Republic of Uganda

MINISTRY OF WATER AND ENVIRONMENT
Climate Change Department (CCD)

October 2014

UGANDA Second National Communication to the **UNITED NATIONS** Framework Convention on **CLIMATE CHANGE**

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UNEP

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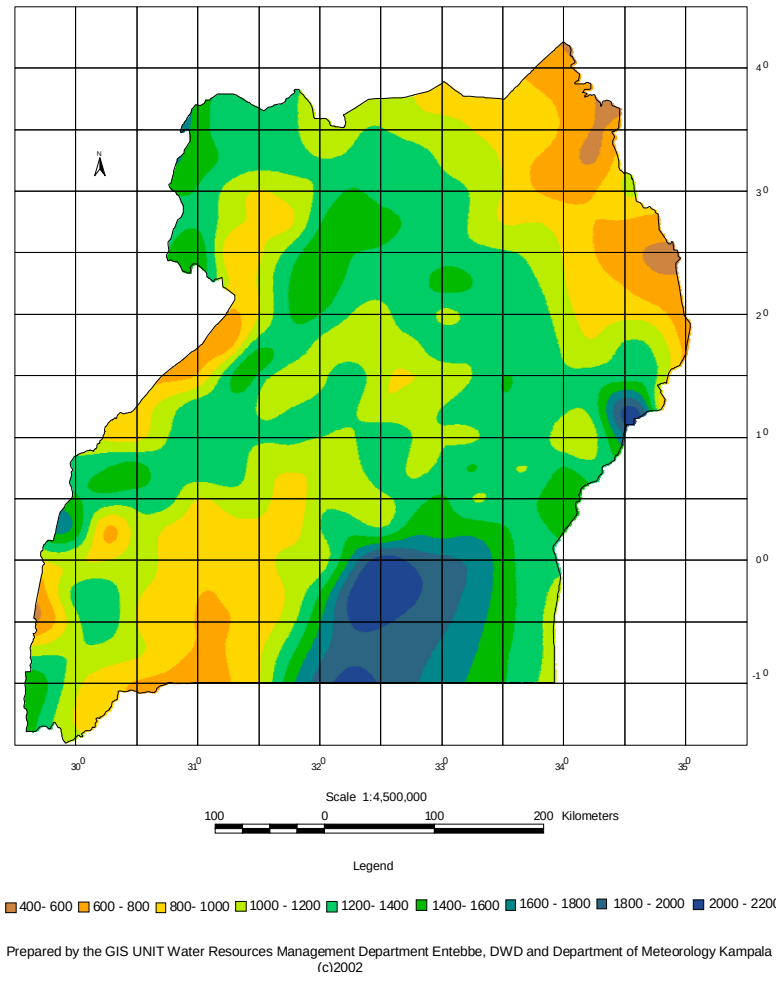
REPUBLIC OF UGANDA

MINISTRY OF WATER AND ENVIRONMENT

Uganda's mean annual rainfall (MAR) (mm)



Uganda Second National Communication to the United Nations Framework Convention on Climate Change

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The Global Environment Facility (GEF), through the United Nations Environment Programme (UNEP), provided funding for preparation of this Second National Communication.

Ministry of Water and Environment,
Climate Change Department
P.O. Box 28119, Kampala, Uganda.

FOREWORD

The challenge of climate change poses the greatest development threat, not only in Uganda, but in almost all the developing countries in particular and the entire globe in general. 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. The very existence of communities in countries like Uganda is particularly threatened by erosion of their natural resource capital by the impacts of climate change.

Uganda has in the past decades, for example, witnessed numerous events associated with adverse impacts of climate change. Different parts of Uganda have experienced record-breaking occurrence of floods, prolonged droughts and erratic rainfall patterns. The impacts have included landslides, loss of biodiversity, land degradation and increased incidences of diseases, pest and vector infestations in both humans and livestock. The recurrent landslides in Bududa District on Mt. Elgon slopes, flooding of River Nyamwamba in the Mt. Rwenzori region, melting of the Mt. Ruwenzori ice caps, and increased desertification across the cattle-keeping belt of Uganda provide clear pointers to the magnitude of the threat.

Coincidentally, the worst impacts are on those with least resilience and adaptive capacity. Uganda's capacity help the affected, especially the local communities, to cope is very limited. This is compounded by the fact that Uganda's economy is heavily dependent on natural resources. Attainment of the country's socio-economic development goals as spelt out in the National Development Plan and Vision 2040 are being 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). Uganda is fully committed to the UNFCCC and all efforts to tackle climate change for the survival of humanity; in accordance with the principle of common but differentiated responsibilities and respective capabilities. In furtherance of the UNFCCC cardinal principles, the Uganda Government has put in place the necessary policy, regulatory and institutional framework to harmonize and coordinate the country's response and actions through a comprehensive National Climate Change Policy that has been approved. A number of national and local initiatives are being undertaken, and planned, to address the reality of climate change in the context of much needed socio-economic transformation to eliminate poverty. And, in line with the convention requirements, Uganda submitted the Initial National Communication (INC) in 2002 and has prepared the Second National Communication (SNC).

On behalf of Uganda, I therefore have the honour and privilege to present Uganda's SNC to the Conference of the Parties to the United Nations Framework Convention on Climate Change. The SNC has been prepared in accordance with Article 4, paragraph 1, and Article 12, paragraph 1, of the UNFCCC. The SNC essentially summarises up to date information as

well as general and specific data on climate change in Uganda, the national greenhouse gas inventory, interventions made and/or proposed in adapting to and mitigating climate change.

Prof. Ephraim Kamuntu
Minister of Water and Environment
Kampala, Uganda

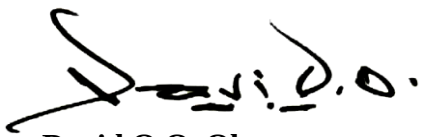
ACKNOWLEDGEMENTS

The importance of strengthening of 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 Second National Communication (SNC) under the UNFCCC has been prepared based on a series of studies, research and modelling by multi-disciplinary Task Force Experts appointed by the Ministry of Water and Environment and executed under the direct supervision of the Climate Change Department. The preparation of this Communication has been made possible with project funding by the Global Environmental Facility (GEF) through the United Nations Environment Programme (UNEP) as the implementing entity. In this respect, the Government of Uganda, through the Ministry of Water and Environment, expresses gratitude to the UNEP and GEF for making this possible.

In preparing the report, Uganda used the Task Force approach where three Task Forces on Greenhouse Gas Inventory and Mitigation Analysis (GIMA), Vulnerability and Adaptation (V&A), and General Circumstances were established. Each Task Force was led by a Chair/Team leader and had the requisite experts as members with individual Terms of Reference (ToRs). The Project Implementation Unit was established under the direct leadership of the Acting Commissioner, Climate Change Department, Ministry of Water and Environment who was assigned additional responsibilities as Project Manager. The Project Management Team (PMT) that brought together the Chairs of the three Task Forces, Project Manager/Acting Commissioner, Climate Change Department provided technical back-up, harmonization and guidance towards the overall project implementation within the agreed timeline. I therefore thank the Task Force Leaders and Members, PIU as wells as the PMT for undertaking their work diligently.

My Ministry is also highly indebted to the various Government Ministries, Agencies and Departments as well as the Civil Society Organizations (CSO) and individuals that made the work of preparing Uganda's Second National Communication possible. I am equally very appreciative of the support provided by the Minister of Water and Environment, Prof. Ephraim Kamuntu and the State Ministers in the Sector namely Hon. Flavia M. Nabugere and Hon. Betty Bigombe.



David O.O. Obong
Permanent Secretary,
Ministry of Water and Environment

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ACRONYMS

ACCRA	African Climate Change Resilience Alliance
ACODE	Advocates Coalition on Development and Environment
ADB	African Development Bank
CAN-U	Climate Change Action Network – Uganda
CC	Climate Change
CCD	Climate Change Department
CCU	Climate Change Unit
CDM	Clean Development Mechanisms
CIF	Climate Change Investment Fund
COMESA	Common Market for East and Southern Africa
CSOs	Civil Society Organisations
DENIVA	Development Network of Indigenous Voluntary Associations
DSIP	Development Strategy and Investment Plan
DWRM	Directorate of Water and Resources Management
EA	Environment Alert
EAC	East African Community
ESA	Ecologically Sensitive Areas
ESL	Energy Saving Lamps
EWS	Early Warning Systems
FAO	Food and Agricultural Organisation
FBOs	Faith Based Organisations
FDI	Foreign Direct Investments
GEST	Gender Equality and Training Programme

GHG	Green House Gasses
GoU	Government of Uganda
IATC	Inter-Agency Technical Committee
ICEIDA	Iceland development Agency
ICT	Information and Communications Technology
IEC	Information, Education and Communication
IPCC	Inter-Government Panel on Climate Change
IWRMN	Integrated Water Resources Management – Network
JICA	Japanese International Co-operation Agency
KCCA	Kampala Capital City Authority
LPG	Liquefied Petroleum Gas
M&E	Monitoring and Evaluation
MAAIF	Ministry of Agriculture, Animal Industries and Fisheries
MoFPED	Ministry of Finance, Planning and Economic Development
MoH	Ministry of Health
MoU	Memorandum of Understanding
MUCCRI	Makerere University Centre for Climate Change Research
MWE	Ministry of Water and Environment
NAADS	National Agricultural Advisory Services
NAFIRRI	National Forestry Resources Research Institute
NAPAs	National Adaptation Programmes of Action
NARO	National Agricultural Research Organisation
NCCPC	National Climate Change Policy Committee
NCDC	National Curriculum Development Centre
NDP	National Development Plan
NEMA	National Environmental Management Authority

NFA	National Forestry Authority
NGOs	Non-Governmental Organisations
NPA	National Planning Authority
PPP	Public Private Partnership
REDD+	Reduced Emissions from Deforestation and Forest Degradation+
REP	Renewable Energy Policy
SNC	Second National Communication
TNC	Third National Communication
UGX	Uganda Shillings
UIA	Uganda Investment Authority
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNRA	Uganda National Roads Authority
USD	United States Dollars
UWA	Uganda Wildlife Authority
WB	World Bank

EXECUTIVE SUMMARY

Es 1: National circumstances

Uganda is a landlocked country in the eastern part of Africa and lies within the northern and southern hemisphere. Neighbouring countries are: Kenya to the East, the Republic of South Sudan to the North, the United Republic of Tanzania and Rwanda to the South and the Democratic Republic of Congo to the West. The country has a total surface area of 241,550 km^2 of which 41,743 km^2 (17.2 %) is occupied by open water and swamps, and 199,807 km^2 is open land. Uganda is basically a plateau surrounded by four main mountain ranges; namely: Rwenzori in the west (with a peak of 5110m), Elgon in the East, Mufumbira in the Southwest and Moroto in the Northeast. The lowest part is within the Albert Nile at 620m above sea level.

Uganda's climate is three-quarters tropical with two rainy seasons (bimodal) annually; namely: March – June and October – December. Only the northern part has a mainly single rainy season during March – mid-October. The Northeast tends toward semi-arid; especially during the dry season. The rainfall level received ranges from 400 to 2,200 mm per year while temperature ranges between 16 to 31ºC. These mild conditions make climate one of Uganda's most valuable natural resources. Climate determines the state of other natural resources such as water, forests, wildlife and biodiversity that form the basis for socio-economic development in other sectors such as agriculture, fisheries, tourism, transport and health. This inherently makes Uganda highly vulnerable to the impacts of climate change.

Natural resources constitute the primary source of livelihood for the majority of the people of Uganda. Not only are these natural resources affected by climate change, but they have also come under increased pressure arising from high population growth and environmental degradation. Studies show a decline of forest cover, for example, which has fallen from 24% in 1990 to 21.3% in 2000 and 18.3% in 2005. This has been due to conversion to agricultural land and the demand for timber and fuel wood by the rapidly growing population. Moreover, given that most of the country's forests lost diversity, this has also affected the wide biodiversity that the country is known for. The annual contribution of forest based biodiversity is estimated to have decreased from US $5.097 million in 2005 to US $4.405 million in 2010 mainly due to deforestation.

Climate change and human activities have not only threatened forests, but also water bodies affecting both the quality and quantity of surface and ground water resources. The surface water resources are found in form of streams, rivers, lakes and wetlands. The Lave Victoria basin, the biggest and most widespread water basin, covers an area of nearly 60,000 km^2 and supports millions of people, gets its recharge water mainly through precipitation. Climate change may have serious consequences on it and other basins. Similarly, ground water resources that supply the bulk of the populations' water needs are declining as monitoring

wells all indicate declining trends. This is mainly attributed to changes in land use, climate variability, land degradation, deforestation upstream, and poor watershed management. The continued erosion of the natural resource base of Uganda through climate and human induced activity such as 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 poses serious sustainable development challenges to Uganda.

In terms of population, Uganda's population was 24.2 million in 2002 and was estimated at 34.1 million in 2012. The population has thus increased at a very high rate (3.2 %) between the First National Communication and 2002. Population density increased from 85 in 1990 to 126 people per square kilometre in 2002. Uganda's population is also slightly female dominated (51%). It is also increasingly younger (under 18 years old children increased from 51.6 percent in 1969 to 56.1 percent in 2002).

The quality of health service delivery in Uganda is generally poor; a reflection of enduring lack of resources while the burden of disease in Uganda is heavily weighted towards climate-sensitive diseases such as malaria, cholera and dysentery. Malaria continues to be the number one killer disease and accounts for up to 50% outpatients' visits.

On the economic front, Uganda's economic growth has been impressive throughout the 2000s following the steady recovery from the recession/decline experienced in the 1970's and 1980's. In the last 23 years, the country's real GDP has grown at an average of 6.52 per cent. However, the high population growth rate (3.2%) greatly over shadows the economic growth in terms of standard of living of the population.

Uganda is heavily an agricultural country; 85% of Ugandans live in rural areas, 73% survive out of subsistence agriculture while agriculture contributes up to 90 percent of the total exports. It has, however, experienced a rapid declining growth rate mainly because of the effects of climate change, pests and diseases as well as decreased direct government funding. Fishing, on the other hand, has experienced rapid growth and importance. It provides a source of livelihood for up to 1.2 million people and employs about 8% of the total labour force. Fish export is Uganda's second largest export earner; it grew at an average rate of 48% per year between 1991 and 2011.

Efforts have been made to revive and grow the tourism sector around the abundant and diverse wildlife and biodiversity. There has been a steady increase in the number of people visiting the National Parks from 90,000 in 2002 to 209,000 in 2011; making the sector one of Uganda's leading foreign exchange earners contributing US$ 590 million in 2008 and US$ 805 million in 2011.

Uganda has a rapidly growing service sector whose contribution to GDP grew from 41.2 percent in 2001/02 to over 45.1 percent in 2011/12. This was mainly attributed to the high growth rate in the transport and communications sub-sector of 24.4 percent per annum. Uganda had a 41.9 percent growth in the fixed internet subscriber base both for fixed and

none fixed. Also the country has had a tremendous progress in telephone penetration and improved coverage in the last 10 years.

Access to electricity in Uganda has been very low. In 2002, only 8 percent of the population and less than 3% of the rural communities had access to electricity. A strategy to increase rates from 1 percent to 10 percent by the year 2010 has been in place and by 2008, 6% of rural households and 40% of urban areas had access to the grid.

Uganda considers has been pursuing an aggressive programme to assess its mineral resources for decades. The results have generally been positive. The discovery of commercial quantities of petroleum reserves in the Albertine Graben is bound to boost this sectors' role in the economy and is likely to save the country from importation of petroleum products as it is prioritizing the building of a refinery instead of exporting crude oil. Other sectors such as the industrial sector occupy equally important positions in the Government's vision and policy actions towards economic and social transformation.

Climate change activities in Uganda, including the preparation of National Communications, in Uganda fall within the mandate of the Ministry of Water and Environment; with the day to day tasks handled by the Climate Change Unit which has been designated Climate Change Department following approval of the National Climate Change Policy. This department shall be responsible for, among other duties, the preparation of national communications on a continuous basis. For the SNC, Uganda used the Task Force approach. Three task forces were established; one on Greenhouse Gas Inventory and Mitigation Analysis (GIMA), one on Vulnerability and Adaptation (V&A), and the other on General Circumstances. The work of the Task Forces was reviewed and discussed at national workshops attended by representatives of other line ministries and government agencies and the final output discussed and approved by the National Climate Change Advisory Committee.

Es 2: National Green House Gas (GHG) inventory

The second Greenhouse Gas (GHG) inventory for Uganda using 2000 as the base year has been prepared in accordance with the guidelines provided in the COP Decision17/CP.8. The first inventory was compiled and submitted as part of the Initial National Communication (INC) with 1994 as the base year.

The team of experts responsible utilized IPCC/UNFCCC guidelines (1996, 2003 and, 2006) and publically available data. The emission estimates cover five inventory sectors: energy, industrial processes, agriculture, land use, land use change and forestry, and waste. The greenhouse gases reported are: Carbon dioxide (CO_2), Carbon monoxide (CO), Methane (CH_4), Nitrous Oxide (N_2O), Nitrogen Oxides (NO_x), Sulphur dioxide (SO_2) and Non-Methane Volatile Organic Compounds (NMVOC).

In summary, Uganda's total national greenhouse gas emissions by sector and removals by sinks in 2000 are shown in Table E1.

Table ES1: Uganda national greenhouse gas emissions by sources and removals by sinks in 2000 in Gg

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O
Total National Emissions and Removals	**11,759**	**-1,651**	**520**	**55**
1 Energy	**1,212**		**146**	**2**
2 Industrial Processes	**159**			**NO**
3 Solvent and Other Product Use	**NE**			
4 Agriculture			**272**	**52**
5 Land-Use Change & Forestry	**10,387**	**-1,651**	**69**	**1**
6 Waste			**33**	**NE**

By gas, the greenhouse gas emissions were: 11,759 Gg of CO_2, 520 Gg of CH_4, and 55 Gg of N_2O while only 1,651 Gg of CO_2 removals occurred. In addition, emissions of indirect gases amounted to 104 Gg of NO_x, 3,947 Gg of CO, 299 Gg of NMVOC and 4 Gg of SO_2.

The energy sector, including transport, contributed 1,212.2 Gg of CO_2, 146.2 Gg of CH_4 and 2 Gg of N_2O as well as 2592 Gg of CO, 297 Gg of NMVOC and 4 Gg of SO_2. The transport sub-category was the major (72%) emitter of CO_2 while other energy categories (which include residential, commercial, institutional and agriculture/forestry/fishing) dominated the CO (97%) and NMVOC (95%) emissions. In the industrial processes sector, cement production was the major contributor of CO_2 emissions; amounting to 158 Gg.

The GHG emissions in the agriculture sector in year 2000 were 272 Gg of CH_4 and 52 Gg of N_2O as well as 12 Gg of CO and 222 Gg of NO_x. Enteric fermentation and manure management generated 241Gg of CH_4, Agricultural soils contributed 51.0 Gg of N_2O and, prescribed burning of savannah contributed 159 Gg of CO; Field burning of agricultural residues contributed 63 Gg of CO while flooded rice cultivation contributed 21.60 Gg of CH_4.

The 2000 annual GHG emissions from the LULUCF sector were 10,387Gg of CO_2, 69 Gg of CH_4 and 1 Gg of N_2O1 as well as 1,132 of CO and 32 Gg of NO_x. Forests were the leading emitters both in CO_2 emissions (over 6,300 Gg) and non-CO_2 emissions (over 1,000 Gg of CO and over 60 Gg of CH_4). Cropland was second to forests in CO_2 emissions; estimated at 3,280 Gg. Land categories that were net removers of CO_2 were cropland (42 Gg) and settlements (4 Gg). Afforestation is estimated to have removed 36 Gg of CO_2 with conversion of cropland to forestland removing 131 Gg and conversion of grassland to forestland removing 97 Gg. Grassland that was converted to cropland removed 946 Gg of CO_2.

GHG emissions from waste were 33 Gg of CH_4 of which 30.8 Gg were from solid waste and 2.7 Gg were from waste water (1.2 Gg from domestic waste water and 1.5 Gg from industrial waste water).

Based on Tier 1 Category analysis, the key sources of GHG emissions in Uganda in 2000 were: N_2O emissions from Agricultural soils (38%), followed by CO_2 emissions from Forest degradation (15%), CH_4 emissions from Enteric fermentation (11.7%), CO_2 emissions from Deforestation (8%) and CH_4 emissions from Fuel Combustion in other sectors (7.4%). Other key categories include CH_4 emissions from forests (3%), CO_2 removals, Land converted into Cropland (2.3%), CO_2 emissions from Transport (2.0%) and CH_4 emissions from solid waste (1.5%).

