnaire that was developed in collaboration with the TNC team in Uganda, complemented with interviews from key informants and focus group discussions, especially from members of gender working groups in selected institutions.

The genda analysis exercise was complemented by a review of relevant documents including government legal and policy instruments, the Ministry of Water and Environment legal and policy documents, guidelines and project documents. Key informants and focus group discussions were conducted with representatives of MDAs and Civil Society stakeholders.

Quantitative data was collected using a questionnaire that was developed in collaboration with the TNC team. The questionnaire was filled in meetings of climate change working groups, and this provided an opportunity for focus group discussions and interviews with key informants as well. The use of the structured questionnaire and the focused discussions with key respondents enabled cross-referencing and validation of results, and deepened the findings and patterns found when analyzing the data.

The gender analysis resulted into important findings about the multi-dimensional factors that affect the welfare of women and girls and overall gender responsiveness in the climate change sub-sector.

Most stakeholders in the climate change sub-sector are government institutions (65%); mainly Ministries, Departments and Agencies that have strong collaboration and partnerships with research organizations, the private sector and civil Society organizations (25%) as well as the academia (10%). This collaboration is provided for under the government multi-sectoral framework of implementation whereby mandate holders work hand-in-hand with other duty bearers who contribute to their mandates. The analysis indicated that the stakeholders on average employ more than 50 staff, with an average of 70% being male scientists. The other categories of technical staff represented less than 30%.

6.4 Conclusions

The analysis examined the level and quality of gender mainstreaming among climate change actors and what can be learned from it for future interventions to ensure programme implementation from a gender lens. The implementation of climate change adaptation and mitigation interventions is on track as far as the objective of gender mainstreaming is concerned, but the good intentions are affected by the institutional arrangements and mechanisms of the stakeholders.

6.4.1 Successes

The Water and Environment sector in Uganda has a stronger gender lens compared to other sectors because it has put in place deliberate measures to address the constraints of women in accessing services. The good practice of affirmative action for water user committees and Young Water Professional is a case to replicate. Gender mainstreaming in climate change goes beyond MWE/CCD and incorporates most water sector stakeholders to address not only women's practical needs but also their strategic interests and broader uneven gender power relations at institutional levels. The MWE/CCD and its stakeholder institutions will have greater transformative potential to ensure women and men equally benefit from the services offered by the various stakeholders if the focus is on addressing gender barriers and supporting female empowerment at all levels.

6.4.2 Influence of Broader Institutional Structures

Broader environmental, economic and political factors influence gender equality and the position of women in every setting. National and local policies and institutions create both opportunities and barriers for females and males. In Uganda, major strides and progressive gender policies and institutional commitments have prioritized women's empowerment and gender equality. For example, Uganda has reached gender parity at the primary level of enrolment for education. The gaps however exist in secondary and tertiary levels where retention and completion rates are not equal, and where there is a glaring gender gap in science subjects.

Uganda's Constitution is gender responsive, providing for affirmative action for marginalized groups including women. The national Vision 40 pays attention to gender as a critical factor that influences development and this is translated into the National Development plan III priorities as well. The Uganda Gender Policy under review provides the overall framework for addressing gender equality in all spheres, including interventions to create conducive working environments for women. Despite the conducive legal and policy framework however, organizational cultures and values including negative patriarchal mind sets are often more relevant to decisions affecting female employees. This is especially true in male dominated fields.

The analysis also revealed the great influence of externally supported interventions in all institutions. In organizations with donor support, their interventions have embraced gender mainstreaming at all stages, including gender training for staff, involving gender experts in policy development and review, programme development and implementation as well as monitoring and evaluation.

6.4.3 Challenges

The analysis identified key bottlenecks and challenges that undermine gender mainstreaming which should be addressed. Despite improved gender laws and policies, informal gender biases dominate most levels of the government, preventing women's access to needed services. Harmful traditional practices and gender stereotypes also undermine female empowerment. Sectors that have –gender-specific policies and strategies lack the resources to implement them while other sectors don't have them at all. Whereas there is an overarching national gender policy, the weakness of domesticating it in various sectors is still visible.

In addition, there are no specific budgets to strengthen gender mainstreaming in sectors and the sole responsibility relies on the Gender Focal Point Officer. The latter are often in junior or middle level positions, unable to influence plans and budgets. Where budgets for supporting gender mainstreaming are available, the resources are very meagre, not allowing for capacity building of all key staff to understand the relevance of gender to their work.

Till now, there are some science-based sectors that do not appreciate the relevance of gender to their mandates, while others lack tangible GEWE indicators to track progress.

What is emerging is the need to revamp gender awareness and retooling of Gender Focal Point Persons where they exist, as well as Heads of Departments and Units. Mixed sex working environments and piece meal affirmative action interventions have not been enough to produce significant changes to unequal gender relations and empowerment of females in climate change sectors. The stakeholders may wish to adopt the MWE model and advocate for its replication in other sectors. This model involves a sector -specific gender policy/strategy, gender specific indicators, affirmative action in projects and special budgets set aside as a portion of the over – all sector budget to address gender mainstreaming.

Overall, MWE/CCD program design is gender-aware but not necessarily gender transformative. It recognizes inequalities among women and men but when it comes down to implementation through the climate change stakeholder institutions, it fails to respond to the complex and unequal gender dynamics that play out in work places. This makes it difficult to translate gender provisions from the design to concrete actions and results within the stakeholder institutions. More so, there is little accountability for gender among climate change stakeholders due to weak gender-sensitive monitoring and evaluation systems and lack of a mechanism to assess the performance of supervisors on gender.