With respect to emissions trends, there was a general increasing trend in emissions from 1994 to 2000 and also from 2000 to 2005. In the energy and transport sector, CO_2 emissions increased by 74.9 % in 2000 compared to 1994 levels. Total CO_2 emission in the LULUCF steadily declined. Emissions due to forest degradation and deforestation continue to decline, though modestly, as area of forests and stock of wood (biomass) in the forest cover reduces. Emissions from the waste sector increased by 71.9% from the year 1994 and to 2005 and by 38.0% from 2000 to 2005

Experience during the compilation of the inventory suggests that there is need to improve the organization process of compilation of future inventories through a formal and institutionalized framework and planned process. Use of appropriate rules of procedure and manual(s) for inventory preparation and a robust archiving system could further facilitate future compilations.

ES 3: Impacts, vulnerability and adaptation measures

ES 3.1: Climate seasonality, variability and trends

Uganda, being in the tropics and across the equator, experiences weather and climate seasons that are determined by the large scale Monsoons and the Inter Tropical Convergence Zone (ITCZ) systems as they move northwards and southwards following the overhead sun. In addition, the medium scale systems related to extensive physical features in the East African region like the Lake Victoria Basin, mountain ranges and the associated rift valleys as well as the extensive Congo Basin forest to the west play a big role in the temporal and spatial distribution and intensity of the weather systems in Uganda. Uganda also experiences teleconnections (El Nino / Southern Oscillation – ENSO) phenomena which are the principal mode/driving force of annual to inter annual rainfall variability in the global tropics. Specifically, the potential impacts are most pronounced in Uganda during the season September to December, where the El Nino is often equated to floods rather than Lanina that is often equated to droughts.

The overall resulting latest Mean Annual Rainfall map of Uganda is shown in Figure ES1. It indicates rainfall patterns with amounts ranging from 400mm within pockets of the eastern Karamoja region to up to 2200mm over Lake Victoria and Mountain Elgon regions.

The map indicating the 16 delineated homogeneous zones used to present and analyse various hydro-climatic regimes of Uganda is given in Figure ES2.

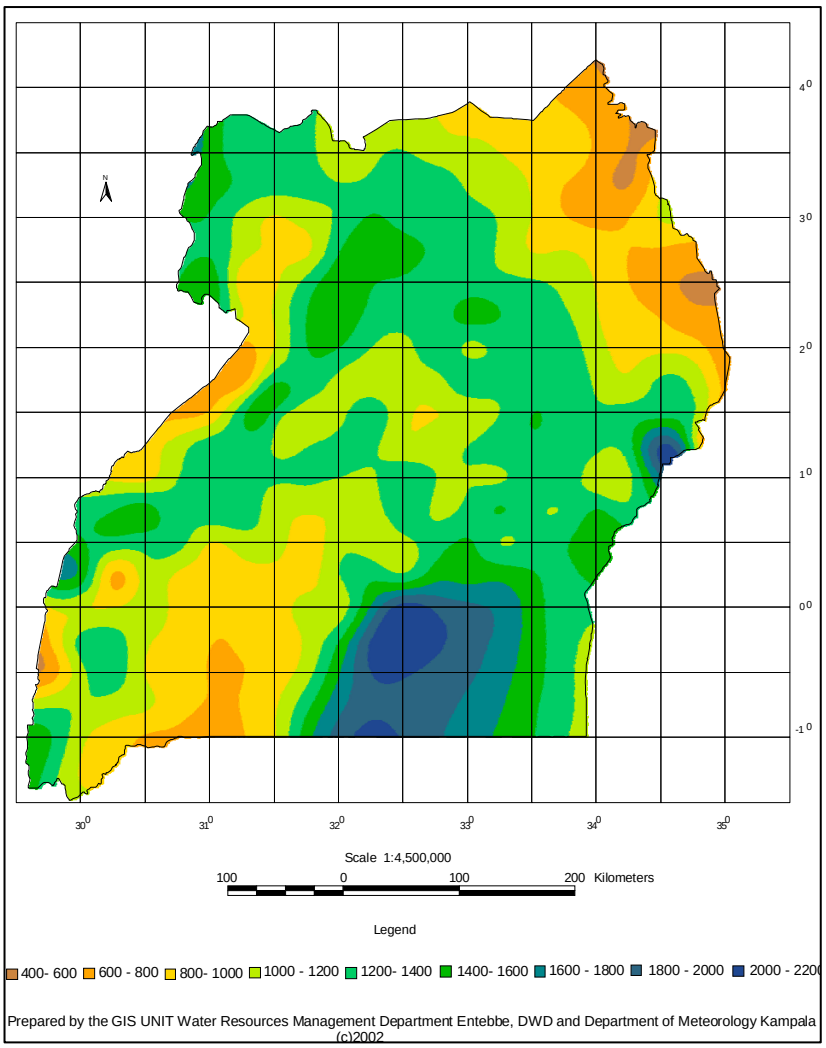


Figure ES1: Uganda's Mean Annual Rainfall Map

A demonstration of the potential impacts of El Nino and Lanina over the country is given in Figures ES3 and ES4, respectively. These indicate extensive flooding related to the 1997 El Nino, and the widespread drought conditions during the Lanina of 1998, respectively.

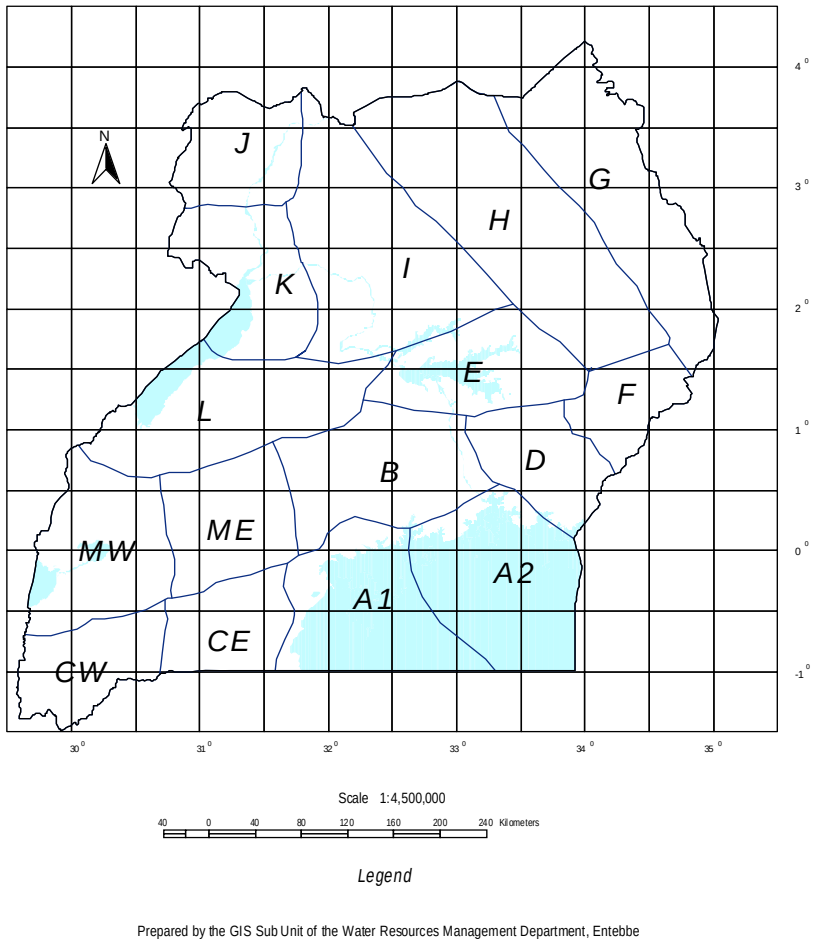


Figure ES2: The 16 delineated homogeneous zones of the country

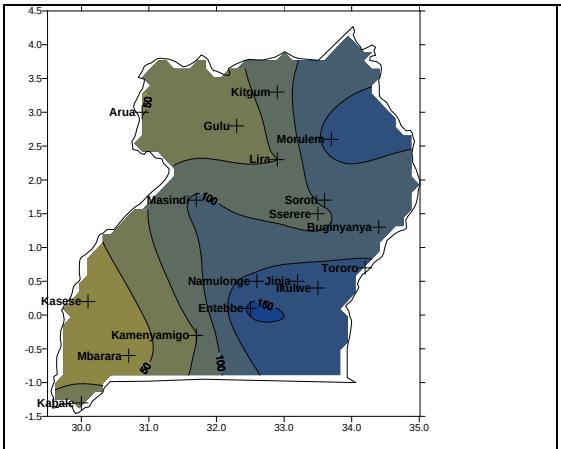


Figure ES3: 1997 El Nino flooding, October to December % seasonal rainfall departures

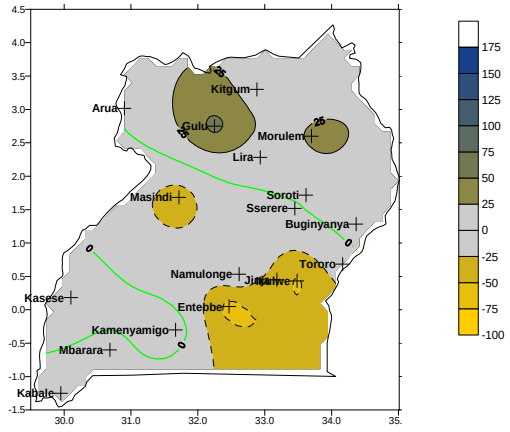


Figure ES4: 1998 Lanina droughts, October to December % seasonal anomalies

The most affected region extends from southeastern areas of the country to the central areas. During the 1997 El Nino, this region received 100-150% more rainfall while during the 1998 Lanina the same region received 25 to 75% below normal rainfall.

Uganda is experiencing significant evidence of global warming. Time series analysis in the form of annual standardized temperature anomalies and trends carried out over the forty year period and covering the high ground southwestern region of Kabale, has showed significant temperature increases, especially the minimum from the early 1990s to 2000 and beyond,. Overall, over a 30 year period, 1970 to 2000, the trend line indicates an increase of the minimum temperature as well as the maximum temperature. Significantly, the gradient for minimum temperature is greater than the one for the maximum temperature. The minimum temperature increases are most pronounced during the period October to April of the El Nino phase of the ENSO cycle. During this phase positive temperature anomalies of over 1º C can occur while during Lanina negative anomalies of up to -0.4º C can occur.

Similarly, a drought duration analysis carried out for two periods April-October, (picking up the dry period between the first and the second rainy season) and October-April (which picks up the dry season between the second and the first rainy season) shows that at rainfall thresholds of 50mm and at the non-exceedance probability of 0.5, the drought duration for the dry period April to October is most pronounced over the southwestern region of the country. It takes up to about three months (18 pentads) to realise the accumulations of 50mm. On the other hand, during the dry period October to April the drought duration is most pronounced over the north-eastern region of the country where it takes up to four months (24 pentads) to accumulate 50mm. Generally, there is wide spatial and temporal variability between the episodes of wet/very wet years and dry/very dry years as well as between wet and dry decades.

Es 3.2: Models of projected climate parameters changes

Projection of climate parameters for the fourteen climatologically homogeneous zones of Uganda using Twenty General Circulation Models, downscaled for two 30 years-periods (Mid-Century, and End Century) and two Representative Concentration Pathways (RCP), have been made. Results show that there are variations in the magnitude of change in minimum and maximum temperatures from one model to the other. All models however show temperature rise in all the Climatologically Homogenous Zones of Uganda. The ensemble mean shows an increment range of Tmax and Tmin for the RCP 4.5 and 8.5 for Mid and End Century respectively. Projected Tmax ranged between 1 and 1.5^{o}C, 1.7 and 2.2^{o}C; 1.7 to 2.1^{o}C; 3.2 and 3.9^{o}C for RCP 4.5 and 8.5 for Mid and End Century respectively. Projected Tmin ranged between 0.8 to 1.8^{o}C; 1.7 to 2.5^{o}C; 1.4 to 2.1; and 1.2 and 2.3^{o}C; for RCP 4.5 and 8.5 for mid- and end-Century; respectively.

In general, the majority of models predict an increment in rainfall with varied magnitude of precipitation increase throughout Uganda. The ensemble means show an increment for all the CHR zones and its mean rainfall amount is predicted to increase significantly and

consistently for three which cover western shores of Lake Victoria and central western region; Mount Elgon region; and to the zone extending from Mount Rwenzori to the southern parts of Lake Kioga. Generally, the range for the reference rainfall pattern is 462.4mm while that for the mid-century is 527.1; implying an increase of 74.8mm between the two while the increase between the mid and end century patterns is 10.0mm. This implies the greatest change in the intensity and frequency of extreme weather events is likely to take place between the current and the mid-century period (Figure ES5).

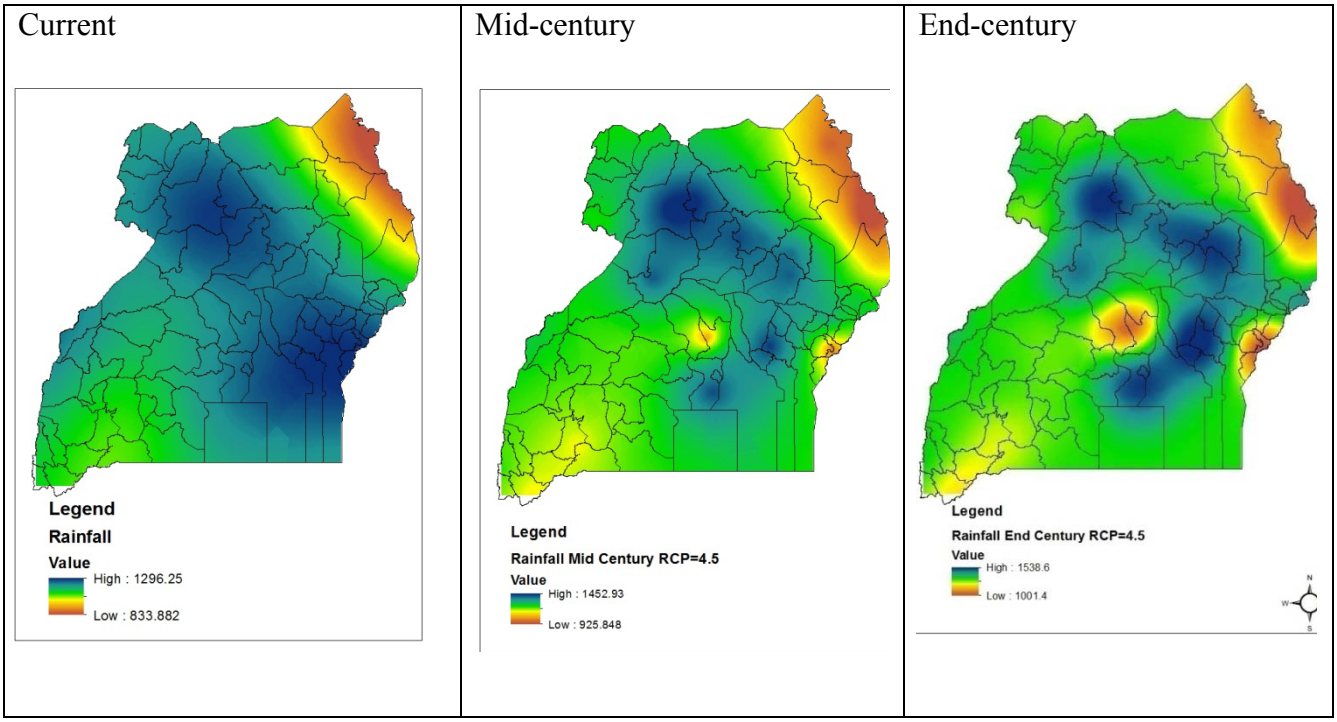


Figure ES5: Rainfall amount ranges for the current and the projected mid and end century

Es 3.3: Vulnerability assessment and adaptation to climate change

Vulnerability assessment is a critical tool for determining how climate change impacts the lives of the most vulnerable of the population. The agriculture, food security, land use, forestry, health, water resources, wetlands, fisheries and biodiversity were considered of particular relevance to Uganda and received special attention.

In the agriculture sector, it was noted that climate change is and will greatly affect farmers in Uganda especially as their capacity to cope is very limited because of poverty. The wide range of impacts identified includes: heavy rains that cause soil erosion and leaching, high temperatures and drought conditions that cause wind erosion and loss of soil nutrients, and heavy storms and rain-induced landslides. Moreover, the level of exposure to soil erosion is facilitated by poor farming practices, loss of vegetative cover and deforestation. Adaptation measures proposed include: the need to support agricultural research to continue coming up with technologies that address climate change issues, revision of bye laws and ordinances to help communities efficiently adopt and implement the recommended climate change

adaptation measures. Among the practices considered most relevant are: 1) soil and water conservation, 2) organic farming practices that enhance soil biological processes to improve soil fertility and structure and also create soil organic matter in forms that are more effective at producing soil carbon, 3) restoration of forests by having integrated watershed management to enhance resilience of watershed vegetation and forests; that will also reduce vulnerability to storm and landslides, 4) preservation and promotion of indigenous species, 5) scaling up all the activities of the pest and disease control program, and 6) enhanced action to reduce crop losses, that are often climate-induced, from the current 50% to 10%.

In the health sector, it was noted that several events in Uganda have clearly demonstrated the magnitude of the impacts of adverse effects of climate change on the Ugandan population and economy in general over the last decade. Uganda experienced an increase in the frequency and intensity of extreme weather events with serious consequences on the health sector. The health impacts identified in Uganda include: outbreaks of water-borne diseases (e.g. cholera, Hepatitis E, dysentery) and vector-borne diseases (e.g. malaria), injuries, loss of lives, and loss of livestock, food insecurity and malnutrition. Climate-sensitive diseases and other illnesses that have greatly been influenced by climate variability and change in Uganda were noted as malaria, schsistosomiasis, hepatitis E, cholera and other diarrhoeal diseases. These challenges are projected to increase due to climate change. Due to global warming, the Relative Malaria Incidence (RMI), for example, is projected to increase gradually from the 2020s to 2070s and double by 2090s across the three major sub-climatic zones of Uganda; with the Western and Northern regions experiencing the highest and lowest RMI, respectively, if nothing is done to adapt to climate change.

In response, Uganda's Ministry of Health has made efforts to mainstream climate change considerations in her policies, plans and programmes. However, there are still health sector challenges/constraints to be addressed, for example: 1) fully mainstreaming climate change in the health sector polices, plans, programmes and activities; 2) raising the capacities of key sectors including the health sector to quickly adapt to climate change and its negative impacts to delivery of services; 3) Raising sufficient health sector financing and technical capacity (human resources, health infrastructure, medical equipment and supplies); and 4) strengthening institutional coordination mechanisms (inter and intra ministerial, public private partnership). To further make the sector resilient to the impacts of climate change, the following adaptation measures have been recommended.

- Mainstreaming climate change into the Health Sector policies, plans and programmes and the Ministry of Health activities in general to cover the following aspects; Environmental health; Water and Sanitation; Control of diseases vectors and pests; and Control of communicable diseases. There is also need for Uganda to 1) Implement the Uganda National Minimum Health Care Package in the HSSP II; 2) Strengthen health multi–sectoral linkages directed at harnessing the contribution of health related sectors (environment, water, meteorology etc.) and communities; 3) Maintain on-going surveillance in the affected districts and those prone to impacts from adverse weather patterns to ensure early detection of epidemics; 4) Scale – up

health education and promotion for the affected communities; 5) Maintain on-going surveillance in the affected districts and those prone to impacts from adverse weather patterns; 6) Promote other disease preventive interventions like improving latrine coverage, access to safe water, provision of insecticide treated mosquito nets.

- Implementation of resolutions of the 61st and 62nd World Health Assembly (WHA) and the World Health Organization (WHO) through; 1) Scaling - up sensitization on climate change at all levels including the health sector; 2) Strengthen institutional linkages internationally and locally; 3) Build capacity at all levels to tackle climate change; 4) Developing and popularizing decision support tools like the malaria early warning system; 5) Providing budget support for climate change activities; 6) Promoting integration of climate change in the development of sector investment plans; 7) Strengthen support to climate –change related programmes (Water & Sanitation, Vector & pest Control, Control of Communicable diseases); and 8) Supporting the strategy of epidemic preparedness and response.

A cost benefit analysis recommends the need for resources, both financial and human, to facilitate a comprehensive mainstreaming of climate change in all the health projects, programs and activities. This will involve review of existing policies and structures.

The water sector in Uganda, which includes water resources management and the provision of water, was found central in adapting to climate change through strategies that would keep all sectors of the economy productive and function effectively, and to minimise the losses and negative impacts from floods and droughts. Wetland management in Uganda was found faced with challenges due to population increase. This has led to reclaiming and encroaching on wetlands to create more farm land in rural areas and land for construction of residential houses in urban areas. Also, as a result of lowering of water tables, a number of wetlands dried-up easing change in land use to cultivation and settlements. A number of adaptation measures included in the agriculture sector could lead to adaptation in the water sector.

Es 4: Measures to mitigation climate change

Uganda's mitigation options and measures in response to climate change in line with the objectives and provisions of the UNFCCC were assessed by the task force composed of experts who also compiled the national greenhouse inventory. The assessment was based on assumptions of GHG emissions projections from 2005 to 2035 following two scenarios: a business-as-usual scenario and a mitigation scenario based on specific actions in the key sectors of energy and transport, agriculture, LULUCF and waste.

The business-as-usual scenario in the energy and transport sector showed that the transport sub-category will be the largest and fastest growing contributor of GHG emissions followed by residential, and manufacturing and construction sub categories. Mitigation options recommendations considered two sides - the supply side and end-use side and include: 1) Use of cleaner technologies; 2) Increasing use of hydropower ; 3) Wider use of solar energy; 4)

Increased co-generation from sugar cane factories; 5) Use of agriculture residues in some industries ; and 6) Exploitation of geothermal potential.

Any mitigation actions in the agricultural sector in Uganda would need to be directed at nitrous oxide (N_2O) and methane (CH_4) sources. The mitigation measures and recommendations include: 1) Improving efficiency of domestic livestock; 2) Livestock manure management practices that minimize escape of N_2O and CH_4 into the atmosphere; and 3) Proper cropland use that enhances productivity while minimizing GHG emissions, such as minimum tillage, efficient use of fertilizers and manure.

In the LULUCF sector, the mitigation analysis showed that crop land is increasing at the expense of the decreasing area under forest. Also, that about 30 percent of central Uganda is burnt during the dry months of December to February. The following are some of the mitigation recommendations: 1) Build a Forestry Monitoring Information System (FMIS); 2) Support NFA to continue maintenance of the Geographical Information and the associated forestry inventory data; and 3) Support Forestry Sector Supervision Division to operationalize forest produce tracking.

In the waste sector, it was noted that the level of waste composting is expected to increase to between 10% and 15% as composting is taken up by more municipalities. Projections are that between 5% and 10% could be realised as annual increment in composting. This will cause a reduction in GHG emissions from landfills. Estimates of reduction of GHG emission from composting would be 2005 - 25%; 2015 - 57%; 2025 - 69%; 2035-78%. Sustained composting would, with time, reduce on solid waste disposal by about 90-95%.

The SNC highlights Uganda's efforts to develop and promote relevant strategies to mitigate climate change are demonstrated within the recently approved Uganda National Climate Change Policy (UNCCP). The country has made efforts to facilitate the implementation of several CDM projects under the Kyoto Protocol. Low emissions related capacity building initiatives under the UNDP Low Emission Capacity Building Programme have also enhanced activity in this area. Uganda will need enhanced facilitation to implement mitigation projects in the areas of forestry, LULUCF, reduced emissions from deforestation and forest degradation+ (REDD+), wetlands, agriculture, energy generation and utilization, transport, waste management and industry.

Es 5: Constraints, gaps and related financial, technical and capacity building needs

The SNC presents several constraints, gaps and related financial, technical and capacity building needs that Uganda experiences as it seeks to enhance the national adaptation measures and contribute to international mitigation action on climate change.

The high population growth, increased rural-urban migration, decline in water resources and reliance on the rain-fed agriculture as well as the high cost of electricity and other energy

sources are major concerns. There are several constraints arising out of use of traditional practices such as bush burning, failure to abandon subsistence farming, relying on speculation about weather and rainfall patterns instead of relying on scientific facts, and gender insensitivity.

Uganda has specific gaps related to lack of local databases for emission factors, limited availability of activity data, poor climate database development as well as management, processing and archiving of information. There is also a severe shortage of technical expertise in climate change modeling and research.

Technologies, capacity building and finance are the most important needs for addressing the constraints and gaps mentioned above. Development of appropriate technologies, promotion of renewable energies and energy efficiency, research into sustainable agricultural practices, improvement of national policies and legislation, climate change education, training and public awareness, setting up of Public Private Partnerships (PPPs) and gender mainstreaming are additional national needs.

Es 6: Other relevant information for reaching convention objectives

Uganda has undertaken several initiatives to address climate change at the national level. These include: establishment of a climate change legal framework, taking steps to integrate climate change into policies programs and development planning through the National Development Plan and production of mainstreaming guidelines, implementing projects in adaptation and mitigation, research and systematic observation, education, training, public awareness and institutional strengthening. Additional areas include: promotion of public monitoring and evaluation framework for climate change activities in Uganda has also been incorporated in the climate policy.

The climate change legal framework is being developed and there is still need to integrate climate change into several policies. Several government ministries, departments and agencies are yet to integrate climate change into their programs. Adaptation and mitigation strategies need to be implemented including the crosscutting issues such as gender inequalities and child welfare as special concerns of vulnerable groups.

Under research and systematic observations, the meteorological services in Uganda are faced with high demand for historic and real time quality data, information, services and products. As part of an appraisal of the available data for analysis/research, weather and climate products and services, the Planned Optimum Climate Observation Network (OCMN) and the necessary Hydro-Climatic Observation Network Development is being carried out with a view to strengthen the research and systematic observational network in the country.

Uganda has been undertaking a number of activities related to climate change education, training and public awareness in order to promote climate change adaptation and mitigation

actions, at national and sub-national levels. This has been through both formal and informal channels but the need to scale up was noted.

With the recently approved National Climate Change Policy and Implementation Strategy, Uganda's response to climate change at the local, regional and international levels is expected to become more effective and efficient, given adequate support.

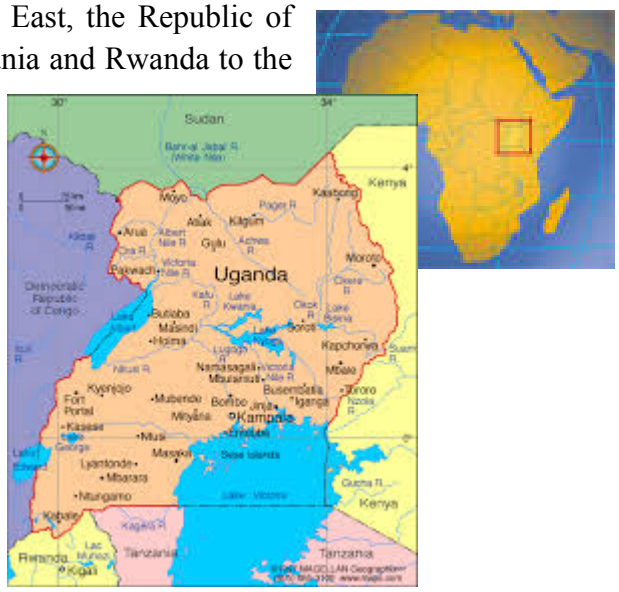
Chapter 1 : NATIONAL CIRCUMSTANCES

1.1 Introduction

In line with the United Nations Framework Convention on Climate Change (UNFCCC) guidelines for preparation of National Communication from non-Annex I Parties, contained in decision 17/Cp.8, paragraph 3, this chapter on the National Circumstances provides information on Uganda which may affect its ability to deal with the mitigation and adaptation challenges to climate change. The chapter gives a short description of Uganda including geographical characteristics, climate, forests, land use, biodiversity and wetland resources, population, culture and history, governance and political systems. The chapter also describes the economy profile of Uganda including energy, transport, industry, mining, oil and gas, tourism, agriculture, fisheries, waste, health and the services sector.

1.2 Geographical characteristics

Uganda is a landlocked country in the eastern part of Africa and lies within the northern and southern hemisphere. It is surrounded by Kenya in the East, the Republic of South Sudan in the North, the United Republic of Tanzania and Rwanda to the South and the Democratic Republic of Congo to the West. The country has a total surface area of 241,550 km^2 of which 41,743 km^2 (17.2 %) is occupied by open water and swamps, and 199,807 km^2 is open land. Uganda's land area stands at an average height of 1,200 meters above sea level. The minimum altitude is within the Albert Nile at 620 meters above sea level while the maximum altitude is the peak of Mt. Rwenzori Peak which is at 5110 meters. The central part of the country is a plateau that is surrounded by four main mountain ranges; namely: Rwenzori in the west, Elgon in the East, Mufumbira in the Southwest and Moroto in the Northeast. Uganda.

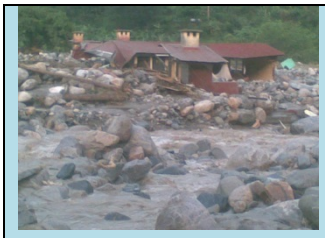


1.3 The climatic profile

Three quarters of Uganda is within the tropical belt. Thus Uganda's climate is largely tropical with two rainy seasons (bimodal) annually; namely: March – May and October – December. Only the northern part has a mainly single rainy season during March – mid-October. The southern part of the country receives between 600 and 2,200 mm of rainfall annually, while the

northern part receives between 400 and 1,600 mm of rainfall per annum. On the whole, the country receives an average of 1180 mm per year of rainfall averages.

Uganda experiences moderate temperatures throughout the year. The mean daily temperature is 28^{o}C; ranging between 4^{o}C in the south-western area of Kabale and 30^{o}C in northern and north-eastern areas of Gulu, Kitgum and Moroto. Temperatures below 0^{o}C are experienced on the mountain ranges of Rwenzori and Mount Elgon. The Rwenzori range has permanent ice caps which are however vulnerable to global warming. The surface area of the cap has reduced by 49 percent between 1987 and 2003, and is projected to disappear within the next two decades.



R. Nyamwamba flooded in 2014

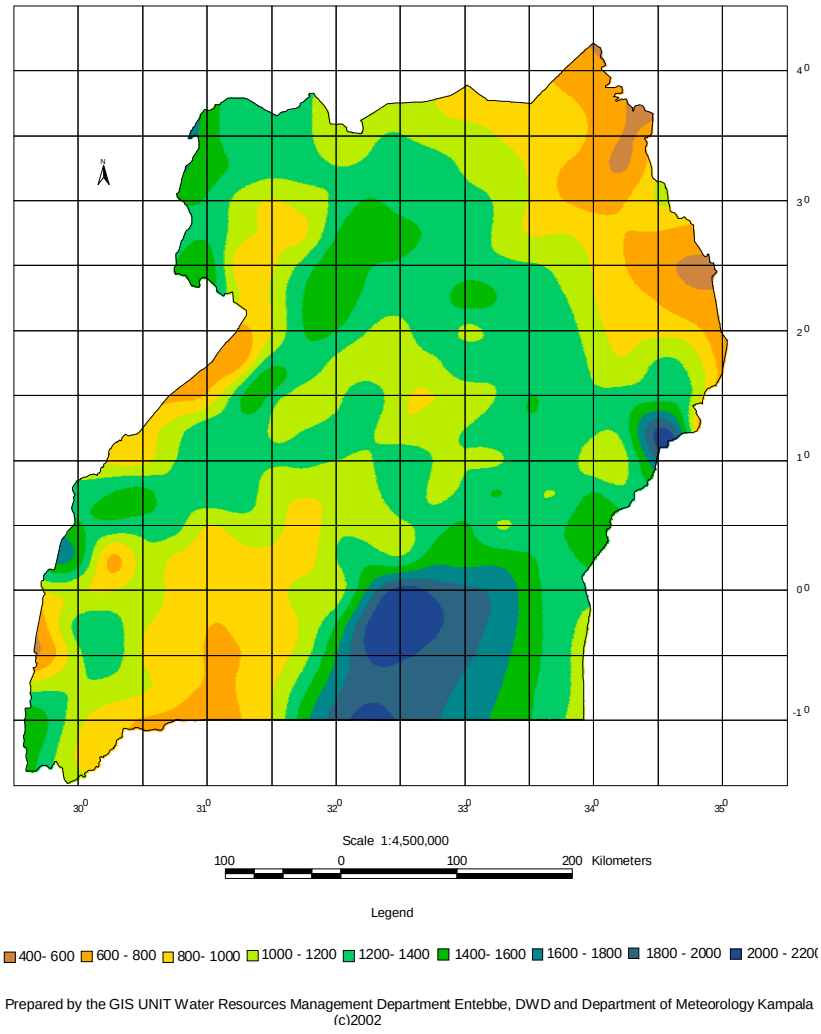
Mudslides in Bududa in 2010

While Uganda natural climatic is moderate as described above, the country has also been experiencing increased frequency and severity of extreme weather events. Uganda has in past decades experienced more erratic rainfalls leading to frequent busting of rivers, mudslides and landslides that lead to loss of lives and property of communities especially those living in the mountainous areas. At the same time those in low lands experience floods. Prolonged dry seasons are also frequent leading to loss of crops and livestock.

1.3.1 Mean annual rainfall (MAR) patterns

In order to track these events, Uganda's Meteorology Department has been collecting and analysing all the climate data when its capacity allows. The MAR map is the tool that the department uses to inform the country on the climatic profile of the country. Usually updated over long periods of time, the last MAR map was developed during a hydro-climatic study by the Meteorology Department and the Water Resources Department basing on data from over 200 weather stations during the period 1943 to 1982 (Map 1-1). The map displays regions of relatively low rainfall (400 to 1000mm) and high rainfall (1400mm and above). The relatively low rainfall areas are dominated by the so-called cattle corridor axis running from the Karamoja region to the Northeast through Ankole region to the Southwest. The other elongated area of low rainfall is along the Western rift valley running through Lake Albert. On the other hand, the main area of relatively high rainfall is over the Central and Western parts of the Lake Victoria basin and over Mountain Elgon region.

Map 1-1: Uganda's mean annual rainfall (MAR) (mm)



1.3.2 Seasonal Rainfall Percentage patterns

While the MAR map shows the long-term patterns, the three-monthly seasonal rainfall map is used to display the spatial and temporal seasonal migration of the dry and wet seasons across the country and within the year. The shift is found to broadly follow the overhead sun (Map 1-2) as follows:

- During the period ***December to February*** when the overhead sun is to the South and the Inter-tropical Convergence Zone (ITCZ) is over southern Africa, most of Uganda is dominated by the hot and dry season. During this period, north-to-northern easterly flow causes the driest conditions over most parts of the country with the northern region

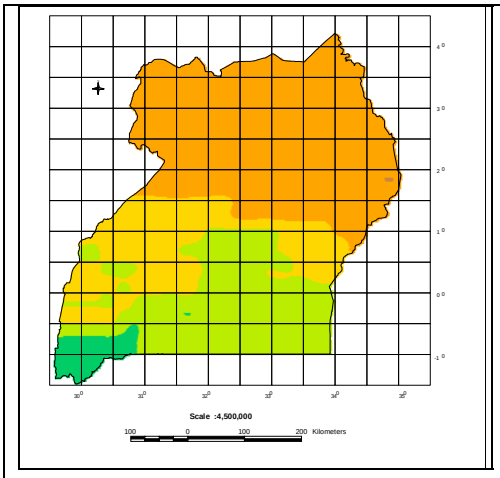
receiving (5 - 10%) and parts of central region (10 – 15%) of the annual rainfall amount. It is only the south-western region that receives moderate rainfall amount (20 – 25%).

- The period ***March to May*** is the main wet season over most parts of Uganda with the percentage levels highest over the South-eastern areas (40 – 45%) and lowest over the North-western areas (20 – 25%). During this period the zonal arm of the ITCZ is within the equatorial areas and the country is dominated by the moist south-easterly flow.
- During the season ***June to August***, the main wet season is centered over the northern parts of the country while the southern part experiences its secondary dry season. Over the northern region the highest percentages (40 – 45%) is recorded over the north-eastern parts of Karamoja while over the southern regions experiences the lowest percentages (5 – 15%) is reported. During this season the main zonal arm of the ITCZ is within the vicinity of the northern region.
- The season ***September to November*** is the secondary rainy season over most parts of the Western and central parts of the country with the main wet season centered over the western parts of the country and extending into the central areas (30 – 40%) while the areas with lowest percentages (15 – 20%) are recorded over the north-eastern parts of Karamoja. During this season, the main dominant synoptic feature is the meridional arm of the ITCZ, which is normally within the vicinity of the Western parts of the country super-imposed by the zonal arm which is within the vicinity of the equatorial areas.

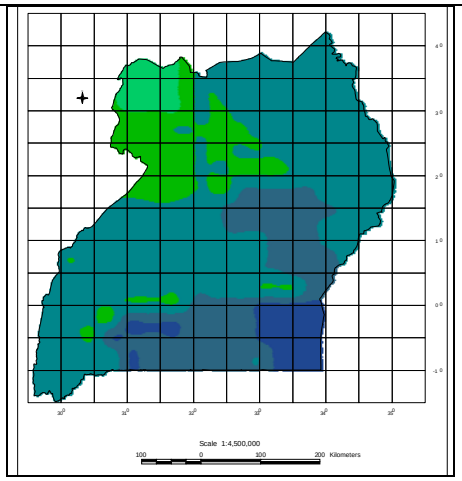
1.3.3 Climate as a resource

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. The good climate of Uganda is reflected in its natural varied beauty once described elegantly by the Prime Minister of the United Kingdom, Winston Church Hill, as the Pearl of Africa. This varied beauty is reflected in its natural resources such as soils, water resources, wildlife and biodiversity. Indeed, because of the generally conducive climatic profile, the country is well endowed with fresh water resources that provide livelihood to over 40% of her population in form of fishing, transport, hydroelectric power as well as tourism. However, the recent events of the last few years have clearly shown that Uganda's climate is changing and that it is threatening the natural resource base thus adversely affecting Uganda's social and economic development.

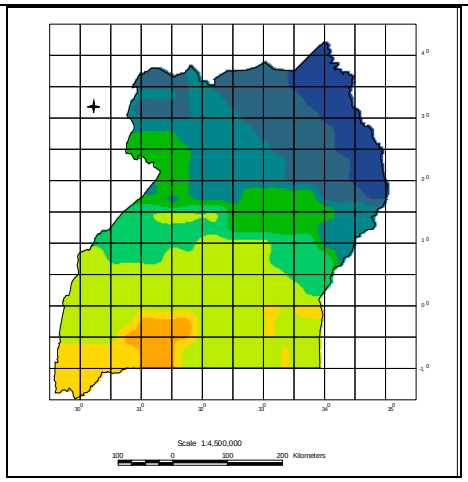
Map 1-2: Three monthly seasonal percent maps



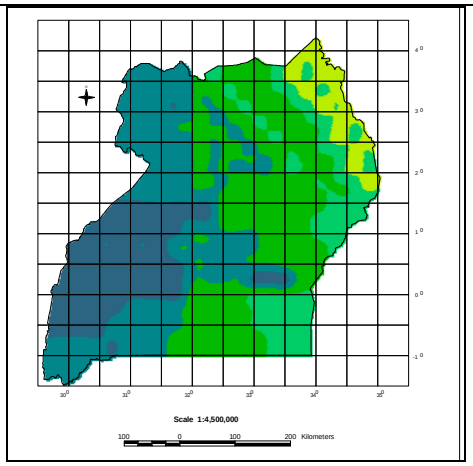
December to February



March to May



June to August



September to November

Legend

400- 600 600 - 800 800- 1000 1000 - 1200 1200- 1400 1400- 1600 1600 - 1800 1800 - 2000 2000 - 220(

Prepared by the GIS UNIT Water Resources Management Department Entebbe, DWD and Department of Meteorology Kampala (c)2002

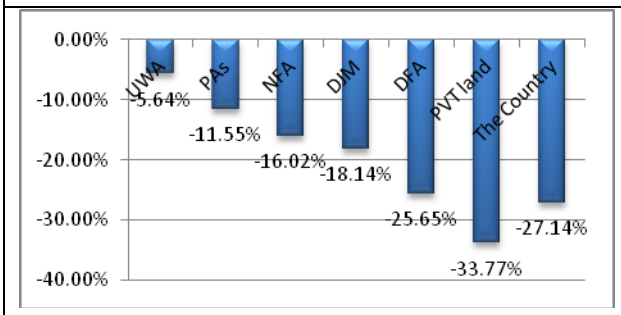
1.4 Natural Resources Profile

Natural resources constitute the primary source of livelihood for the majority of the people of Uganda. Its economy depends on exploitation of these natural resources and will remain so for the foreseeable future. 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, associated basic livelihood needs and environmental degradation.

1.4.1 Forestry resources

Forestry resources play a significant role in national development through their contribution to ecological balance, energy and industrial activities. Uganda's forestry sector has been making a fair share of the GDP. For example in the years 2007, 2008, 2009, 2010 and 2011, the sector contributed about 3.5 percent, 3.5 percent, 3.6 percent, 3.4 percent and 3.0 percent, respectively, to the GDP. Thus, to have a stable ecological system, Uganda needs to have a recommended national forest cover of 30 percent. Yet, Uganda's national forest cover has been reducing over years. Results from the National Biomass Study show that the area under forests in Uganda has seriously reduced between 1990 and 2005. It has fallen from 24% in 1990 to 21.3% in 2000 and 18.3% in 2005 (**Figure 1-1**). The majority of the districts of Uganda have lost either all the forest cover or more than 50 percent of the forest that existed at the start of the 1990s (Table 1.1). This decline, estimated at 1.8 percent per annum is largely attributed to increasing demand for agricultural land and fuel wood by the rapidly growing population. The most affected is the area of forest under private land.