Whereas Gender Focal Point Officers exist in government sectors, they often lack voice and authority because they are in lower ranks of authority. At institutional levels, gender units are low on the hierarchy, making gender priorities also a low priority. In addition, there is weak capacity for gender focal points to support gender mainstreaming in climate change interventions because they lack resources and there is general lack of gender sensitivity among officials to support these focal points.

Gender mainstreaming guidelines developed by the Ministry of Gender, Labour and Social Development are not well disseminated, and questions of 'how do I mainstream gender' are not fully answered.

6.4.4 Next Steps

Whereas most climate change stakeholders fall short in achieving concrete results to promote gender equality and address the needs of women and girls as well as other vulnerable groups, there is still room to propose strategies for integrating a more gender transformative strategy with potential to make significant contributions to addressing the situation of women and girls; and broader institutional arrangement for GEWE.

The MWE/CCD can add much value to gender programming through building capacity of its stakeholders in the water and environment sector in order to address the existing gaps. To support meaningful changes, MWE/CCD must develop and implement a strong capacity building program in close collaboration with the government Ministry in charge of gender and other agencies focusing on GEWE. This will facilitate climate change stakeholders to develop gender sensitive indicators and checklists for tracking progress in facilitating female employees and broader gender mainstreaming.

The gender analysis strongly recommends gender awareness and sensitization and a strong capacity building component. MWE/CCD may wish to consider securing additional funding for strengthening the objective on gender equality in order to support overall gender mainstreaming in the water sector.

6.5 Recommendations

Based on these findings, recommendations to address both gender inequality and the empowerment of women are proposed. Key recommendations include:

a) Support the broader institutional environment to be gender responsive through a shared vision on GEWE by all climate change stakeholders.
b) Develop a strategy that addresses organizational and programming levels with a gender sensitive monitoring and evaluation system backed by an action plan with proper human and financial resources.
c) Strengthen linkages with the national machinery for GEWE and other programs working on gender issues.
d) Ensure that the climate change decision-making structures address both men's and women's needs through deliberate affirmative action measures.
e) Promote women's leadership at the program level.
f) Build capacity and gender sensitivity of mixed-sex project committees and boards to facilitate male involvement in addressing GEWE.
g) Support the development and implementation of sector- specific gender policies and strategies.
h) Adopt the concept of gender and equity budgeting as a good practice, underpinned by tailor made gender awareness and training.

i) Develop multimedia campaigns in advocating and taking actions against gender-based violence especially sexual harassment in work places.

At a strategic level, affirmative action for girls and women in science subjects and in overall recruitment is recommended.

6.6 Good Practices

The following good practices are recommended for successful gender mainstreaming in the climate change sub-sector. They include gender and equity budgeting, gender training and gender audits as well as the institutionalization of the position of Gender Officer in order to spearhead the process of gender mainstreaming in sectors. The good practices are ranked according to the weight in Table 6.1.

Table 6.1: Categories of good practices recommended for the Climate Change sub-sector

	Good Practice	**Rating %**
1	Gender training (gender analysis, practical steps for gender mainstreaming, understanding WID and GAD approaches and how to use them, tracking gender in sector interventions and reporting)	60
2	Developing sector-specific gender policies and strategies	60
3	Gender sensitization and awareness to enable the technical officers to know the relevance of gender to their work and to the mandates of their institutions.	30
4	Increasing budget allocations for gender mainstreaming work	30
5	Implementing women-specific affirmative action strategies at all levels.	30
6	Incorporating gender in monitoring and evaluation systems through setting gender specific indicators.	20

6.7 REFERENCES

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2. Republic of Uganda (2010) Vision 2040
3. Republic of Uganda (2020), National Development Plan 2019/20-2024-2025
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7. Ministry of Gender, Labour and Social Development (2014), National Guidelines for monitoring Gender Mainstreaming in Local Governments
8. Ministry of Water and Environment (2017): Environment and Natural Resources Gender Strategy
9. Ministry of Water and Environment Sector Strategic Plan 2015-2020
10. Ministry of Finance, Planning and Economic Development: Training Manual for Gender and Equity Budgeting (Adapted) 2019

CHAPTER 7

ANY OTHER INFORMATION CONSIDERED RELEVANT TO ACHIEVEMENT OF THE CONVENTION

7.1 Research and Systematic Observation

With Uganda being particularly vulnerable to the increasing frequency and severity of droughts, floods, and severe storms (hail, thunder, lightning and violent winds), and their impacts on sectors such as agriculture, fisheries, as well as infrastructure, it is critical for the country to prepare for adaptation to climate change. Part of the preparation includes provision of meteorological services as well as promotion of longterm observation and collection of meteorological, hydrological and climatological data. Such actions also help in meeting international commitments and obligations as well as contributing to international cooperation.

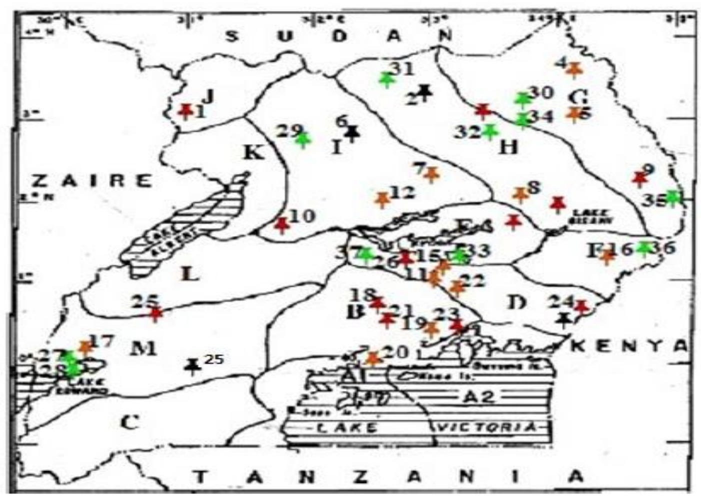
7.1.1 Institutional Framework

The core of the institutional framework for this critical activity in Uganda has been placed on the Uganda National Meteorological Authority (UNMA). UNMA was established on 24th January 2014 following the enactment of the UNMA Act 2012. UNMA is mandated to provide weather and climate services. It undertakes and coordinates systematic observation of meteorological parameters through observation network of manned and automatic weather stations (AWS) categorized as Synoptic, Agrometeorological, Hydrometeorological and rainfall stations as well as a weather Radar. The station network distribution based on climatic zones has a coverage 57% of the 146 Districts in Uganda. The climatic parameters observed include rainfall, temperature, wind (direction/speed), radiation and relative humidity.

It is important to note that due to insufficient coverage of the country by weather stations and other challenges, various institutions whose operations rely on weather information have resorted to installing their own stations in consultation with UNMA. These include, agricultural organizations, such as NARO, state authorities such as UWA and Academic institutions. In some of these cases, there are protocols of data sharing and management between UNMA and these institutions to ensure efficiency and thus improve institutional collaboration.

7.1.2 National Meteorological Observation Network

Uganda's meteorological observation network under UNMA comprises of manned and automatic weather stations (AWS) categorized as Synoptic, Agrometeorological, Hydrometeorological and rainfall stations as well as a weather Radar. There are 52 manual and 43 automatic weather stations across the country. The 52 manual weather stations include 12 synoptic stations, 23 agromet stations and 17 hydromet stations which are manned by weather observers. Figure 7.1 shows the national meteorological observation network of Uganda.



Key

	Non-Operational AWS
	Automated weather station(coordinates provided)
	Automated weather station (no coordinates provided by UNMA)
	Manual weather station

Figure 7.1: Distribution of Weather Stations in Uganda

Source: The WIMEA-ICT project. "Report on the status of weather stations in Uganda". 2015

Uganda's weather radar supports the systematic observation of extreme/severe weather (thunderstorms, heavy rainfall, strong winds) for early warning. Uganda has two Radars and a low-level wind shear alert system to support this function. The increase in coverage of systematic observation network has been possible with political will, support from Government of Uganda and development partners like UNDP. However, UNMA still faces financial and technical capacity challenges to increase the coverage and functionality to 100%.

7.1.3 Activities and Programmes in Climate Research and Observation

In response to the global call under Article 5 of the United Nations Framework Convention on Climate Change (UNFCCC), the country is participating in and contributing to activities and programmes as appropriate, of regional and global climate change-related research networks and observing systems. This has been done by both State and Non-State actors, through the following projects, programs, and activities:

a) On-going initiatives to breed, promote and disseminate climate-resilient crop varieties that are resistant to drought, pests and diseases in different agro-ecological zones. These are closely linked to weather observation. The targeted crop varieties have superior attributes over the current existing varieties with respect to yield advantage, pest and disease resistance, adaptation to drought-prone environments and culinary attributes (MAAIF, 2020b).
b) The Multinational Lakes Edward and Albert Integrated Fisheries and Water Resources Management (LEAF II) Project which is a Joint Fisheries Management Information System for capturing, storing, analysing, and disseminating data and information from fisheries assessments, for Uganda and Democratic Republic of Congo. Furthermore, a Bathymetry / hydrographic survey of the lakes Edward and Albert were undertaken, and bathymetric maps developed to guide and strengthen fisheries research and its related sectoral activities; water resources planning and management; navigation and maritime safety; and other lake-based activities (MWE, 2020a).
c) The health sector, over the period 2015-2020, has rolled out Core hybrid (digital and paper) Health Management Information Systems (HMIS) tools. These include; DHIS2.3, mTrac and Integrated Human Resource Information System (iHRIS). The DHIS2.3 has enabled improvement in timeliness of monthly health facility reporting but there are still challenges of completeness of reporting especially by the private health facilities and data quality (MOH, 2020a).
d) **The CHASA project** (Kaddu *et al*., 2020), implemented in Nakasongola, Nakaseke, Soroti, Gulu, Kitgum, Sembabule, Butambala, Kampala and Wakiso and designed a model for predicting the occurrence of climate-sensitive diseases; and a software application that provides, as an output, the estimated number of occurrences of the climate sensitive diseases included in the predictive model.
e) **The National Forestry Resources Research Institute (NAFORRI**): This research institute under the National Agricultural Research Organisation (NARO), is mandated to conduct research in all aspects of forestry in the country, with a goal of increasing the benefits derived from trees and forests through conservation and sustainable management of forests and tree resources (MWE, 2020a). It conducts substancial research activities.
f) **EUMETCAST Service:** An operational electronic platform (eStation) has been established in Uganda hosted by the National Environment Management Authority (NEMA) to provide free access to remotely sensed data and satellite-derived products to support planning and decision making in environmental management.

g) **Air quality Monitoring network:** The Government of Uganda through support from UN Environment has set up an affordable air quality monitoring network in Kampala City. Twenty-five (25) air quality monitoring stations have been installed with 5 stations in each Division of Kampala.