Figure 1-1: Percentage change in the Uganda forest cover between 1990 and 2005



Key:
UWA – Uganda Wildlife Authority
PAs – protected Areas
NFA – National Forestry Authority
DJM – District under Joint Management
DFA – District Forest Areas
PVT Land – Private land

Source: National Biomass study 2009

Table 1-1: The loss of forest cover in some districts 1990 and 2005

District	1990(ha)	2005(ha)	Loss	% Loss
Kibaale	114,102.66	58,268.06	-55,834.60	48.9
Mukono	100,626.65	63,977.12	-36,649.53	36.4
Wakiso	28,461.12	3,781.68	-24,679.44	87.7
Hoima	75,143.95	58,889.27	-16,254.68	21.6
Mayuge	15,162.05		-15.162.05	100.0
Mubende	18,618.86	3,906.65	-14,712.22	79.0
Mpigi	40,300.64	27,169.67	-13,130.98	32.6
Mityana	10,247.86	4,137.66	-6,110.20	59.6
Masindi	36,373.82	31,933.49	-4,440.34	12.2

Source: State of Environment Report for Uganda 2008

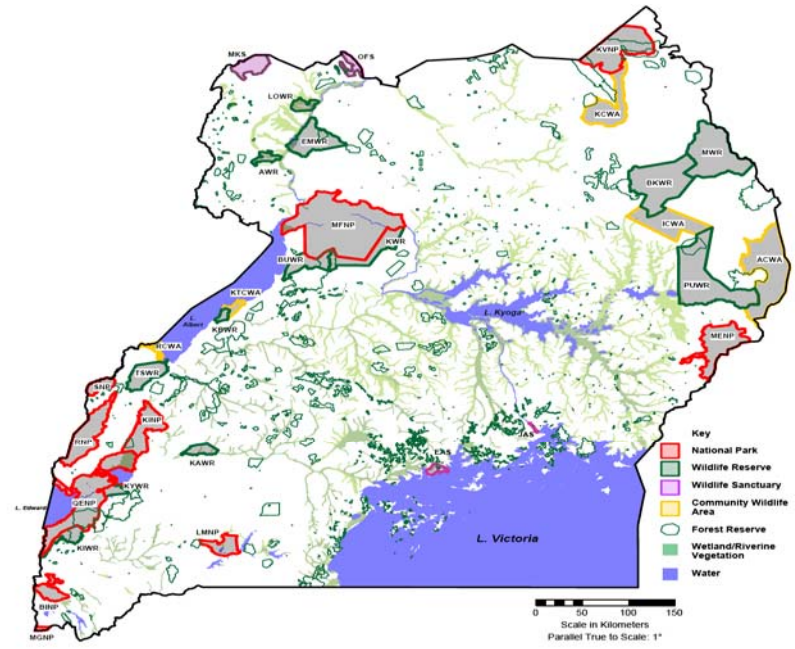
1.4.2 Biodiversity resources

Uganda's location in a zone between the ecological communities that are characteristic of the drier East African savannas and the more moist West African rain forests, combined with high altitude ranges, means the country has a high level of biological diversity. Most of the biodiversity is found in natural forests and other natural ecosystems such as mountains, savannahs, wetlands, lakes and rivers. Uganda has approximately 18,783 species of which 7.5 percent are mammals, 10.2 percent of birds, 6.8 percent butterflies and 4.6 percent dragonflies. These are globally recognized. Uganda's forests are particularly rich in biodiversity in terms of species and genetic potential. This is especially so for farmed or domesticated species. The natural forest have an estate estimated stocks of 1,259 species of trees and shrubs, 1,011 species of birds, 75 species of rodents (small mammals), 1,245 species of butterflies, 115 species of hawk moth (large moths) and 96 species of silk moths. To conserve this biodiversity, Uganda has gazetted specific areas; including 10 national parks, 12 wildlife reserves, 506 central forest reserves (1,173,753 ha), local forest reserves covering 4,957 ha. Uganda also boasts of 12 Ramsar Sites.

The protected areas have all been rationalized and regazetted under Section 17 of the Uganda Wildlife Act Cap 200 (See Map 1-3).

For the case of transboundary areas, Uganda has established collaborative arrangements for management of trans-boundary protected area systems. For example, a Memorandum between the 3 Protected Area Authorities in Uganda, Rwanda and DR Congo was signed in Goma in January 2004, detailing collaboration objectives of Transboundary Collaborative Management of the Central Albertine Rift (CAR). As result of this collaboration, a Strategic Plan for the transboundary protected areas and the entire CAR landscape developed as a framework to guide this collaboration over the next ten years.

Map 1-3: Wildlife Protected Areas



National Parks (10)	
1.BINP	Bwindi Impenetrable
2. KINP	Kibale
3.KVNP	Kidepo Valley
4.LMNP	Lake Mburo
5.MENP	Mount. Elgon
6.MFNP	Murchison Falls
7.QENP	Queen Elizabeth
8.RNP	Rwenzori Mountains
9.SNP	Semliki
10.MGN	Mgahing Gorilla

Wildlife Reserves (12)	
1.AWR	Ajais's
2.BKWR	Bokora Corridor
3.BUWR	Bugungu
4.EMWR	East Madi
5.KAWR	Katonga
6.KBWR	Kabwoya
7.KWR	Karuma
8.KIWR	Kigezi
9.KYWR	Kyambura
10.MWR	Matheniko
11.PUWR	Pian-Upe
12.TSWR	Toro –Semliki

Community Wildlife Areas (5)	
1.ACWA	Amudat
2.ICWA	Iriri
3.KCWA	Karenga
4.KTCWA	Kaiso-Tonya
5.RCWA	Rwengara

Wildlife Sanctuaries (10)	
1.EAS	Entebbe
2.JAS	Jinja
3.MKS	Mt. Kei
4.OFS	Otze Forest
Sanctuaries in QENP/Kyambura	
5. KHAS	Kahendero
6. KSAS	Kashaka
7. KYAS	Kayanja
8. KZAS	Kazinga
9. KIAS	Kisenyi
10. RWAS	Rwenshama

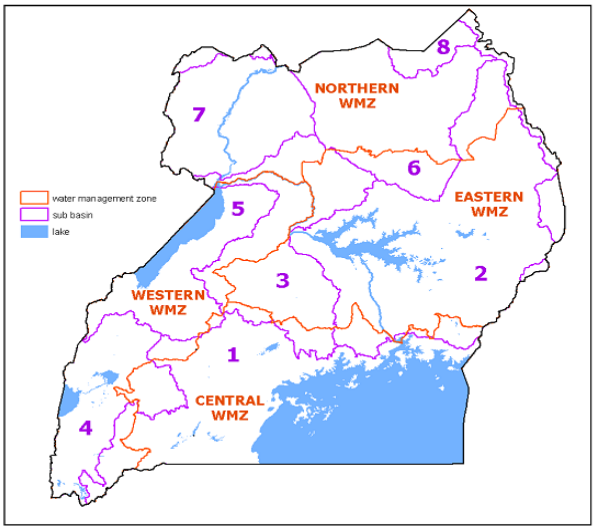
(Source MTWA, 2012)

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.

1.4.3 Water resources

Uganda is well endowed with water resources; both surface and ground water. The surface water resources are found in form of streams, rivers, lakes and wetlands divided into eight water catchment basins of various sizes. Uganda has been divided into eight sub-basins, which cover most of the country, excluding only minor parts on its eastern and north-western fringes (Map 1-3). Details of the information on these sub-basins are shown in Table 1-2. For the purposes of managing water resources, the country has been further divided into four Water Management Zones, (WMZ).

Map 1-4: The eight major drainage basins (purple) and four Water Management Zones (brown)



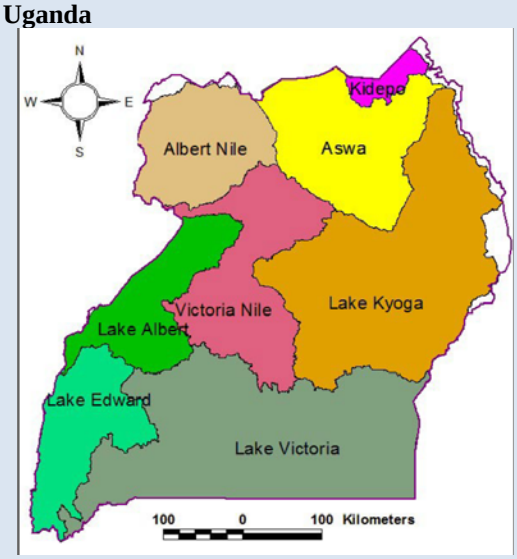
The Lake Victoria catchment is the largest with an area of 59,858 km^2 followed by Lake Kyoga (57,233km^2). Others are: Albert Nile, Kidepo, Aswa, Victoria Nile, Lake Albert and Lake Edward (Table 1.2).

Table 1-2: The eight water management sub-basins

Basin No.	Description	Area (km^2)
1	Catchments discharging into Lake Victoria, including the eastward-flowing component of the Katonga River, the Koki lakes, and Lake Wamala; it also includes the Ugandan part of Lake Victoria	59,858
2	The Lake Kyoga catchment, including the lake itself and the drainage area of the Victoria Nile downstream of Jinja	57,669
3	Catchments draining into the Kyoga Nile - downstream of Lake Kyoga, including the Kafu River, as well as smaller tributaries like the Tochi and Ayago Rivers on the northern bank	26,796
4	The area discharging into Lakes George and Edward , including the Ishasha and Birira Rivers, as well as the Mubuku and Mpanga on the south-eastern slopes of the Rwenzori mountains	18,624
5	Catchments downstream of Lake Edward draining into Lake Albert, which include the Semliki and Muzizi Rivers, and the west-ward flowing component of the Kafu	18,223
6	The Aswa basin, which discharges into the Bahr el Jebel immediately downstream of the South Sudan border	26,868
7	Catchments draining directly into the Albert Nile within the Uganda territory	20,004
8	The Kidepo basin draining into the Akabo–Pibor complex in South Sudan, which is part of the Nile basin	3,129

The country's biggest and largest lake (Lake Victoria) gets its recharge water mainly through precipitation (82%) with the balance coming from the two main seasons of rain water (March to May and September to December) that give it about 2,100 mm annually. However, the lake water level has shown a significant downward trend over the last 10 years. The long-term average lake level between 1900 and 2004 was 1,134.4m (amsl). In 2006, the lake had reached an 80-year low; thereby affecting the water levels for Lakes Kyoga and Albert since it is their main source of inflow through River Nile.

Map 1-5: The eight main drainage basins in Uganda



Source: NEMA State of Environment report 2010

Compared with Lake Victoria, Lake Kyoga is shallow. It has a surface area of 4,000 km^2 and acts as a source of livelihood for about 500,000 people who mainly live on the lake shores. Over the last 10 years, the Lake Kyoga levels have shown a significant downward trend as well with the current level being around the long-term average lake level. The last 10 year average was 1,033.4 amsl.

A substantial section of Uganda households utilize groundwater as their source of domestic water. The principal source of Uganda's groundwater (Table 1-3) is precipitation which depends on recharge and its associated mechanisms, especially climate. The three principal aquifer systems in Uganda are the fractured rock aquifer, Regolith aquifer and a combination of the Regolith-Fractured rock aquifer; the latter being the more commonly developed. Despite the on-going efforts to study ground water resources, this area remains largely unknown which complicates the ability to adequately plan and manage the resources. However, data from the groundwater monitoring wells in Pallisa, Soroti, Rakai and Rwonyo (Mbarara District) all indicate declining trends. This is mainly attributed to changes in land use, climate variability, land degradation, deforestation upstream, and poor watershed management.

Table 1-3: Sustainable available ground water by basin (WMRD 2011b)

Main River Basin	Area (km^2)	Land Area (km^2)	Average Sustainable groundwater (mm/yr)
Lake Victoria	61,886	32,924	24.7
Lake Albert	18,079	14,882	23.7
Victoria Nile	27,961	27,807	39.9
Lake Kyoga	57,236	53,899	36.1
Albert Nile	20,727	20,484	24.4
Aswa	27,637	27,635	17.3
Kidepo	3,229	3,228	6.3
Miscellaneous	5,716	5,679	15

Another major source or sink for Uganda's water resources are classified as wetlands. Wetlands provide a large array of ecosystem services to Ugandans in urban and rural areas. They are used for farming, fishing, and livestock grazing. They supply families with basic needs such as water, construction material, and fuel. In addition to these local uses, the system of interconnected wetlands plays a crucial role at a regional level by filtering pollutants and regulating water flows (influencing groundwater recharge, flood impacts, and water availability during the dry season). Of a total population of 28 million Ugandans, it is estimated that wetlands provide about 320,000 workers with direct employment and provide subsistence employment for over 2.4 million.

Uganda's wetlands also provide important ecological benefits that reach beyond the region. They are the home of globally endangered species including birds such as the Shoebill (Balaeniceps rex) and Fox's weaver (Ploceus spekeoides), and fish species of the Cichlidae family. Many wetlands are an important stopover for large congregations of migratory water birds. Wetlands

can act as a reservoir to store carbon dioxide, mitigating climate change impacts. National and international visitors seek out wetlands as tourist attractions and educational opportunities to learn about their unique animals and plants

The wetland coverage on the surface area of Uganda was 15.6% in 1994 and in 2008 it was 10.9% indicating a loss of 4.7%. In terms of wetland coverage as an ecosystem, what has been lost is about 30%. The changes have been attributed to massive wetlands degradation for rice cultivation and dairy farming with occasional conversion for human settlement (Table 1.5).

Table 1-4: Sustainable available ground water by basin (WMRD 2011b)

	Total areas (Sq Km)	**% Surface Area of Uganda**	**% Area of wetlands**
1994	**37575.4**	**15.6**	
2008	**26307.7**	**10.9**	
Loss	11267.7	4.7	30.0

The wetlands in Uganda are formed mainly along river systems and lakes. It is therefore difficult to separate wetlands and the drainage systems of Uganda because they are highly associated. Changes in the drainage basin and therefore reflected in the wetlands as well. For example, when the data set for 1994 as well as that of 2008 was split into drainage basins and compared, the results shown in 5 were obtained.

Table 1-5: Changes in the drainage basin area between 1994 and 2008

Drainage Basin	1994 Area (Sq. Km)	2008 Area (Sq. Km)	Loss/gain (Sq Km)	% Loss/ Gain
Albert Nile	1736.3	1255.2	-481.1	-27.7
Aswa	3028.0	2168.9	-859.1	-28.4
Kidepo-	168.1	197.2	+29.1	17.3
Lake Albert	2838.6	2421.7	-416.9	-14.7
Lake Edward	1671.1	1096.3	-574.8	-34.4
Lake Kyoga	15008.3	11028.5	-3979.8	-26.5
Lake Victoria	7167.6	3310.2	-3857.4	-53.8
Victoria Nile	5728.3	4829.4	-957.0	-16.5

The results show that the drainage basin which has been highly changed is that of Lake Victoria; with about 54% loss. This is probably because Lake Victoria has most of the fish landings which are centres of growth that attract people who end up degrading wetlands. In addition, the growth in the number of flower farms has also been mainly along the shores of Lake Victoria; especially in Mukono, Wakiso and Kampala districts. Since, the catchment of Lake Victoria also includes

wetlands from Bushenyi through Mbarara, Ntungamo, Lyantonde, Rakai and Isingiro, the development of the dairy cattle keeping in the wetlands along the catchment of river Rwizi-Rufuha, has also led to the large loss of wetlands in the Lake Victoria catchment.

In summary, Uganda's natural water resources are experiencing both natural and man-induced variability as well as the impact of climate change uncertainties. The high population growth rate is particularly threatening both the quality and quantity of surface and ground water resources which subsequently threatens the health and wellbeing of people, their livelihoods and the economy.

1.4.4 Land as a resource

Land is one of the most critical resources of Uganda and is utilized in a wide variety of ways. Most of Uganda's land is under cultivation (60.7% or 99,018.4 km^2), while 31.4% or 51,152.7 km^2 is grassland. Bushland takes up 7.3 percent of the total land which is about 11,893.6 km^2. The rest of the land is either estimated as building area (0.22%), commercial farmland (0.42%) or impediments (0.02%). In general, about 80 per cent of the country's total land area is arable. The conservation activities cover 45,222 km^2 (18.7%) total land area. The proportion of land covered by forests was estimated as 18.3% in 2005 down from 21.3% in 1990 mainly as a result of human activities.

The southern parts of Uganda mainly cultivate perennial crops that include coffee and green bananas, while livestock farming is practiced in the drier areas of northern and western Uganda's cattle corridors. Generally, Uganda has about 3 million smallholder subsistence farmers owning on average 2.5 ha of farmland.

Only 71,000 km^2 of land in Uganda is under commercial farming, settlements and conservation as wildlife and forest conservation estates. The conservation activities cover 45,222 km^2 (18.7%) total land area. The proportion of land covered by forests was estimated as 18.3% in 2005 down from 21.3% in 1990 mainly as a result of human activities.

1.4.5 Natural resource degradation

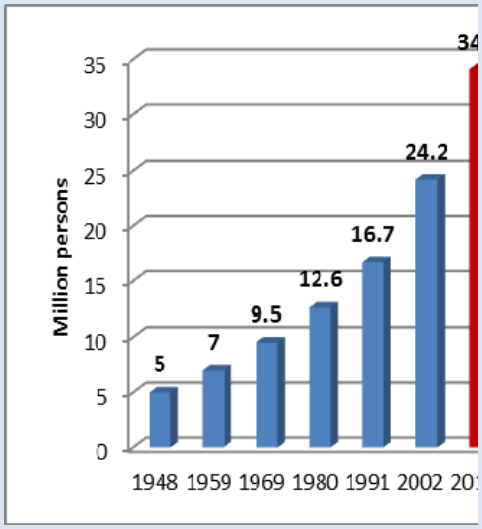
Uganda is experiencing natural resource degradation which is a direct threat to sustainable development. It is estimated that up to 97% of Uganda's land area suffers from some form of human induced land degradation. Such problems include soil erosion and declining soil fertility, deforestation, pollution 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. The absolute cost of land degradation was conservatively estimated at US$ 129.3 million per year in 2010.

1.5 Population Profile

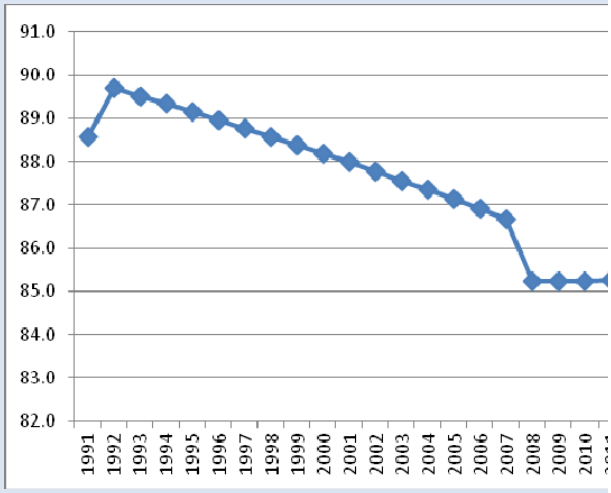
Uganda's population has had a steady increase from 5 million people in 1948 to 24.2 in 2002 and an estimated 34.1 million people in 2012 (Figure 1-2). Between 1991 and 2002, the population increased at a very high rate (3.2 %) which is above the Sub-Saharan Africa average of 2.6 %. The high population growth rate has also resulted into increased population density from 85 in 1990 to 126 people per square kilometre in 2002. The population is also slightly female dominated (51%) with sex ratio of 96 males per 100 females. Uganda's population is also increasingly becoming younger (under-18 year old children increased from 51.6 percent in 1969 to 56.1 percent in 2002).

Figure 1-2: Trend of Uganda's Population1948 to 2012



Source UBOS 2012

Figure 1-3: Trend in the proportion of rural population 1991 to 2012



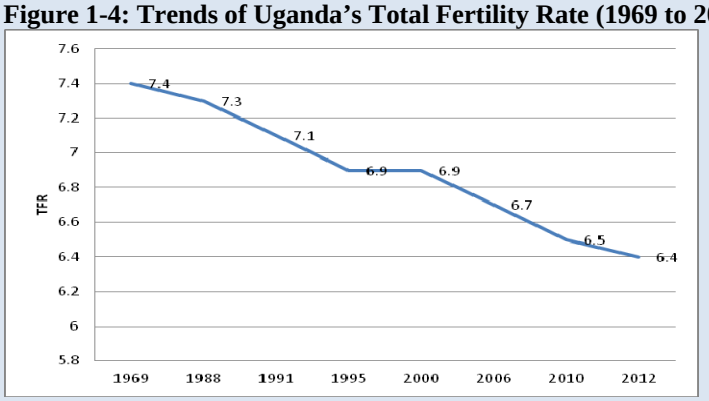
Source UBOS Statistical abstracts 1996 to 2012

Uganda is rapidly urbanising. The urban population in Uganda has increased rapidly from less than 0.8 million persons in 1980 to about 5.0 million persons in 2012, signifying a reduction in the proportion of rural population from 90 percent in 1992 to 85 percent in 2012 (Figure 1-3). This increase is mainly attributed to the creation of new urban administrative units, natural

growth, and rural-urban migration as well as declining agriculture productivity which has continued to discourage rural settlements.