7.1.4 Regional and International Research Networks and Observing Systems

Additional initiaties in which Uganda has been an active participant and contributor include:

a) Severe Weather Forecasting Programme (SWFP) – Eastern Africa which is a regional WMO programme initiated in 2010 (now in Phase III) for monitoring and issuing severe weather alerts to save lives in the partner states of Uganda, Kenya, United republic of Tanzania, Rwanda, Burundi, Southern Sudan and Ethiopia.

b) Global Telecommunication System (GTS) and Automatic Message Switching System (AMSS) through which Uganda's National Meteorological Services are linked to the regional hub in terms of exchange of meteorological data, information and reports with WMO and to regional and global systems in terms of weather forecasting and aviation/pilot briefing and consultations, respectively.

c) Synergy System established following implementation of the Monitoring for Environment and Security in Africa (MESA) project under African Union Commission (2013-2017) for weather and climate monitoring and forecasting. MESA is important building block of "Global Monitoring for Environment and Security and Africa" an initiative on earth monitoring with a view to enhance access to earth observation data for policy makers.

d) Nile Basin Regional HydroMet System where Uganda is participating and supports monitoring and data collection efforts of Member States and the region at large. The system typically comprises ground observation networks, including for measuring river and lake levels, rainfall, temperature, atmospheric pressure, wind speed, solar radiation or other parameters; data transmission systems (to relay data from terrestrial observation stations to data centres; data management systems (databases and associated data management tools), system of procedures for data quality control and processing, precipitation, solar radiation, lake levels, many water quality parameters, among others, are 'observed' through Earth Observation satellites. The accuracy and diversity of remotely sensed/observed parameters is on the rise, which makes it increasingly attractive for river basin monitoring.

7.2 Education, Training and Public Awareness

Given Uganda's particular vulnerability, the country prioritises access to weather and climate information by the population. One of the major barriers to the flow of the relevant information is the low levels of understanding of and the need for such information. The following sections provide some of the recent interventions undertaken in Uganda in this regard.

7.2.1 Background and Context

Human resource is the most precious assert of a nation. It is the "soul" of the country, in all aspects of development. Thus, availing of education and training for capacity to address impediments, like climate change, to national advancement is a noble contribution to national development.

Elements of the building blocks of climate change education and training have always been part of Uganda's national science education curricula at all levels i.e., primary, secondary, BTVET, and higher education, within both the physical and life sciences. With the onset of the work programmes of the World Meteorological Organization (WMO), concepts of global warming entered curricula.

Beyond the educational perspective, and owing to the fact that the economy of Uganda, like that of many Least Developed Countries, is dependent on exploitation of natural resources, both the state and non-state entities continue to engage in activities that allude to climate change education and training (CCET). This prevailing condition provides suitable base upon which to build issues of CCET.

7.2.2 The National Strategy and Capacity Challenge

In endeavours to fulfil national obligations under Article 6 of the United Nations Framework Convention on Climate Change, Uganda, through the Climate Change Department of the Ministry of Water and Environment developed a "National strategy and action plan to strengthen human resources and skills to advance green, low-emission and climate-resilient development 2013 – 2022: Uganda's Climate Change Learning Strategy" (MWE, 2013).

The strategy was developed to partially address insufficient human resource capacity, lack of knowledge and skills. The stragey sought to address the major gaps identified in surveys. These included:

a) Lack of knowledge and skills
b) Avcademic training not matching performamnce needs
c) Insufficient staff
d) Lack of incentives for staff.

Figure 7.2 shows the major tasks that the country needs to be undertaken. Table 7.1 shows the priority topics identified in the strategy.

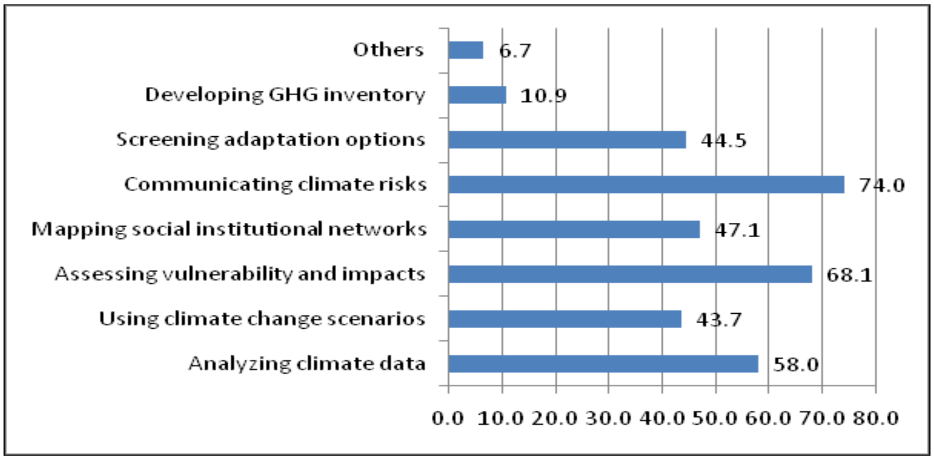


Figure 7.2: Climate-related tasks performed by staff in various institutions identified during survey in Uganda

(Source: MWE, 2013)

Table 7.1: Priority topics for Climate Change Learning identified by respondents during the survey on climate change learning needs in Uganda

Topic	Score (%) under each level (low, medium, & high) of priority		
	Low	Medium	High
Fundamentals of Climate Change Science	3.4	11.8	84.9
Predicting Climate Change Variability	7.0	23.7	69.3
Vulnerability and Adaptive Capacity Assessment	6.0	22.2	71.8
Adaptive and Climate Resilient Decision-making	6.2	21.2	72.6
Climate Change and Disaster Risk Management	7.9	15.8	76.3
Climate Change and Population Dynamics	11.6	24.1	64.3
Greenhouse Gas Inventory Development	27.5	30.3	42.2
Mitigation and Emission Reduction Strategies/ NAMAs	14.4	19.8	65.8
REDD	12.8	25.5	61.7
Green Economy, Growth and Jobs	15.2	33.3	51.4
Development of a Climate Investment Plan	12.2	26.2	61.7
International Climate Change Funding	15.2	16.2	68.6
Carbon Markets and CDM	19.2	32.7	48.1
International Climate Change Law and Negotiations	22.9	34.3	42.9
Green Technologies/ Renewable Energies	9.3	23.2	67.6
Social Dimensions of Climate Change	5.5	26.4	68.2
Communicating climate change	6.0	16.4	77.6
Gender and climate change	8.6	23.3	68.1

Source: MWE, 2013

The key strategies pertinent to climate change education and learning identified in Uganda include the following: (i) Continue to undertake climate change learning as a continuous process; (ii) Assess the impact of climate change learning through reviews, after all the educational levels have anchored climate change learning in their respective curricula, and take appropriate action according to the prevailing condition; (iii) Harmonize climate change learning among different institutions to streamline climate change learning at the various levels (PE, SE, BTVET, HE) and to decide on who imparts what knowledge at each level, (iv) Provide fellowships, scholarships and undergraduate/ postgraduate assistantships and internship to improve research in climate change adaptation and mitigation in Uganda, (v) Promote education, research and outreach programmes through development and implementation of an education and outreach programme, (vi) Build the capacity of high and mid-level government officials, civil society, private sector, and the media to understand climate change and address the impacts of climate change based on the priority topic; and (vii) design and deliver sort-term, medium-term, and long-term training programmes on climate change for IITCP members, members of civil society, PFCC, private sector, and others.

The priority actions for the strategy were identified as follows: (i) Strengthening climate change education at upper primary level to complete ongoing development of resource materials for climate change education at upper primary level (supplementary materials on climate change for pupils at upper primary level, resource boon climate change for primary level teachers, strengthening capacities of subject specialists, piloting, as well as dissemination, of supplementary materials and the resource book.), (ii) Building climate change competencies of newly pointed Climate Change Desk Officers to support them in performing their new tasks, (iii) Support for advancing medium and long-term implementation of the National Strategy to ensure sustained implementation of the Strategy in the medium and long-term.

Pursuant to the launch of the National Climate Change Learning Strategy, various actions are continuing towards climate change education and training in Uganda, at both the policy level and the technical level, across sectors, by both the state (MDAs) and non-state entities {Private sector, Development partners, and member-based organizations (MBOs) (NGOs, FBOs, CSOs and CBOs). For example, while Busitema University offers postgraduate (MSc) training linked to climate change, elsewhere there is the Makerere University Centre for Climate Change Research and Innovation (MUCCRI) dedicated to awareness raising and knowledge building through research and outreach.

In an effort to enhance the anchoring of climate change knowledge across sectors the Ministry of Water and Environment, which is the climate change focal ministry, in 2017, developed a 207-page "National Climate Change Training Manual for the Inter-Institutional Climate Change Desk Officers and Relevant Stakeholders for Uganda" (MWE, 2017). The aim was / is to enable training of desk officers from MDAs, private sector, and MBOs on climate change, its diverse impacts plus possible options for adaptation and mitigation. The training manual is key reference material aiming at strengthening knowledge and skills for the integration of climate change into MDAs and promotion of green low-carbon and climate-resilient economy. The content of the training manual focuses on: (i) Basic elements of climate change (the science, as well as perspectives at the various levels – global, regional, national, and sub-national); (ii) Introduction to the roles of MDAs, plus climate change impacts on sectors, as well as possible sectoral actions; (iii) Climate change in cross-cutting sectors, reflecting on the direct and the indirect impacts of climate change plus options for adaptation and mitigation; and (iv) Recommendations for possible actions emanating from the production of the training manual.

Beyond the National Climate Change Training Manual, a range of knowledge up-skilling efforts, coordinated by the MWE-CCD, is continuing, partly to respond to the emerging demands in operationalizing the various instruments under the UNFCCC across sectors. In this regard the role played by development partners in the enhancement of the management of climate change knowledge in Uganda, both multilaterally and bilaterally is hugely indispensable currently. This is evidenced, for example, in the development of various climate-related tools, with accompanying training, such as the "Climate and Disaster and Risk Screening" tool; as well as methodologies for various kinds of assessments in the mitigation and the adaptation arenas. There is high expectation that Uganda's climate change law (currently a Bill) (GoU, 2020) will provide a framework for ensuring translation into action the outcomes of climate change learning and training in Uganda.

7.3 Capacity Building

Uganda's National Climate Change Learning Strategy underpins the country's resolve to strengthen human resources and skills for climate-resilient development at both the policy level and the technical level, across sectors. During the course of the TNC project, two capacity building initiatives were undertaken. These are documented below.