Though Uganda has experienced a decline in Total Fertility Rate (TFR) from 6.9 in 1995 to 6.7 in 2006 and subsequently 6.2 in 2012 (Figure 1-4), it still remains highest in the world. Uganda seems unable to curtail the prevailing high population growth rate.

Figure 1-4: Trends of Uganda's Total Fertility Rate (1969 to 2012)



Source: PRB, 2012 and Tumwine (2012)

1.6 Health Services

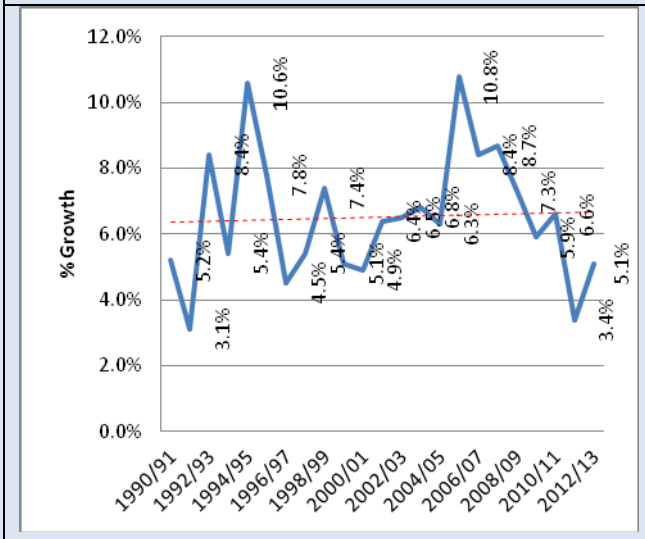
Uganda's health sector is made up of the public and the private sectors. The public health sector delivery system comprises of the regional and referral hospitals, the health centre IV, health centre III at the sub county levels, Health centre II at Parish and Community Health Volunteers/Workers at the villages.

The prevailing burden of diseases in Uganda is still heavy and the quality of public health service delivery generally poor; a reflection of enduring lack of resources (especially skilled manpower, scarcity of essential medicines, obsolete medical equipment). Uganda currently has a high burden of climate sensitive diseases such as malaria, cholera and dysentery. Malaria transmission is high in 88 percent of the regions of Uganda where 63 percent of the population is exposed to high malaria transmission, 25 percent are exposed to moderate transmission, and 12 percent live in areas with low or unstable transmission. Malaria continues to be the number one killer disease in Uganda today and accounts for 30%-50% of all outpatients' visits at health facilities; 35% of hospital admissions; and 15% of in-patients deaths.

1.7 Economic development

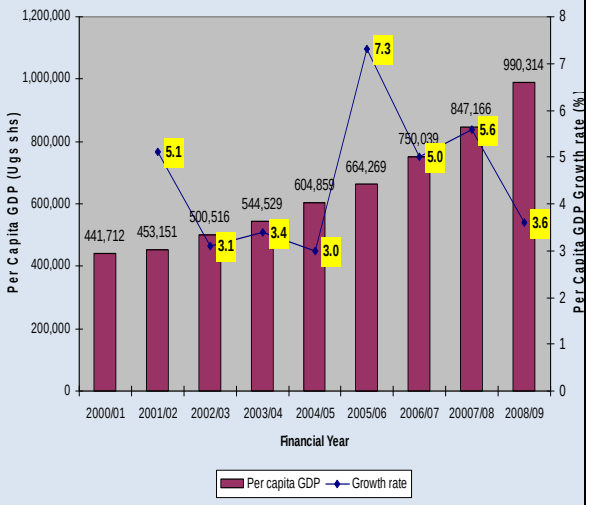
Uganda's economic growth has been evidently impressive. It has recovered steadily from the recession/decline experienced in the 1970's and 1980's. In the last 23 years, Uganda's real GDP has grown at an average of 6.52 per cent. The country's highest growth rate occurred in 1994/95 and 2005/06 while the lowest growth rates were in 1991/92 and 2011/12 (**Figure 1-5**). Uganda's per-capita GDP has grown from Ug. Shs. 322,859 (about 129 US$) in 1997 to Ug. Shs. 1,384,566 (about 553 US$) in 2011; signifying a growth rate of 10.4 per cent over that period (Figure 1-6). Simultaneously, Uganda's economy has undergone major structural changes.

Figure 1-5: Trend in GDP growth rate, 1990-2013



Source: UBOS Statistical Abstracts (1993 through 2013)

Figure 1-6: Per Capita GDP at Market price, 1997-2011



Source: UBOS Statistical Abstracts (2002 through 2013)

1.8 Crop and livestock agriculture

Agriculture is a core sector of Uganda's economy. Indeed, Uganda is heavily an agricultural

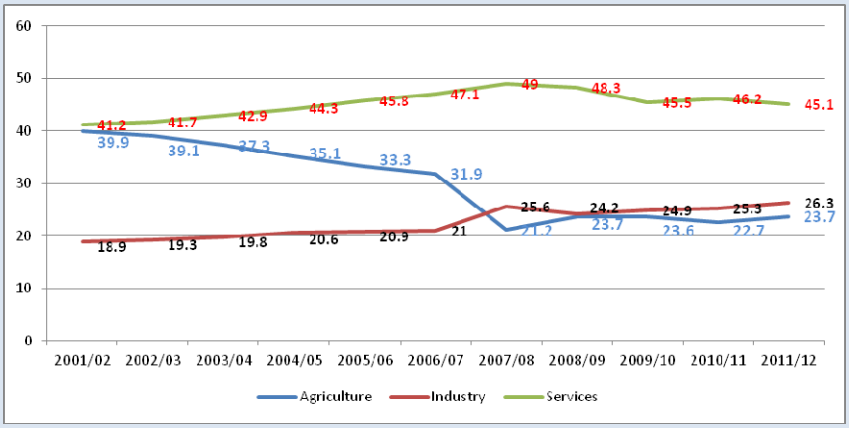
country in a number of perspectives. First, in the terms of the proportion of work force engaged in the sector which stands as 73%. Secondly, in terms the environmental conditions, Uganda is gifted with fertile soils, regular rainfall and biodiversity. Agriculture thus provides a substantial contribution to the GDP, employment, export trade, food security and household incomes and hence eradication of extreme poverty. National figures show that agriculture contributed up to 90 percent of the total export in 2010. However, the sector is characterized by small land holdings with a few isolated commercial holdings. It is estimated that out of about 31 million Ugandans, 85% live in rural areas of which 73.3 percent are engaged in subsistence agriculture.

Despite the sector's importance, it has experienced a rapid declining growth rate from 3.8 percent per annum in 2003/4 to 1.5 percent in 2004/5. It further declined to 0.4 percent in 2005/06. In 2011/12, the sector grew at annual rate of 3 percent. The observed declining sectoral growth rate has contributed to the decline in the sector's contribution to GDP which declined from 39.9 percent in 2001/02 to 21.2 percent in 2007/08 and 23.7 percent in 2011/2012 (Figure 1-7). In general, Uganda's agricultural annual growth rate is below the national objective of 5.6 percent that is specified in the National Development Plan. It is also below the target of 6 percent

agreed in the African Union's Comprehensive Africa Agricultural Development Program (CAADP).

Uganda's agriculture is dominated by food crop cultivation. The food crops sub-sector accounts for over 50%. Other than cocoa, the industrial crops[1] have not been expanding. The food crops sub-sector grew by only 1% in fiscal year 2011/12. The main reasons are inadequate productivity improvements, adverse weather conditions[2], crop diseases, and inability of the small scale farmers to respond to climatic challenge effects. Most of these are as a result of Uganda's agriculture sector being predominantly rain fed with limited or no back stoppers to help mitigate the effects of climatic changes. The sector has had to bare the blunt effects of prolonged drought, delayed rains and floods that have been experienced in most parts of the country.

Figure 1-7: Trend in Sector contributions to the GDP at market Prices (2001-2012)



Source: UBOS Statistical Abstracts 2002 to 2012

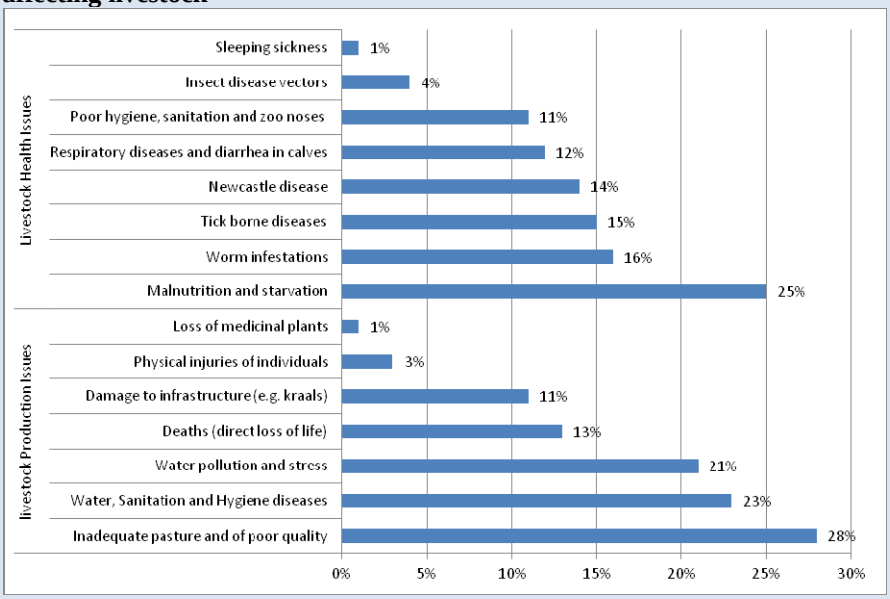
Substantial livestock agriculture takes place in Uganda; in many communities side by side with crop agriculture. Livestock keeping has been an agricultural activity in Uganda from historic times. The common livestock kept in Uganda include cattle, sheep, goats, pigs, and poultry with a few donkeys and camels. Due to population increase, urbanisation and economic growth, it is projected substantial increase in livestock agriculture will be needed. To meet the demand for meat and milk for Uganda's growing population over the next 30 years, the country requires a cattle population of 10.4, 13.9, 18.7, 27.4 and 40.2 million during the years 2010, 2015, 2020, 2025 and 2030, respectively. This is a major national challenge amidst the problem of climate change.

[1]These include coffee, tea, cotton, tobacco, sugarcane, cocoa, wheat, oil palm, sorghum, barley and oil seeds

[2] Estimated that in 2004/05 between 10% and 19% of the crop was damaged by crop diseases and rainfall shortage respectively

Livestock productivity is very low and is adversely affected by climate and annual weather patterns. The various factors associated with climate change include extreme drought and floods that lead to death of animals due to severe reduction in quantity and quality of pastures, drinking water, increased disease and vector prevalence. Indeed, water and pasture account for 72 percent of livestock production challenges (droughts) while malnutrition and worm infection account for about 41 percent of livestock health problems. Other diseases like Tick borne and Newcastle represent 29% (Figure 1-8).

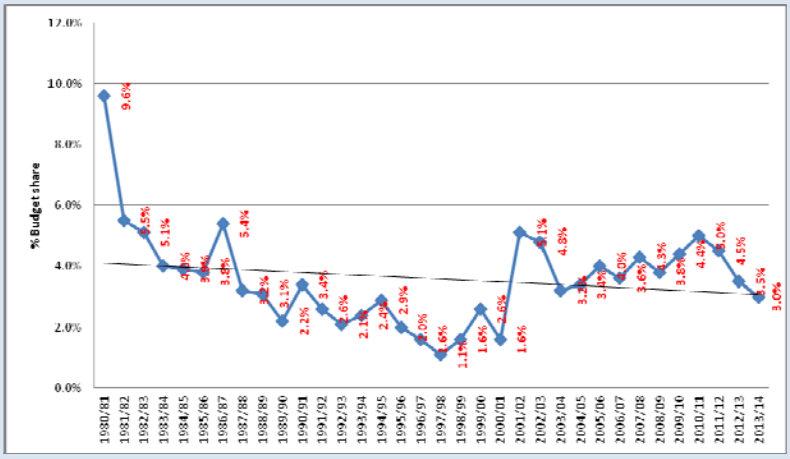
Figure 1-8: Percentage ranking of major production and health challenges affecting livestock



Source: NAPA 2005

In summary, the contribution that agriculture plays in poverty reduction and overall economic growth in Uganda is immense. However, the national budget expenditure on the sector remains too low to meet the country's requirements; leave alone commitments. 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. In Uganda, public funding to the sector has instead declined over the last 34 years by 69 percent (9.6 to 3.0 %) as shown in Figure 1-9. The budget allocation to the agriculture sector in the FY 2010/11 was only 5 percent; it was 4.5 percent in FY2011/12 and 3 percent in 2013/14.

Figure 1-9: Share of Agriculture in the GoU funded budget between 1980 and 2013



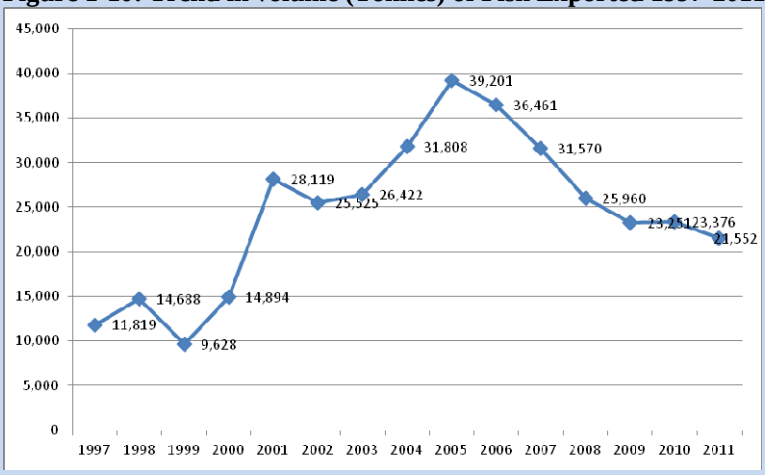
Source: Ministry of Finance (Background to the budgets)

1.9 Fisheries

Fisheries resources are among the most significant natural endowments of Uganda as Uganda's expansive water resources support a large and varied fish population. Fishing is thus one of the most important sub-sectors in Uganda's agricultural sector; giving about 700,000 -1.2 million people a source of livelihood. The sub-sector employed about 6 percent and 8 percent of the total labour force in 2009 and 2010, respectively. Fish export is also the second largest export earner for Uganda and has experienced substantial growth. 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 (Figure 1-10) when the country earned about USD 143 million. In 2006, Uganda's total informal fish export to South Sudan, DRC, Rwanda and Kenya totalled to about USD 33 million (about 14% of all total fish exports).

Uganda's fisheries resources are diverse in both aquatic ecosystems and fish species biodiversity. The Ugandan fisheries industry is largely artisanal, based on inland capture fisheries from lakes; Victoria, Kyoga, Albert Edward, George and Kazinga Channel, rivers, swamps and flood plains all of which are critical habitats, breeding and nursery grounds for fish covering about 18% (42 000 km^2) of Uganda's total surface area (Map 1-6). There are also over 160 minor lakes occurring in eastern and western Uganda with unknown fish production but with big potential for aquaculture development.

Figure 1-10: Trend in volume (Tonnes) of Fish Exported 1997-2011



Source: UBOS Statistical abstracts 2002 through 2012

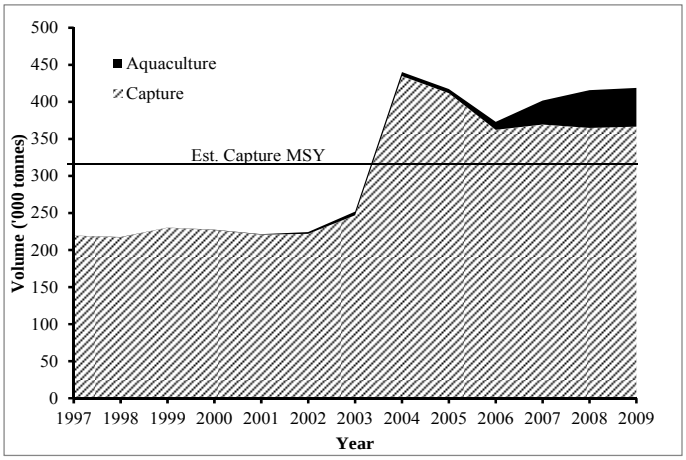
Fish farming is being promoted to cover fish production shortfall left by capture fisheries. Currently there are about 2000 fish farms owned by both commercial and subsistence farmers covering about 5,650 km^2 producing approximately 100,000 metric tons per annum (Figure 1-11).

Fish production from the natural water bodies is currently the main stay of the fisheries industry in Uganda with Lake Victoria supplying some 50% of the total national fish catch. However, other large lakes, including George, Edward, Albert, and Kyoga, along with the River Nile, swamps and streams, also contribute substantially to the annual national fish catches. Total fish production potential in Uganda stands at about 560,000 metric tonnes with about 82% (460,000 MT) contribution from the five water bodies/several small lakes and 18 % (100,000 MT) from culture fisheries. However, production has averaged at about 220,000 tonnes per year after peaking at 276,000 tonnes in 1993.

Total annual fish production is currently lower than the Maximum Sustainable Yield (MSY) estimated at 330,000 tons. Although this gives an impression that the fisheries are being harvested sustainably this is contrary to what is actually happening. Increasing fishing effort is exerting high fishing pressure on capture fisheries thereby fish scarcity and prompting use of destructive fishing gears and technologies. This has led to increased investment and costs in fishing operations in order to chase and catch scarce fish.

Map 1-6: Major capture fisheries resources

Figure 1-11: Trends in total volumes of capture fisheries and aquaculture



Source: UBOS 2010; FAO-Fishstat 2009

Table 1-6: Contribution of the fisheries sector in Uganda

1	Exports:	**Fish exports continue to grow and contributed US$137 million to Uganda In 2006 fish was the second highest foreign exchange earner commodity.**
2	**Employment:**	About 1,000,000 – 1,500,000 people are directly or indirectly employed in fisheries related activities about 5,000 people are working with industrial fish processing plants.
3	**Income:**	More than 1.2 million people are directly dependent on the fisheries sector as the main source of household income and livelihood.
4	**Food Security**	Fish is a major source of critically required animal protein diet for about 34.5 million Ugandans where the average per capita fish consumption is about 10 Kg per year which is below the recommended WHO level of 12.5 Kg per capita). Besides fish have a highly desirable nutrient profile and provide an excellent source of high-quality animal protein that is easily digestible and of high biological value.
5	**GDP contribution**	Fisheries sub-sector contributes 2.5% of the national GDP and 12% of the agricultural GDP.
6	**Tourism:**	Fisheries is tourist attraction and sport fishing is one of the activities enjoyed by tourists

1.10 Tourism

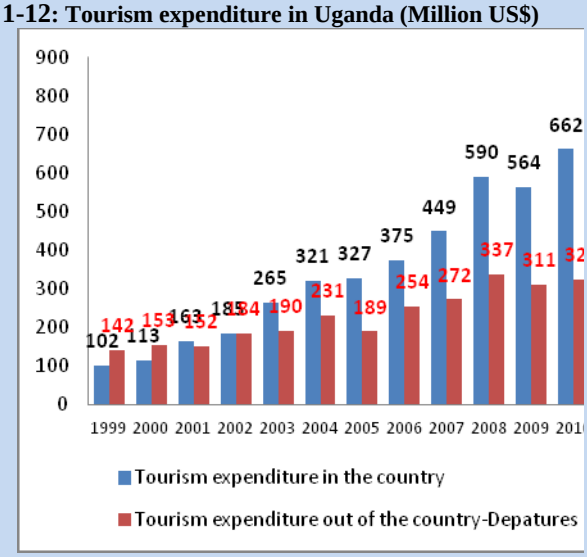
Uganda, as well as the wider East African region of Africa, is well known for its popular tourist industry mainly driven by natural wildlife such as the mountain gorilla, tree-climbing lions, to name a few. The Ugandan tourism sector thus receives priority attention in the economic and

sustainable development of the country. Government expenditure in the sector has experienced a steady increase for over a decade (Figure 1-122). 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.

Uganda Wildlife Authority, which was created in 1996 embarked on, and has continued to enhance, conservation of the country's wildlife resources. It also provides security against poaching and offers concessions to private investors in the gazetted game park areas. Consequently, there has been a steady increase in the number of people visiting the National Parks from 90,000 in 2002 to 209,000 in 2011 (Figure 1-14, 1-14 and 1-15). The hotel and restaurant business output grew from 6.5 percent to 10.7 percent between 2004 and 2008 and then to 20.6 percent in 2011/12 hence making a significant contribution towards the general service sectors share of GDP (45.1 percent, at current prices in 2011/12). Tourism is thus one of Uganda's leading foreign exchange earners; contributing to US$ 590 million in 2008 and US$ 805 million in 2011.

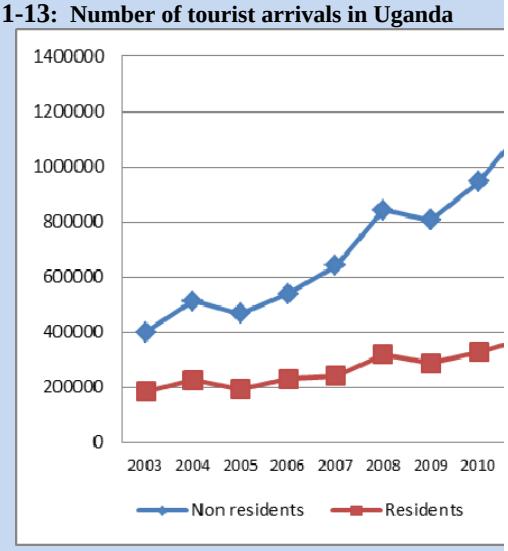
Tourist arrivals (residents and non-residents) had annual average growth rate of 18 percent between 2003 and 2011 and an overall increase of 161 percent over the same period. The non-residents had an overall increase of 187% (average 21% per annum) while the resident category had an overall increase of 103% (annual increase of 11%).

Figure 1-12: Tourism expenditure in Uganda (Million US$)



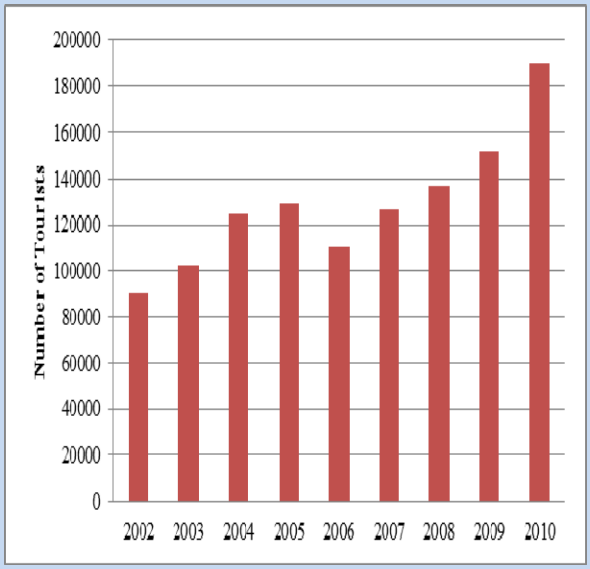
Source: UBOS (2002 through 2012)

Figure 1-13: Number of tourist arrivals in Uganda



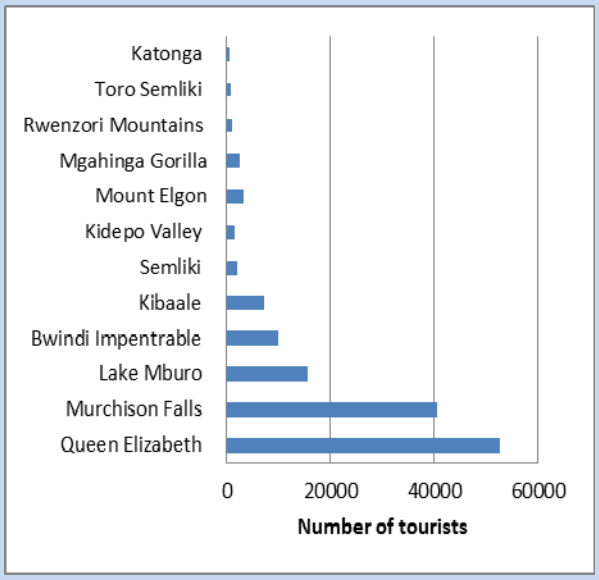
Source: UBOS Statistical Abstract 2004-12

Figure 1-14: Total number of tourists visiting national parks



Source: UBOS 2004 through 2012

Figure 1-15: Average tourists visiting each National Parks



Source: UBOS 2004 through 2012

1.11 Transport and communication

Uganda has experienced a rapidly growing service sector with its contribution to GDP growing from 41.2 percent in 2001/02 to over 45.1 percent in 2011/12. This has mainly been attributed to the high growth rate in the transport and communications sub-sector of 24.4 percent per annum.

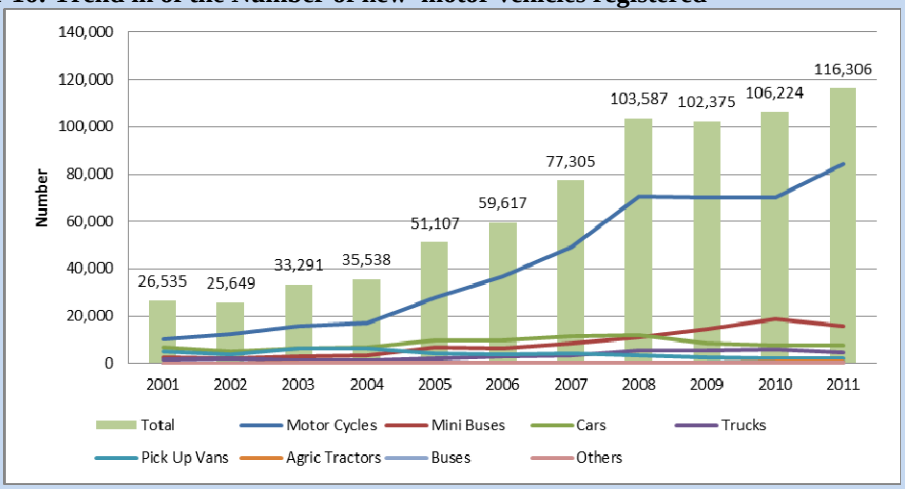
Uganda's transport subsector is heavily dominated by road transport. The country has invested heavily on road infrastructure. Uganda has a road density of 190 m/sq-km. In 2001, Uganda had a total road network of approximately 35,700 km (excluding community roads) of which about 8 percent was paved. The classified road network consisted of about 9,500 km of which 24 percent was paved. By the end of 2008, the country had increased its total road network to 78, 100 km of which 20,800 km were national roads, 17,500 km were district roads, 4,800 km of urban roads, and 35,000 km community access roads. Paved road network increased from 3,112 km in 2010 to 3,264 km in 2011.

Despite the heavy investment in road infrastructure, only about 67 percent of households have access to a usable road all year round. Uganda's motorization rate is quite low and stands at 9.3 vehicles per 1000 Ugandans; of which 3.4 were motorcycles. Figure 1-6 shows that there were 201,520 vehicles in Uganda in 2001 and 552,653 vehicles in 2009. Most of the registered motor vehicles are motorcycles followed by cars.

Rail transport is even more limited. By 1990, the total rail network was 1,266 km which has since declined to 321 km of functional rail network from Malaba at the Kenya border to Kampala (251 km), the Kampala to Port-Bell link on Lake Victoria (9 km) and the Tororo to Mbale line (61 km). In addition to rail transport, Government has built a new passenger/cargo ferry (MV Kalangala) between Kalangala and the main land to supplement the already existing ferries.

The demand and use of air transport services has had a steady increase through the decade. It stood at 20 percent between 2002 and 2011 with actual number of passengers rising from 422,000 to over 1,342,000 in 2011 (218% increase). Proportionately, over the same period, the aircraft movement had an annual increase of about 10 percent.

Figure 1-16: Trend in of the Number of new motor vehicles registered



Source: UBOS Statistical Abstracts 2002 to 2012

With regard to the telecommunication sub-sector, Uganda has had tremendous progress in telephone penetration and improved coverage. By December 2008, Uganda's coverage was at 28 telephone lines per 100 inhabitants. In 2011, national telephone penetration rose to 52.1 lines per 100 populations; having risen from 41.1 lines per 100 populations in 2010 (representing a total of 4,006,463 new subscribers). The volume of talk time traffic increased from 10,038 million

minutes in 2010 to 13,028 million minutes in 2011 giving a 29.8 percent increase. The liberalization of the telecommunications sector boosted investors' interest and as of 2013, Uganda had 6 telecommunications operators. The level of communication sector investment thus grew steadily from 43,197,100 US$ in 2003 to 150, 000,000 US$ in 2007.

Uganda has experienced a 41.9 percent growth in the fixed internet subscriber base with a total of 88,786 fixed internet subscribers by the end of December 2011 compared to 22,000 in December 2008 and 8000 in 2004. The emergence of mobile wireless internet access has complemented fixed internet access. By the end of 2011, there were about 977,500 wireless accounts having risen from 220,000 in December 2008. Internet users have also increased by 769 percent during the period 2004-2008. Uganda registered a 91.7 percent growth in the number of internet subscribers in 2011. Generally, there has been an exponential growth in the number of internet users as well as internet subscribers.

1.12 Energy Profile

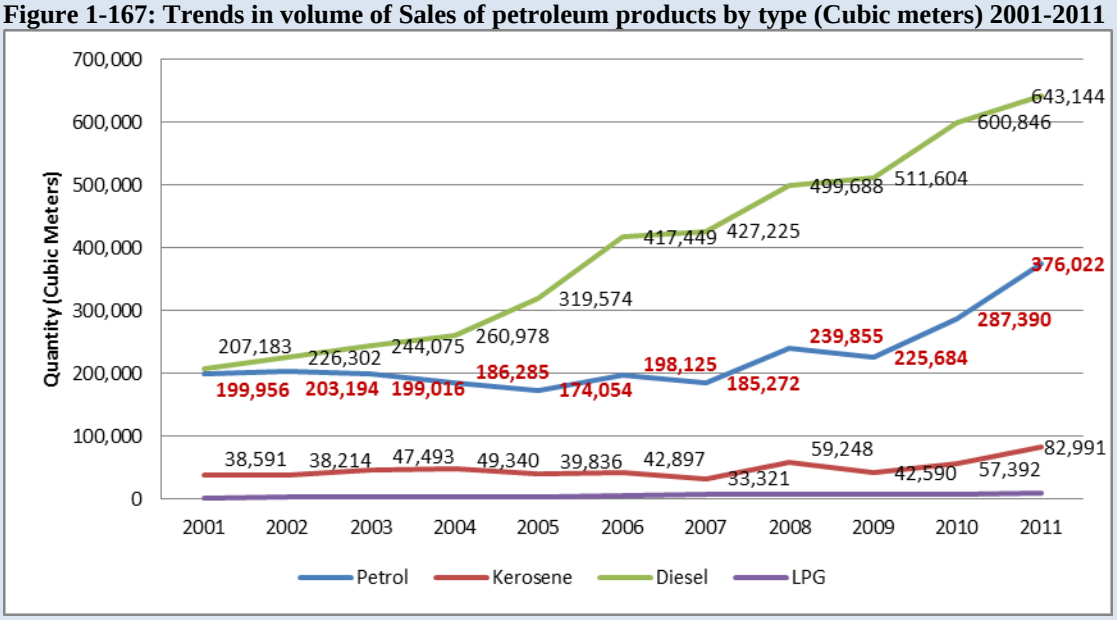
The energy sector in Uganda comprises of both traditional and conventional energy sources that include petroleum and renewable energy sources. The dominant locally produced energy sources are fuel wood and charcoal which have negative impact on vegetation cover. The increased urbanization and high cost of electricity have continued to increase the demand for charcoal in urban areas. Generally, Uganda generates its own electricity, mostly from hydroelectric power stations supplemented with power from thermal plants. It also generates small quantities of power from other sources like biomass and solar.

According to the Energy Balance, Uganda's total energy consumption in 2000 was 6,824,797 tons of Oil Equivalent (TOE). Firewood and agricultural wastes consumption was 82.9 percent and 4.7 percent, respectively. Charcoal consumption was 4.7 percent of the total energy and it was mostly used in urban households and commercial sector. Petroleum products and electricity consumption was 6.1 percent and 1.1 percent, respectively. Most of the petroleum was used in the transport (75.5%) and industrial (15%) sectors. Most of the kerosene (90%) and LPG (80%) was consumed by the household sector leaving the rest to the commercial and industrial sectors. The industrial sector used biomass as the major source of thermal energy and was estimated to be using 384,165 TOE of wood (Energy balance 2000). Diesel generators were used as back up for grid electricity. Commercial and institutional establishments mainly use wood fuel, charcoal, kerosene and electricity energy sources in their operations.

Uganda imports all her petroleum requirements including Premium Motor Spirit (Petrol), Automotive Gas Oil (Diesel), Bulk Illuminating Kerosene, Aviation Fuel, Liquefied Petroleum Gas (LPG), Lubricants and Bitumen. The most sold of them on the Ugandan market include petrol, diesel and kerosene and to some extent LPG. Diesel sales have registered the highest

increase (210%) since 2001 to 2011 followed by petrol (88%) and then kerosene (115%) – (Figure 1-167).

Figure 1-167: Trends in volume of Sales of petroleum products by type (Cubic meters) 2001-2011



Source: UBOS Abstracts 2002 -2012

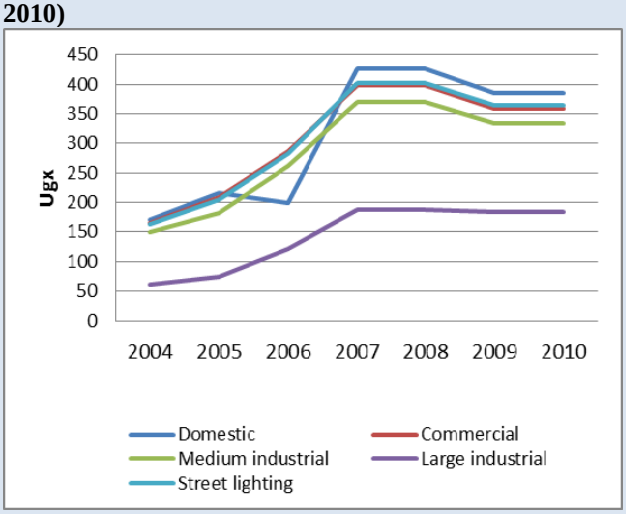
The determination of the percentage of petroleum products used in the transport sector is a challenge in Uganda. There is no dependable data on the total number of motor vehicles on the road. Vehicle data that is available is only the number of vehicles imported. The energy consumption data in this subcategory is compiled by the Ministry of Energy and Mineral Development (MEMD). For the energy balance, the data on fuel sales from oil companies has been used. It is estimated that 68 percent of the diesel is used in the transport sector. It is assumed that all gasoline is used in the transport sector.

In 2002, only 8 percent of the Uganda population had access to electricity. For rural communities, it was less than 3%. To transform this situation, Uganda has been implementing a 10 year Energy for Rural Transformation program with an overall goal of increasing rural electricity rates from 1 percent to 10 percent by the year 2010. By 2008, 6% of rural households, and 40 percent of their counterparts in urban areas, had access to grid power.

In 2009/10, 48 percent of households in the urban areas used electricity as source of energy for lighting and only 2 percent used it for cooking. Considering rural Uganda, only 4 percent and none use it for lighting and cooking, respectively. On the whole, 12

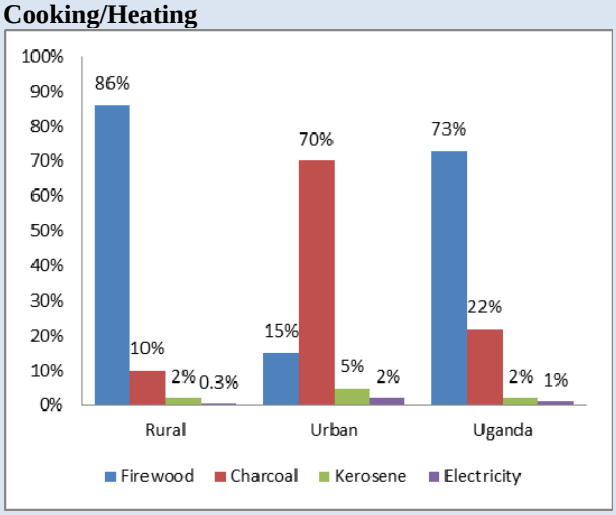
percent and 1 percent of Ugandan households use electricity for lighting and cooking, respectively. The limited use of electricity for cooking is mainly attributed to the high tariff rate (Figure 1-178) hence directly encouraging the use of biomass, especially charcoal for urban dwellers and firewood mainly for rural population which threatens the much needed national forest cover (Figure 1-189). In 1994, charcoal production utilized 6 million m^3 of round wood which increased to 11 million m^3 in 2007. In 2007, 59.4 percent of the total wood production from forests was used as wood fuel. In 2010, the annual national consumption of firewood was estimated at 32.8 million m^3 of woody biomass energy.

Figure 1-178: Trend in Tariff rates over time (2004 to 2010)



Source: UBOS Statistical Abstracts 2005-2012

Figure 1-189: Source of Energy for Household Cooking/Heating



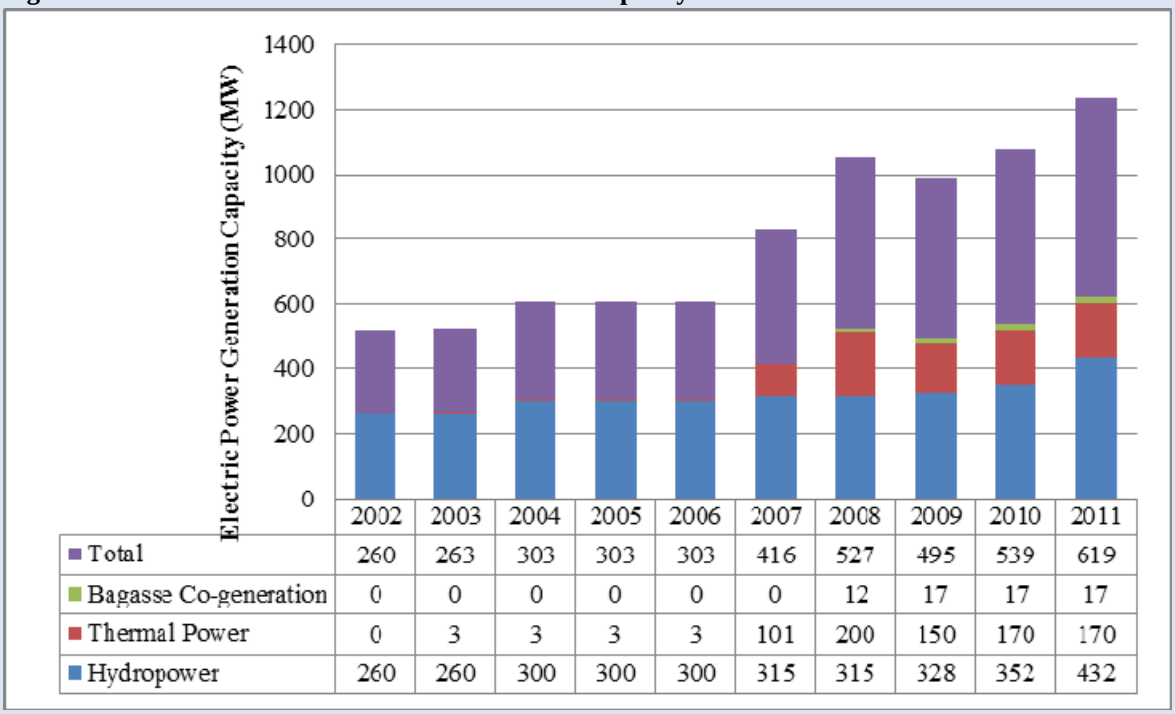
Source: UBOS UNHS 2009/10

Generally, the cost of power (tariff rate) has been increasing since 2004 (Figure 1-178). Between 2004 and 2010, the domestic rate increased by 125 percent while the commercial, medium industrial, large industry and street lighting increased by 117 percent, 122 percent, 206 percent, 124%, respectively. In all this, the domestic tariff rate remains high a fact that forces most households to use grid power only for lighting rather than cooking and heating as well.

Uganda has an estimated overall electrical power potential of over 5,300 MW; comprising of 2,200MW of hydropower, 1,650 MW from biomass, 200 MW from solar power, 450 MW from geothermal and 800MW from peat. By 2011, Uganda (Figure 1-20) had a total installed generation capacity of 569 MW (which is about 11% of the total estimated capacity), compared with 260 MW in 2000. A total of 150 MW of thermal power plants were installed and commissioned over the last 10 years (2001 to 2011) leading to an overall increase of power supply from GWh 1,887.7 in 2001 to GWh 2,891 in 2011; which is a 53 percent increment. The government has of recent invested in Bujagali, and Karuma hydro-power dams. Out of Uganda's total installed capacity;

hydroelectricity accounted for 76 percent, thermal electricity (21%) and bagasse (3%).

Figure 1-20: Trends in Installed Power Generation Capacity



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total	260	263	303	303	303	416	527	495	539	619
Bagasse Co-generation	0	0	0	0	0	0	12	17	17	17
Thermal Power	0	3	3	3	3	101	200	150	170	170
Hydropower	260	260	300	300	300	315	315	328	352	432

Source: UBOS Statistical abstracts 2002 to 2012

1.13 Mining, oil and gas

Uganda's mining sub-sector has consistently contributed about 0.3 percent to the GDP. Efforts are continuously made by the government of Uganda to boost its contribution. Uganda has conducted airborne geophysical surveys aimed at understanding rock formations and identification of mineral targets. In this regard, magnetic and radiometric data covering a total 630,612 line kilometres has been collected.