7.3.1 Development of Training Materials to Build Capacity for LDC

As part of the national efforts on education and training, Uganda in 2020 accessed resources through the Global Support Programme funded by the Least Developed Countries Fund (LDCF) under its project "Building capacity for LDCs to participate effectively in intergovernmental climate change processes" implemented by UNDP and UNEP. This was a small-scale grant agreement that provided technical support to enable Uganda to participate and negotiate more effectively during UNFCCC processes.

The main problem addressed was that Uganda, as part of the Least Developed Countries (LDCs) needs capacity to effectively participate in the climate change negotiations by building sufficient technical capacity and resources. These problems are exacerbated by: (i) the increasing pace of the UNFCCC negotiations; (ii) the increasing number of topics, agenda items being negotiated; and (iii) insufficient institutional capacity of the country to follow these negotiations.

The strategy taken in the training was to strengthen the national coordination mechanism for climate change in the country. This national coordinating mechanism consists of officials from Ministries, Departments and Agencies (MDAs) that are responsible for implementing the country's climate change policy. These also form the team that participates in international meetings and facilitates knowledge sharing between different stakeholders. Officially they are called National Climate Change Focal Officers in the MDAs. It is expected that these facilitate the integration of climate change information into development planning within their mandates. In addition, there is also a National Climate Change Forum that brings together a wider constituency of actors including non-state actors. This should help the country to participate more effectively in intergovernmental climate change negotiations and allow the CCD to coordinate mitigation and adaptation efforts at global, regional and national levels.

The support provided technical support was mainly achieved through providing guidance on national coordination mechanisms to improve the communication of climate change related information and training materials relevant to help negotiators acquire skills necessary for effective negotiation during international climate change negotiations. These resources were made available at CCD. Table 7.2 summarizes the training modules.

The three training modules are intended to enhance the capacities of Ugandan climate change negotiations. Module one focuses on "climate science fundamentals, impacts and responses".

Table 7.2: Summary of training modules for negotiators

Module No.	Topic	Main Objective
1	Climate change science fundamentals, impacts and response in the context of climate change negotiations	Explain the basic concepts of climate change, its causes, the instruments against it and the obligations of parties to the UNFCCC.
2	International legal and policy framework to address climate change	Describe the main aims and provisions, Identify the main organizations and bodies, and outline the implementation modalities of the UNFCCC, the Kyoto Protocol and Paris Agreement.
3	The United Nations Framework Convention on Climate Change (UNFCCC) process and procedures	Explain the procedure, the roles of the key actors and the process of negotiation.

7.3.2 Capacity Building for Enhanced Transparency Requirements of Article 13 of 2015 Paris Agreement

As a party to the UNFCCC convention and signatory to the Paris agreement Uganda was supported under Capacity-building Initiative for Transparency (CBIT) that GEF established and operationalized to implement the Paris Agreement. CBIT enabled Uganda to establish and or strengthen its in-house capacity to be able track progress on national commitments made under the Paris Agreement and also to produce more comprehensive and accurate reports capturing their implementation in the medium to long-term.

The implementation arrangement of the CBIT project in Uganda was well balanced among the stakeholders as it was funded by the Global Environment Facility (GEF) through Conservation International (CI), and delivered through the Capacity Building Initiative for Transparency (CBIT) "Strengthening the Capacity of Institutions in Uganda to Comply with the Transparency Requirements of the Paris Agreement" project. The CBIT project was executed by the Ministry of Water and Environment, Climate Change Department (MWE-CCD) of Uganda and the Africa Innovations Institute (AfrII).

Uganda identified three main CBIT components through assessments, systematic review of literature, secondary information, profession/expert consultations and MRV workshop discussions. The identified components focused on: a) addressing the weak inter-institutional collaboration among the MRV stakeholders, b) technical and capacity building to overcome human capacity and technology shortcomings; and c) strengthening the GHG inventory and pilot-testing the transitioning of the MRV system from tier 1 to tier 2/3 reporting. These components were inter-linked with activities that inform each other.

The CBIT Uganda project was a success and some of the achievements are still being implemented and operationalised. Uganda's experience has been shared with the government of Liberia through a south to south exchange visit to get first-hand experience and lessons learnt from implementation of Uganda's CBIT project. Uganda hosted and shared with Liberia team the achievements of implementing the CBIT project. Among others Uganda shared knowledge and information on how they developed, is managing and operationalising a robust MRV system. The key project achievements of Uganda CBIT project are presented in Table 7.3.

Table 7.3: Key achievements by CBIT Project Uganda

Objectives	Key achievements of Uganda CBIT Project
1) Establishing institutional arrangements for a robust national system for GHG emission inventories and MRV systems (Component 1)	a. Institutional arrangements for a robust GHGI and MRV with the coordinating agency and five sectors initiated. b. Inter-ministerial Cooperation Agreements signed among 10 ministries including c. Six data sharing MoUs for GHG data collection, processing and transmission (NFA, NEMA, MEMD, MoWT, MAAIF, MTIC) d. Technical guide on GHG data sharing approved and signed as Annex to MoU e. Integrating Gender in GHGI and MRV operations -Established gender focal points in 5 sector hubs and Developed a procedure manual on generating gender disaggregated information in GHG inventory
2) Build capacity of key stakeholders to collect, process and feed data into the GHG emissions inventory system and (Component 2)	a. The training involved 81 participates, 55 from six lead sector institutions and 26 from other institutions. b. A total of 62 individuals successfully finished the curse, 35% were women and graduated as National GHGI Experts. c. Equipment procured for 5 sector Hubs, CCD and AfrII d. Protocols and tools developed for 4 sectors e. Over 80 people sensitized and trained on GHGI and MRV f. Exposure &/ international trips (COP 24, COP 25) 33% women g. 81 officials sensitized on GHGI, domestic MRV and IPCC requirements 55 from CCD, MAAIF, NEMA, MoWT, MEMD, MTIC; 10 from non-state actors and the rest from other institutions h. Information and knowledge sharing through policy briefs, status reports and fact sheets. All reports and knowledge sharing materials are uploaded on the CCD MWE, AfrII websites and the CBIT global coordination platform. Links below for access to the documents o http://ccd.go.ug/cbit/# o https://www.afrii.org/publications-2/ o https://www.cbitplatform.org/projects/strengthenin o capacity-institutions-uganda-comply-transparency-requirements-paris
3) Test and piloting the GHG emission inventory and MRV system (Component 3)	a. 6 sector GHG inventories (2016-2019) developed b. Handed over the six sector 2016-2019 GHGI to the CCD-MWE to integrate in the national GHGI and MRV systems c. Trained CCD staff to manage the Uganda MRV portal and link the portal to the National Integrated MRV tool being developed at CCD-MWE d. The established sector hub teams with the sector focal points and gender focal points to be engaged in GHGI and MRV

7.3.3 Strengthening of Technical Capacity the National Adaptation Technical Working Group

Members of the National Adaptation Technical Working Group (NATWG) fall under the following sectors/ institutions/ areas: Agriculture and Livestock, Water, Fisheries and Aquaculture, Transport and works, Forestry, Wetlands, Biodiversity and Ecosystems services, Health, Energy, Wild life and tourism, Human settlement and social infrastructure, Disaster risk management, and Vulnerable groups. Other Sectors / Institutions / cross-cutting issues / considerations are as follows: Finance, Gender, Science & Technology & Innovation, Monitoring and Evaluation, National Planning Authority, Statistics, Communication, CSOs, FBOs, NGOs, UNDP Small Grants programme, Modeling (part of V&A core team), Vulnerability assessment (part of V&A core team).

To be able to undertake adaptation assessment and provide information on adaptation measures effectively, the NATWG requires Technical capacity strengthening. The topics reflected in Table 7.4, which are updatable with time for the technical capacity strengthening were identified and ranked (bracket) previously by members of the core team, and published (MWE, 2013).

Table 7.4: Topics identified for climate change learning in the "National Strategy and Action Plan to strengthen human resources and skills to advance green, low-emission and Climate-resilient development in Uganda 2013 – 2022"

Ser. No	Topic	Priority (percentage)			Rank
		Low	Medium	High	
1	Fundamentals of Climate Change	3.4	11.8	84.9	1
2	Predicting Climate Variability and Change	7.0	23.7	69.3	6
3	Vulnerability and Adaptive Capacity Assessment	6.0	22.2	71.8	5
4	Adaptive and Climate Resilient Decision-making	6.2	21.2	72.6	4
5	Climate Change and Disaster Risk Management	7.9	15.8	76.3	3
6	Climate Change and Population Dynamics	11.6	24.1	64.3	12
7	Mitigation and Emission Reduction Strategies / NAMAs	14.4	19.8	65.8	11
8	REDD+	12.8	25.5	61.7	13
9	Green Economy, Growth and Jobs	15.2	33.3	51.4	15
10	Development of climate investment plan	12.2	26.2	61.7	13
11	International Climate Change Funding	15.2	16.2	68.6	7
12	International Climate Change Law and Negotiations	22.9	34.3	42.9	17
13	Green Technologies / Renewable Energies	9.3	23.2	67.6	10
14	Social Dimensions of Climate Change	5.5	26.4	68.2	8
15	Communicating Climate Change	6.0	16.4	77.6	2
16	Gender and Climate Change	8.6	23.3	68.1	9
	Other Topics (needed for National Adaptation Plan Implementation)				
17	Monitoring and Evaluation (M&E), Adaptation indicator development				
18	Mindset (NDP III, section 4.6, page 17)				
19	Digital Transformation				
20	MRV Adaptation				

7.3.4 Capacity Building at the Sub-regional and Regional Level

In addition to the national level, Uganda has actively participated in sub-regional and/or regional capacity-building activities for integrating mitigation and adaptation of climate change into medium and long-term planning. The regional training has enhanced participants' understanding of international climate change negotiations and strengthened their skills to effectively follow and participate in the international climate process.

On mitigation, Uganda through the Ministry of Water and Environment, Climate Change Department with support from the Global Environment Facility (GEF) through UN Environment supported four technical officers Nairobi to attend a training on *GHG baselines and monitoring for the freight and passenger transport sector* that was organized by the United Nations Framework convention on Climate Change (UNFCCC) and GIZ in Nairobi, Kenya from 11th -13th February 2020. The purpose of the training was to build countries capacity in developing suitable tools and approaches to analyze pathways of development and greenhouse gas emissions under new and existing mitigation policies and actions GHG accounting and developing baseline and mitigation scenarios at a national level for the freight and passenger transport sector. The Technical Training Workshop covered GHG emissions quantification and prioritizing policies, actions and measures in the transport sector (11 to 13 February 2020, Nairobi, Kenya).

Through this training, Uganda was able to join a group of senior climate change experts and officials from several countries in Africa, and gained important knowledge and skills in GHG inventory and mitigation aspects in the transport sector, gained access to useful tools and approaches to GHG inventory and mitigation analysis in the transport sector, as well as developed a list of further capacity building needs.