Particular efforts have been put to support and promote petroleum exploration in Uganda. The discovery of commercial quantities of

petroleum reserves in the Albertine Graben has boosted interest and investment in finding more petroleum resources. Investment in this sub-sector by December 2008 was about US$ 540 million.

1.14 Manufacturing and industry

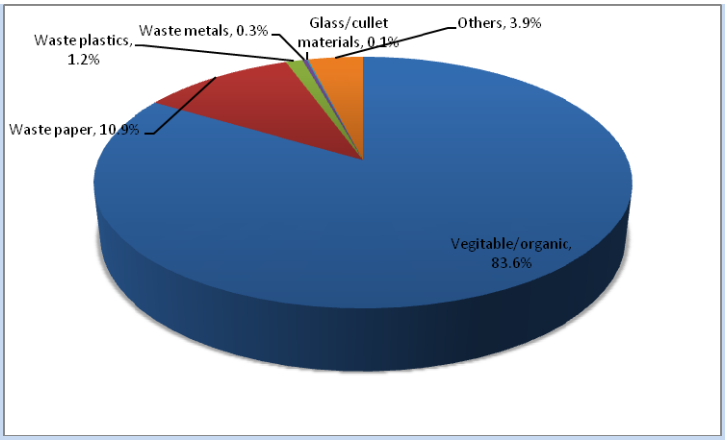
Industrialization occupies a central position in Uganda's economic development and social transformation objectives, strategies and policy actions. The sector's contribution to GDP has grown from 18.9 percent in 2001/02 to 24.2 percent in 2008/09 and further increased to 26.3% in 2011/12 making it the second largest sector. Uganda has continued to attract investors in the manufacturing sub-sector over the last ten years, and by 2008 the sub-sector was employing about 32,125 people.

Uganda's industrial sector is closely tied to the other economic sectors, particularly agriculture. Manufacturing activity in Uganda is mainly composed of processing of agricultural produce including meat, fish and milk, coffee processing, grain milling, tea processing. There is substantial activity in the food and beverage sub-sector including bakery and other food products, beverages and tobacco. Other industrial activities include manufacture of textiles and leather products, sawmilling, and processing of chemicals and chemical products.

1.15 Waste

Uganda is experiencing increasing volumes and complexity of waste. This is mainly associated with economic growth and urbanization. Serious risks to ecosystems and human health are thus inevitable. There is high solid waste generation in urban areas of approximately 0.56 kg/person/day. The urban solid waste (Figure 1-191) is mainly composed of vegetable / organic matter (83.6%) and waste paper (10.9%). These 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.

Figure 1-19: Main sources of waste



Source: Science Journal of Environmental Engineering Research -2013

1.16 Uganda's history and culture

Uganda was first explored by the Europeans and Arab traders in 1844. An Anglo – German agreement of 1890 declared her a British sphere of influence in the heart of Africa. Uganda was a protectorate of the United Kingdom from 1894 to 1962 when she became attained independence.

Before the British renamed and reconfigured the territory, that is now Uganda, the area was then an array of kingdoms (Buganda, Bunyoro, Ankole and Toro) and communities located in the Lango, Acholi, Madi, West Nile, Bukedi, Bugisi, Busoga, Teso, Karamoja, Sebei and Kigezi regions. It was a heterogeneous area, with a variety of customary practices, social and political structures.

Uganda is thus made up of a diverse culture of her hospitable people that is closely tied to the rich cultural practices and life style of the different tribes and their historical origin dating from the 14th Century when the inter lucustrine kingdoms were formed. The Bantu who speak related languages and have similar social and cultural characteristics are believed to have settled in the areas making Uganda in around 500BC. The Nilotics group is divided into the highland Nilotics and plain Nilotics which in Uganda include the Nilo Hamiates (Karamajong, the Iteso the Kumam and the Langi) the river lake Nilotics (the Alur, the Acholi, and the Japadhola). The people were organised around the original five monarchies of Buganda, Bunyoro, Busoga,Tooro and Ankole and others some of whose origin is not known because their early history was not written down. There are also several other cultural institutions that include chiefdoms, clans and

family. In general, communities look up to their respective traditional/cultural institutions for their identity.

In this regard, Uganda has 65 indigenous communities with diverse cultural heritage and a wealth of indigenous knowledge, languages, folklore, customs and traditions. These cultural beliefs, traditions and values enhance social cohesion and sustain an acceptable moral fabric. Dance and drama is one aspect that is crucial in the lifestyles of all tribes in Uganda. There is music for every social occasion and aspect of life and generations. For example, there is music for birth of a child, naming a child, for twins, marriage and death. A variety of art and craft reflect cultural tradition and history with the drum dominating in all Uganda cultures. Many programs in the country adopt these in their education, training and awareness activities.

Policies and plans in Uganda recognise these communities' culture and some cultural sites are part of the national heritage. These include:

- Kasubi Tombs & Wamala tombs – Buganda kings' burial sites
- Karugutu (Fort-Portal) – Tooro kings' burial site
- Nkokonjeru (Mbarara) – Ankole kings' burial site
- Nagalabi (Budo)– Buganda coronation ground
- Kabaka's Lake
- The sezibwa falls, Namugongo shrines, Nakayima tree in Mubende, Nyero Rocks

1.17 Governance and political systems

Uganda is an independent State and a Republic. It is governed by a constitution which is the supreme law. The Constitution of Uganda 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:

- 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.

- 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 Defense 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.

- 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 county has over 30 political parties with leading ones including the National Resistance Movement (NRM) which is the ruling party, the Forum for Democratic Change (FDC), Democratic Party (DP), and Uganda People's Congress (UPC).

1.18 Institutional arrangements

The Ministry of Water and Environment is the lead institution for Climate change activities, including the preparation of National Communications, in Uganda. Prior to the approval of the National Climate Change Policy in 2014, the Ministry had established a Climate Change Unit to oversee the preparation of the Second National Communication. The Uganda Climate Change Policy has now established a Climate Change Department which shall be responsible for, among other duties, the preparation of national communications on a continuous basis.

With respect to the SNC, Uganda used the Task Force approach where three Task Forces were established; one on Greenhouse Gas Inventory and Mitigation Analysis (GIMA), one on Vulnerability and Adaptation (V&A), and the other on General Circumstances. Each Task Force was led by a Chair/Team leader and had the requisite experts as members with individual Terms of Reference (ToRs). The Project Implementation Unit was established under the direct leadership of the Deputy Coordinator, CCU who was assigned additional responsibilities as Project Manager. The Project Management Team (PMT) that brought together the Chairs of the three Task Forces, Project Manager and the Coordinator, Climate Change Unit provided technical back-up, harmonization and guidance towards the overall project implementation within the agreed timeline. The work of the Task Forces was reviewed and discussed at national workshops attended by representatives of other line ministries and government agencies; including Ministries of Energy and Mineral Development, Finance, Planning and Economic Development, Agriculture, Works and Transport; Uganda Bureau of Statistics, National Forestry Authority, National Environment Authority and Kampala Capital City Authority; academia; representatives of NGOs and CBOs.

The final draft was discussed and approved by the National Climate Change Advisory Committee which is chaired by the Minister for Water and Environment and brings together technical representatives from the various government departments at the national level, along with representatives from private-sector associations, civil society, academia and district authorities.

Chapter 2 : NATIONAL GREENHOUSE GAS INVENTORY

2.1 Introduction

This chapter presents the second Greenhouse Gas (GHG) inventory for Uganda. The first inventory was compiled and submitted as part of the Initial National Communication (INC) to the eighth Conference of the Parties to the UNFCCC in 2002. The communication contained among others, the first Greenhouse Gas (GHG) inventory compilation of the country with a base year of 1994. The preparation of the second national inventory of anthropogenic emissions by sources and removal by sinks of all GHGs not controlled by the Montreal Protocol for Uganda used 2000 as the base year in accordance with the guidance provided in 17/CP.8.

The compilation took note of the GHG inventory in the First National Communication, utilized up-to-date guidelines, software, databases and on-going projects to prepare the inventory not only as an obligation but also to enhance technical capacity, improve data/information collection and analysis.

In accordance with Decision 17/CP.8 and following the IPCC guidance, the GHG inventory is defined within five inventory sectors: Energy, Industrial Processes, Solvent and Other Product Use, Agriculture, Land-Use Change and Forestry and Waste. Within these sectors, individual sources were defined and respective activity data collected, emission factors obtained and the respective GHG emissions computed. The IPCC/UNFCCC software and emission factors were used in the computation. The gases reported from these sectors are: Carbon dioxide (CO_2), Carbon monoxide (CO), Methane (CH_4), Nitrous Oxide (N_2O), Nitrogen Oxides (NO_X), Sulphur dioxide (SO_2) and Non-Methane Volatile Organic Compounds (NMVOC).

2.2 National Inventory Institutional Arrangements and Management

At the time of compiling the Second National Communication, Uganda had no national inventory system. It was decided that a task force of experts be constituted to undertake the task. While the Climate Change Unit (CCU), under the Ministry of Water and Environment, had the overall responsibility for the task as Uganda's national coordinating institution on climate change matters, the compilation of the GHG inventory was assigned to a team of five persons comprising of a Team Leader, an energy expert, an agriculture and ecology expert, a waste expert and a LULUCF expert. These technically and administratively reported to the Project Manager of the SNC project; who in turn reported to the Coordinator, CCU.

About half way through the exercise, Uganda was included in the Low Emission Capacity Building Programme of the UNDP. A project entitled, "Low Emission Capacity Building-Uganda (LECB-U)", funded by the European Union and the governments of Germany and

Australia was initiated. One of the objectives of the project was to support Uganda to build a robust national inventory system. Thus, under this project, the country simultaneously embarked on building a robust GHG inventory system. The task force helped identify the organizations that are to form the core of the system and the expertise required. The task force members also documented the methodologies, emission factors, data and improvements used in and arising from the compilation of the second inventory. These are for future reference as well as development of an inventory archiving system.

2.3 Summary of GHG Emissions by Sources and Sinks for 2000

The direct gas emissions within Uganda in 2000 were 11,759 Gg of CO_2, 520 Gg of CH_4, and 55 Gg of N_2O. Only 1,561 Gg of CO_2 was removed. The emissions of indirect gases amounted to 104 Gg of NO_x, 3,947 Gg of CO, 299 Gg of NMVOC and 4 Gg of SO_2 (Table 2.1).

Table 2-1: Greenhouse Gas Emissions for 2000 for Uganda based on IPCC Categories

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)								
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	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							
2Manufacturing 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**							

2.4 Greenhouse Gas Emissions by Gases

Table 2.2 shows Uganda's GHG emissions by gas without LULUCF while Table 2.3 shows emissions with LULUCF.

Table 2-2: Total Emissions by Gas without LULUCF for Uganda

GREENHOUSE GAS	Total Emissions Gg	Gg CO_2eq.
CO_2	1372	1372
CH_4	451	9471
N_2O	54	16740
Total	-	**27583**

Table 2-3: Total Emissions by Gas with LULUCF for Uganda

GREENHOUSE GAS	Total Emissions Gg	Gg CO_2eq.
CO_2	10,108	10108
CH_4	520	10920
N_2O	55	17050
Total	-	**38078**

2.5 Major sources of GHG emissions by sector

2.5.1 Energy and transport

Estimates of GHG emissions from the energy and transport sector were derived from the following energy uses; 1) industries utilizing various energy fuels including agricultural residues; 2) households; 3) commercial establishments; 4) transport; 5) energy use in agriculture, fishing and forestry; 6) energy for power generation;.

The data was mainly sourced from;- The Energy Balance of the Ministry of Energy and Mineral Development; Uganda Bureau of Statistics (UBOS); Ministry of Works and Transport (MoWT); and Department of Forestry Support;

The analysis was based on the following categories; energy industries, transport, bunkers, manufacturing and construction, commercial and institutional, residential and agriculture/forestry/fishing. The emissions were subdivided into CO_2 combustion, non-CO_2 combustion and fugitive emissions. However, fugitive emissions levels were insignificantly low thus not reported on. Where paraffin was used as feedstock, a 10 percent estimate of total consumption was used.

Computations were based on the Revised 1996 IPCC guidelines, specifically Tier1. This excludes, SO_2. Hence, these emissions were computed separately. To ease computations, it was assumed that:-

- Default conversion and emission factors provided by the IPCC apply to Uganda
- 99% of the carbon in liquid fuels is oxidized
- 99.5% of the carbon in gaseous fuels is oxidized.
- All petroleum sales represent petroleum consumption in Uganda

Uganda's GHG total emission from the energy and transport sector in the year 2000 stood at 1212.2 Gg for CO_2, CO at 2,567.8 Gg, and NMVOC at 300.1 Gg. Other estimated emissions from the sector were CH_4, NO_x, SO_2, and N_2O. The transport sub-sector contributed most of the CO_2 (72%) as shown in Figure 2-1. Other sectors (which include residential, commercial, institutional and agriculture/forestry/fishing) produced most of the CO (97%) and NMVOC (95%) emissions (See Table 2-4).

Figure 2-1: Percentage Contributions of energy sub-sectors to CO_2 emissions

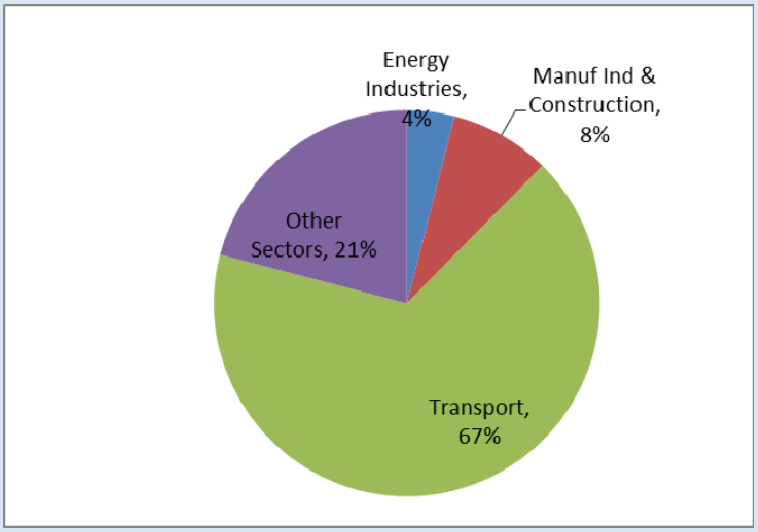


Table 2-4: Summary of Emission of GHG Gg from the Energy Sector

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1 Energy	1212.1	0	143.1	1.9	58.2	2567.8	300.1	6.8
A Fuel Combustion (Sectoral Approach)	1212.1		143.1	1.9	58.2	2567.8	300.1	6.8
1 Energy Industries	48		0	0	0	0	0	0
2 Manufacturing Industries and Construction	102		1	0	3	47	1	0
3 Transport	808		0	0	8	55	10	0
4 Other Sectors	254		145	2	49	2,491	285	4
5 Other (please specify)	0		0	0	0	0	0	0
B Fugitive Emissions from Fuels	0.0		0.0		0.0	0.0	0.0	0.0
1 Solid Fuels			0.0		0.0	0.0	0.0	0.0
2 Oil and Natural Gas			0		0	0	0	0

2.5.2 Industrial processes

In Uganda, the industrial activities contributing to GHGs fell into the following IPCC categories:

- Cement Production
- Lime Production and Use
- Food and drink
- Emissions of substitutes for ozone depleting substances (ODS) - including aerosols, solvents, foam manufacture and refrigeration arising out of imports of these substances (not estimated)

In general, the IPCC 1996 Revised Guidelines were followed and Tier 1 used in all the different industrial activities. The data used was sourced from UBOS and was mainly on the industry activity that generates GHC emissions. To avoid double computation, the Energy consumption in industry was excluded in this section.

Fumes from Hima Cement Factory-Kasese

There was low GHG emission in the industrial processes sector in 2000. In that period Cement production was the major contributor of CO_2 emissions amounting to 158 Gg followed by lime with 8 Gg. Food and drink were the major contributor of NMVOC amounting to 2.0 Gg. The emissions of substitutes for ozone depleting substances (ODS) - including aerosols, solvents, foam manufacture and refrigeration arising out of imports of these substances could not be estimated due to absence of credible data (Table 2.5).

Table 2-5: Major Emissions from the Industrial Processes Sector for the year 2000

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	NMVOC	SO_2
Cement Production	158		0.1
Lime Production and Use	1		
Food and drink		2	

2.5.3 Agriculture

Agriculture is a key sector contributing to anthropogenic GHG emissions in Uganda. The GHG result from: enteric fermentation; animal wastes; rice cultivation; savannah burning; field burning of agricultural residues and agricultural soils. Methane (CH_4), Carbon monoxide (CO), Nitrous Oxide (N_2O) and other Nitrogen Oxides (NO_x) are the major GHGs emitted in the agricultural sector. The activity data used was from livestock, crop, soils, crop residues, and savannah burning, flooded rice cultivation and fertilizer use.

Flooded rice in Busoga sub-region

The data was mainly obtained from MAAIF and UBOS and compiled using the Revised 1996 IPCC guidelines; specifically the Tier 1 method. This was due to unavailability of sufficiently disaggregated source category and emission factors data.

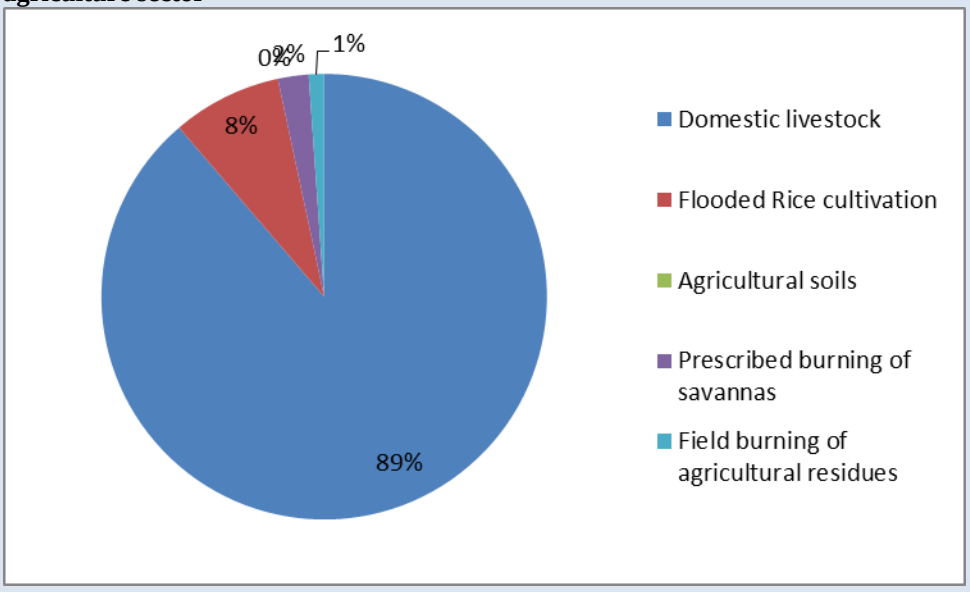
The total GHG emissions in the agriculture sector in 2000 were:- 271.91 Gg of CH_4, 222.38 Gg of CO, 51.95 Gg of N_2O and 11.77 Gg of NOx (Table 2.6). Enteric fermentation and manure

management was the most significant emitter of methane which generated 241.23 Gg of CH_4 (Figure 2-2). Likewise, agricultural soils were the most significant source of $NO_{x,}$ contributing 50.67 Gg of N_2O. Carbon monoxide came from prescribed burning of savannas (generated 159.05 Gg of CO); and field burning of agricultural residues generated 66.33Gg of CO. NO_x emissions were from field burning of agricultural residues (77%) and prescribed burning of savannas (23%).

Table 2-6: Summary of GHG emissions from the agriculture sector for 2000

GREENHOUSE GAS SOURCE CATEGORIES	Methane (CH4) Gg/yr	Nitrous oxide (N2O) Gg/yr	Carbon monoxide (CO) Gg/yr	Nitrogen oxides (NOx) Gg/yr
Domestic livestock: Enteric fermentation and manure management	241.23	0.96	----	---
Rice cultivation: Flooded rice fields	21.6	---	---	---
Agricultural soils	---	50.67	---	---
Prescribed burning of savannas	6.06	0.07	159.05	2.71
Field burning of agricultural residues	3.02	0.25	63.33	9.06
Total emissions	271.91	51.95	222.38	11.77

Figure 2-2: Percentage contribution of agriculture source categories to CH_4 emission in the agriculture sector



2.5.4 Land use, land use change and forestry-- LULUCF

LULUCF is a key component of the GHG inventory. CO_2 and non-CO_2 GHG emissions and removals were estimated in the six LULUCF land categories which are: forests, grassland, crop land, wetlands, settlements, other lands. Uganda's forest definition as submitted to UNFCCC is "all lands more than 1 ha in area, with a tree canopy density of more than 30% and height of more than 5 metres (or potential to attain 5 meters at maturity)".