Uganda also participated in the First East Africa Regional MRV Network Training and Peer Review Workshop in Dar es Salaam. Tanzania, 23 – 26 July 2019 as part of the Global Support Programme on the MRV Network capacity building program and plan. During the training, participants shared information with the Consultative Group of Experts (CGE), GEF and UNFCCC as part of the review of BUR reports. Participants were National BUR/NC Coordinators, and those familiar with GHG inventories or mitigation analysis. Buys o doing, capacity building in preparation of NCs and BURs is enhanced, especially the G*HG Invitatory* and *Mitigation Actions and Effects components*. At the Dar meeting, highlights were provided on the key considerations in Enhanced Transparency Framework of the Paris Agreement, the new reporting structure including the key requirements of a full-fledged national inventory report (NIR) and reporting on Vulnerability. Countries also mapped national preparedness on new reporting requirements, including National Inventory Reports. Introduction and demonstration on use of the 2006 IPCC Inventory Software, with a view to getting countries to start using this software after previous trading on 2006 IPCC GHG Inventory Methodology.

Uganda has also participated in the capacity building activities of the Eastern African Alliance for carbon Markets and Carbon Finance which are supported by the GIZ Carbon Markets Programme in Uganda and East Africa, on behalf of the German Federal Ministry for Environment (BMU) and together with the UNFCCC Regional Collaboration Centre (RCC) Kampala. This programme has been going on for over three years. The programme supports countries in the East African Region through pre-COP training workshops to improve negotiators' skills and build their understanding on the key themes in the UN discussions. This workshop is a continuation of that series. With respect to Article 6 of the Paris Agreement, the training has strengthened the understanding of participants on Article 6 as a key negotiation topic at recent COPs and how it relates to transparency and climate finance under the Paris Agreement, focusing in particular on the needs and priorities of countries in Africa as well facilitate participants' making inputs to the Article 6 negotiation positions of the African Group of Negotiators (AGN) and Least Developed Countries (LDCs) and identifying ways to improve readiness to participate in international cooperation under Article 6.

7.4 Information and Networking

The Republic of Uganda has been keen to participate in information sharing and networking at both regional and international levels. It is recognized that effective and enhanced information sharing and networking assists the country adapt to the negative impacts of climate change. In this regard, Uganda plays an active role in addressing the global climate change problem through cooperation with other countries. Uganda is a Party to several Multilateral Environmental Agreements and various other Protocols and accords the sharing of information, networking and joint actions the necessary priority.

Specific actions in this regard include; 1) facilitating and strengthening all MDAs that foster the country's international collaboration, linkages and networking among parties involved in environment and climate change related issues. 2) facilitating the follow up of parties' obligations especially UNFCCC and 3) participating in and promoting international North-South and South-South collaboration in climate change and mitigation actions.

Some specific information sharing and networking activities include:

a) As a Partner State of the East African Community Uganda, subscribes and contributes in sharing information on Climate Change as part of the implementation of the East Africa Community Climate Change Policy.
b) Uganda is a member of the Eastern African Alliance on Carbon Markets and Climate Finance. Through the Alliance, member states work towards a long-term vision on carbon markets and carbon finance as well as coordinate action and participation in international negotiations and other international fora.

c) Uganda participates effectively as a host Party of the Regional Collaboration Centre (RCC) of the UNFCCC which has its offices in Kampala.
d) Uganda participates in the East Africa Regional MRV Network through which Eastern African countries together develop capacity in underrating GHG inventory and National Communications reporting
e) As a beneficiary of international projects such as the Capacity Building Initiative for Transparency, Uganda shares her experience with other governments (most recent example was Liberia) through a south to south exchange
f) Uganda is participating in the Nile Basin Regional HydroMet Project currently under implementation to support monitoring and data collection efforts of Member States and the region at large.
g) Uganda participates in the Monitoring for Environment and Security in Africa (MESA) project under African Union Commission. This synergy system was established for weather and climate monitoring and forecasting. MESA is an important building block of "Global Monitoring for Environment and Security and Africa" an initiative on earth monitoring with a view to enhance access to earth observation data for policy makers.
h) Uganda's National Meteorological Services are linked through GTS to the regional hub in terms of exchange of meteorological data, information and reports with WMO. The AMSS communicates to regional and global systems in terms of weather forecasting and aviation/pilot briefing and consultations.
i) Uganda is part of the Severe Weather Forecasting programme (SWFP)- Eastern Africa. This is a regional WMO programme initiated in 2010 (now in Phase III) for monitoring and issuing severe weather alerts to save lives in the partner states of Uganda, Kenya, United republic of Tanzania, Rwanda, Burundi, Southern Sudan and Ethiopia.

7.5 Summary and Conclusion

The Government of Uganda has made efforts to educate and raise awareness of the entire population about climate change and its impacts on national development with enhanced attention being given to decision makers. In addition, substantial progress has been made in the institutional and legal regimes. However, limited progress is evident in transfer of mitigation and adaptation technologies in the country. The ongoing Technology Needs Assessment is expected to help identify the technologies that are best suited to meet Uganda's specific needs considering the country's natural, environment and development circumstances.

Uganda has benefited from the support provided by Development Partner agencies in the critical areas of climate change through enhanced education, training, research, capacity building and information. Specific projects around the National Communications have been particularly supported and have enhanced the local capacity.

The Government of Uganda will continue to place concerted efforts in developing plans and actions at both local and national level and looks forward to the continued bilateral and multilateral support towards their implementation.

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