2.5.4.1 Activity data, emission factors and GHG inventory approach

In 1995, the National Biomass Study (NBS) carried out the first Wall to Wall Land use / cover mapping and the first forest inventory covering all vegetation types in Uganda. The NBS classification system developed 13 land use / cover categories. Estimation of biomass stock and biomass stock changes per land subcategory is based on a three to four year time's series stock inventory by the NBS (Table 2.7). These estimates give annual stock changes of the above ground biomass based on locally developed algometric equations. Total biomass stock change is estimated using a root / shoot ratio of 1.24 as provided in the IPCC guidelines.

Table 2-7: Stock changes in various land subcategories (Adopted from NBS 2002)

Land Cover/Use	Predicted Weight 1st Visit(Tons/ Ha Airdry)	Predicted Weight 2nd Visit(Tons/Ha Airdry)	Difference between the 1st and 2nd Visit	Duration in Decimal Years	Rate of annual change (Tons/Ha Airdry)	Rate of annual change (%)
CLASS	VistA (TON-HA)	VistB (TON-HA)	Difference	YEARS	change	Change in %
Plantations (Hardwoods)	46	38	-7.8	2	-3.4	-7%
Tropical High Forest THF	189	110	-79.0	3	-24.3	-13%
THFDegraded	119	87	-31.2	4	-8.3	-7%
Woodland	39	33	-6.3	3	-1.9	-5%
Bushland	15	12	-2.3	4	-0.6	-4%
Grassland	8	7	-0.2	3	0.0	-1%
Wetlands	0	0	0.0	2	0.0	
Subsistence Farmland	8	8	0.2	3	0.1	1%
Commercial Farms	0	0	0.0	4	0.0	-25%
Built up Area	4	5	0.4	3	0.1	3%

In 2005, NFA carried out a second Nation-wide mapping based on Landsat images (30M resolution). The two times series data sets have been used to generate Uganda's 10 years land use statistics. The land use pattern for the year 2000, the year of the GHG inventory, was derived by averaging the change in the area under different land categories between 1995 and 2005.

To be in conformity with IPCC reporting procedures, the nationally defined land use / cover classes were grouped as sub categories under the six LULUCF categories of IPCC. Within these land categories, estimates were made in three pools: above-ground biomass (AGB), below-ground biomass (BGB), and soil organic carbon (SOC). Emissions/removals from litter and dead

wood were assumed to be zero due to lack of data and as per IPCC Good Practice Guidelines for LULUCF (IPCC, GPG LULUCF 2003).

CO_2 emissions from soils were estimated for land that has been converted either from forests to cropland or from grassland to cropland, using IPPC default values (i.e., Tier1).

Non CO_2 emissions from fires was estimated based on area burnt (as per data provided by MODIS), mass of available fuel (using NBS data), and default IPCC values on combustion efficiency of biomass and emission factors for CH_4, CO, N_2O and NO_x

2.5.4.2 Carbon stock changes

Carbon stock changes were estimated per land use category as outlined below.

Land remaining forest

Overall, forests had a net reduction in carbon stocks; estimated at over 5.8million tones – see (Table 2.8). Natural forests within protected areas had a net stock of about 1.7 million tons while those outside protected areas had a net reduction of over 7.5 million tons of carbon in living biomass. All forest plantations were net emitters though at a much smaller scale. It is important to note that about 70% of forests in Uganda lie outside gazetted areas and there are no management plans to guide harvesting of forest products on private land.

The highest changes in carbon stocks were in woodland and Tropical High Forest outside gazetted areas with each having an annual net loss of over 3,000,000 tones.

Forest degradation is a long time process (may take up to 2 decades) and biomass in many forests may substantially decline over time though technically the land remains forest. In some instances, forests are converted from one forest subcategory to another one; for example from woodland to forest plantation. Conversions from one forest type to the other resulted in net carbon losses in living biomass of close to 800,000 tones. Details show that conversion of woodlands and Tropical High Forest (THF) into bush resulted into the highest net loss of over 500,000 tones and close to 190,000 tons of carbon respectively. Establishment of forest plantations (coniferous and deciduous) on degraded sites such as bush land and degraded Tropical High Forest (DTHF) resulted in net gain in carbon stocks of close to 3,000 tones. Also, the conversion of 350 ha of woodlands into coniferous and deciduous plantations resulted in a net gain of over 7,000 tons of carbon stock.

Table 2-8: Carbon stock in forest remaining forest (protected and non- protected)

Initial Land use	Reporting Year Land use (Sub-categories)	Annual area of forestland – (ha)	Annual growth rate of biomass(tonnes C ha^{-1} yr^{-1})	Annual carbon stock in biomass removed or harvested (tonnes C ha-1 yr-1)	Annual change in carbon stocks in biomass (tonnes C yr-1) (D = A * (B-C)
Sub-categories		A	B	C	D
Deciduous Plantation	Deciduous Plantation	11,674	8.06	10.168	-24,608
Conifer Plantation	Conifer Plantation	13,623	6.2	9.3	-42,231
THF Protected	THF Protected	392,038	9.3	6.0915	1,257,854
THF	THF	220,521	9.3	24.366	-3,322,374
D THF Protected	D THF Protected	101,080	6.82	5.983	84,604
D THF	D THF	109,503	6.82	11.966	-563,504
Woodland protected	Woodland protected	411,817	3.1	2.139	395,756
Woodland	Woodland	2,756,006	3.1	4.278	-3,246,575
Bush Protected	Bush Protected	259,203	0.62	0.496	32,141
Bush	Bush	1,036,812	0.62	0.992	-385,694
Total		5,312,278			-5,814,632

Conversion other land categories into forest

Conversion of non-forest land into forest resulted in a net gain of over 200,000 tons of carbon in living biomass with the highest being from cropland to forest conversion (**Error! Reference source not found.**

Table 2-9: Carbon Stock changes in land converted to forestland

Initial Land use	Reporting Year -2000 Land use Sub-categories	Annual area of land converted to other forest(ha yr^{-1})	Carbon stocks in biomass immediately after conversion to other	Carbon stocks in biomass immediately before conversion to other	Carbon stock change per area for that type of conversion when land is converted to	Change in carbon stock from one year(tonnes C ha^{-1}) forest growth	Annual change in carbon stocks in living biomass in land

			forest(tonnes C ha^{-1})	forest(tonnes C ha^{-1})	other forest(tonnes C ha^{-1}) D= B-C		converted to other forest(tonnes C yr^{-1}) F = A*(D+E)
		A	B	C	D	E	F
Cropland	Forestland						
	Deciduous	786	26.4	6.8	19.5	8.1	21,688
	Conifer	283	26.4	6.8	19.5	6.2	7,271
	Bush	47,040	8.4	6.8	1.6	0.6	102,077
	Sub-total	48,109					131,036
Grassland	Forestland						
	Deciduous	136	26.4	5.0	21.4	8.1	4,003
	Conifer	127	26.4	5.0	21.4	6.2	3,511
	Bush	22,292	8.4	5.0	3.4	0.6	89,837
	Sub-total	22,555					97,351

In Uganda, extraction of biomass from small holder farms is mainly for domestic requirements in form of twigs, tree branches and small trees. Under such circumstances, extraction is normally less than annual increment and thus more sustainable than commercial extraction. Biomass use in towns and many settled areas is more often sourced from rural areas rather than extracted from within and thus towns tend to have net gains of carbon stocks in living biomass.

Table 2-10: Carbon stock changes in land not under forest that is not converted

Land use	Land Subcategory	Area remaining	Annual change in carbon stocks in biomass
Cropland	Subsistence farmland	7,865,894	487,685
Cropland	Commercial farms	68,447	0
Grassland	Grassland	4,478,949	0
Settlement	Settlement	36,572	7,314

Converted Land

Conversion of non-forest land into cropland, grassland, settlement and others (less significant categories like degraded sites) resulted in net loss in carbon stocks. The highest carbon stock loss resulted from conversion of forestland to cropland with a net loss of close to 1,900,000 tons of carbon.

2.5.4.3 Carbon Stock Changes in Soils

Uganda does not have country specific data on reference soil organic and carbon stocks of the different land categories, the spatial distribution of these soils, and relative stock change factors for management activities on for example different types of cropping systems. The relevant default values of IPCC GPG 2003 for LULUCF waere used. Conversion of grassland to cropland resulted in the highest carbon stock changes in mineral soils emissions estimated to be over 190,000 tons of carbon.

2.5.4.4 Non CO2 emissions from Fires

Non-CO_2 GHG emissions were estimated for land subjected to burning. Activity data for the area burnt was downloaded from MODIS (NASA) website on http://wist.echo.nasa.gov. MODIS data was over layered on NBS biomass stock data in a Geographical Information System (GIS) to determine mass of available fuel. Emissions from fires were calculated using the following equations;

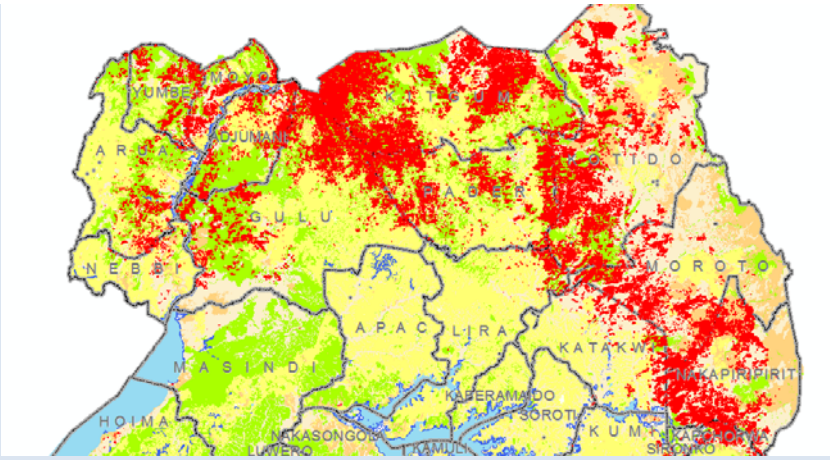
$Lfi\ re = A \times B \times C \times D \times 10^{-6}$, Where

Lfire = quantity of GHG released due to fire, tonnes of GHG

- A= area burnt, (ha), estimated from MODIS data
- B= mass of "available" fuel, kg d.m./ ha, Derived from overlaying MODIS data on NBS land cover data
- C= combustion efficiency (or fraction of the biomass combusted), dimensionless, IPCC Default value used)
- D= emission factor, g/(kg d.m.), IPCC default value used

Example of using Geographical Information System (GIS) to overlay and display MODIS data of burnt areas in northern Uganda, over NBS is shown in data Map 2-1.

Map 2-1. Example of burn area (in red) over forests (in green) and grassland (yellowish),



Source: Adopted from MODIS data

Bush fires in West Nile

It is estimated that aver 550,000 ha of forest were burnt in 2000. The highest Non CO_2 emissions from forest wildfires were from CO (estimated at 1,000,000 tonnes of CO) most of it attributable to burning of woodlands. CH_4 emissions were second most important estimated to release over 60,000 tonnes of CH_4.

2.5.4.5 LULUCF Emissions in 2000

The aforementioned carbon stock changes resulted in emissions from the LULUCF sector of about 10,387.4 Gg of CO_2; 1,132 of CO; 69 Gg of CH_4, 32 Gg of NO_x and 1 Gg ofN_2O. Total removals amounted to 1,651 Gg of CO_2 (Table 2.11). All the six land categories were net emitters. Forests were the leading emitters both in CO_2 emissions (over 6,000 Gg) and Non CO_2 emissions (over 1,000 Gg of CO and over 60 Gg of CH_4). Cropland was second to Forests in CO_2 emissions estimated at 3,280 G grams. Non-CO_2 emissions in cropland were mainly estimated under the agriculture sector.

Land remaining forest but degraded to other low stock biomass categories was the biggest CO_2 emitter estimated at over 6,300 Gg. Emissions attributable to conversion of forests into cropland (deforestation) were estimated to be slightly over 3,200 Gg of which 10% is attributed to the release of carbon from soils due to soil degradation. Conversion of forests to grassland and settlements emitted about 204 and 9 Gg of CO_2, respectively.

Land categories that were net removers of CO_2 were cropland (428 Gg) and settlements (47 Gg). Afforestation is estimated to have removed 36.5 Gg of CO_2. An estimated 946 Gg of CO_2 was removed by converting grassland to cropland.

2.5.5 Waste Sector

The computations of GHG in the waste sector were based on the Revised IPCC 1996 GL guidelines. The categories for the inventory were: 1) Solid waste dump sites- methane emissions from waste dumps; and 2) Wastewater treatment -methane emissions from domestic and commercial wastewater; and methane emissions from industrial wastewaters. Categories such as waste incineration, waste used directly as fuel or converted into a fuel was calculated and reported under the Energy sector, while Carbon dioxide emissions from decomposition of organic materials were assigned to the Agriculture and Land Use Change and Forestry sector(s). Calculations were done for only methane (CH_4) emissions leaving out calculations for NMVOC.

Solid waste open dump

Due to inadequacy of national data on waste, Tier1 was used so to facilitate use of default values for calculating emissions. In this regard, Kampala City is the only urban centre with a population of more than one million inhabitants and with the only landfill in the country. All the other municipalities have unmanaged landfills that range from deep to shallow pits. National urban population data was assumed to be a better option than individual urban population data for the computation of the emissions.

Table 2-11: LULUCF emission and removals 2,000 reporting year

GREENHOUSE GAS SOURCE AND SINK CATEGORIES (Gg CO_2)		CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO
Total Land Use, Land-Use Change and Forestry		10,387.4	-1,651.4	68.8	1.4	32.4	1,132.2
A. Forest Land		6,373.4	-36.5	61.7	1.2	29.0	1,013.9
	1. Forest Land Remaining Forest Land	6,373.4		61.7	1.2	29.0	1,013.9
	2. Land Converted to Forest Land		-36.5	0.0	0.0	0.0	0.0
B. Cropland		3,280.5	-1,374.3	0.0	0.0	0.0	0.0
	1. Cropland Remaining Cropland		-428.6	0.0	0.0	0.0	0.0
	2. Land Converted to Cropland	3,280.5	-945.7	0.0	0.0	0.0	0.0
C. Grassland		204.5	0.0	7.1	0.1	3.3	117.1
	1. Grassland Remaining		0.0	7.1	0.1	3.3	117.1

	Grassland						
	2. Land Converted to Grassland	204.5		0.0	0.0	0.0	0.0
D. Wetlands		0.0	0.0	0.0	0.0	0.1	1.2
	1. Wetlands Remaing Wetlands			0.0	0.0	0.1	1.2
	2. Land Converted to Wetlands			0.0	0.0	0.0	0.0
E. Settlements		6.8	-48.7	0.0	0.0	0.0	0.0
	1. Settlements Remaining Settlements		-1.5	0.0	0.0	0.0	0.0
	2. Land Converted to Settlements	6.8	-47.2	0.0	0.0	0.0	0.0
F. Other Land		9.3	0.0	0.0	0.0	0.0	0.0
	1. Other Land Remaining Other Land			0.0	0.0	0.0	0.0
	2. Land Converted to other land	9.3		0.0	0.0	0.0	0.0
G. Other (Please specify)		512.8	-191.9	0.0	0.0	0.0	0.0
	Harvested Wood Products						
	Abandonments		-191.9				
	Soils	512.8					

Table 2.12 shows that CH_4 was the only GHG emission estimated from waste in 2000. The GHG emission from waste was estimated at 33.49 Gg of which 30.8 Gg was from solid waste and 2.66 Gg from waste water. Emissions contribution from the waste categories are: - solid waste 92.1%, domestic/commercial wastewater – 3.53%, and Industrial wastewater – 4.39%.

Table 2-12: Greenhouse Gas Emissions for 2000 from the Waste Sector

Category	Methane Emission (Gg/yr)
Net CH4 Annual Emission Gg from waste	33.49
Emission from Solid waste	30.83
Emission from Domestic/commercial wastewater	1.19
Emission from Industrial wastewater	1.47
Sub-Total for CH_4 emission wastewater	2.66

2.6 Key Sources

Key categories are those that contribute greatly to the overall level of national emissions. This is also easily seen from prepared time series of emission estimates as those categories that have the largest influence on the trend of emissions over time. The task of carrying out the key category analysis on the inventory was facilitated by the technical and other support of the UNDP Low Emission Capacity Building Project.

The key sources of GHG emissions in Uganda based on Tier 1 Category analysis, are shown in Table 2.13. N_2O Emissions from Agricultural soils tops the list (38%). This is followed by CO_2 emissions from Forest degradation (15%), CH_4 emissions from enteric fermentation (11.7%), CO_2 emissions from Deforestation (8%) and CH_4 emissions from Fuel Combustion in other sectors (7.4%). Other key categories include CH_4 emissions from forests (3%), CO_2 removals from Land converted into Cropland (2.3%), CO_2 emissions from Transport (2.0%), solid waste (1.5%), N_2O emissions from combustion activities in Other Sectors (1.4%), CO_2 emissions from forest soils (1.2%), CH_4 emissions from rice cultivation (1.1%, CO_2 removals cropland (1.0%) and N_2O emissions from forests (0.9%).

Table 2-13: Key Categories for Uganda in 2000

CATEGORIES	Current Year Emission **Estimate** (Gg CO_2eq)	Level assessment	Cumulative Percentage
3C5 - Indirect N2O Emissions from Managed Soils - indirect N2O	15,686	0.379	38%
3B1a - Forest Land Remaining Forest Land (Emissions) - CO2	6,373	0.154	53%
3A1 - Enteric Fermentation - CH4	4,830	0.117	65%
3B2b - Land Converted to Cropland (Emissions) - CO2	3,280	0.079	73%
1A4 - Fuel Combustion Activities - Other Sectors - CH4	3,045	0.074	80%
3 - Miscellaneous – Forests - CH4	1,302	0.031	83%
3B2b - Land Converted to Cropland (Removals) - CO2	-946	0.023	86%
1A3b - Fuel Combustion Activities - Transport - Road transportation - CO2	808	0.020	88%
4A - Solid Waste Disposal - CH4	630	0.015	89%
1A4 - Fuel Combustion Activities - Other Sectors - N2O	589	0.014	90%
5B - Other LULUCF Soils - CO2	513	0.012	92%
3C7 - Rice Cultivations - CH4	454	0.011	93%
3B2a - Cropland Remaining Cropland (Removals) - CO2	-429	0.010	94%
3 - Miscellaneous – Forests - N2O	372	0.009	95%

2.7 Trends in Total Greenhouse Gas Emissions 1994 - 2005

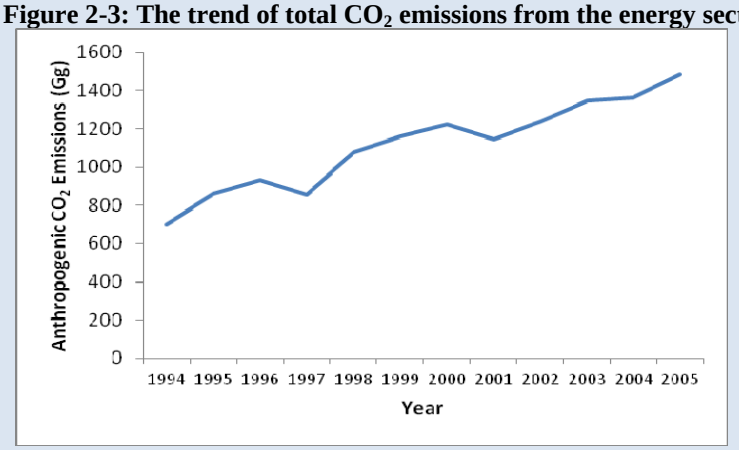
2.7.1 Energy and Transport Sector

The trend of the GHG emissions from 1994 to 2005 in the energy and transport sector had a steady increase as shown in Table 2.14. The CO2 emissions more than doubled from 699.3 Gg in year 1994 to 1,486.2 Gg in the year 2005 (Figure 2-3). The CO increased from 2,003 Gg in 1994 to 2,969 Gg in 2005. The CO_2 emission increased by 74.9 % in 2000 compared to 1994 levels. The other increases were of CO and CH_4, which increased by 29.2% and 29.4%, respectively. There was an increase in N_2O by 27% based on 1994 levels.

Table 2-14: GHG Emissions trends 1994-2005 in Gg

Year	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2	CO_2 (biomass)	CO_2 (Bunkers)
1994	699.3	113.2	1.58	45.8	2003	213.3	2.9	25,178	103.0
1995	861.4	116.4	1.59	46.95	1119	237.8	3.0	24,727	69.7
1996	934.5	120.3	1.64	48.9	1164	246.0	4.5	25,577	93.3
1997	854.9	124.2	1.0	50.2	2,189.2	253.3	3.6	26,467	98.6
1998	1,075.9	129.5	1.14	53.1	2286	264.3	3.3	27,594	134.1
1999	1,161.3	131.0	1.80	55.3	2385	153.4	3.5	28,165	117.8
2000	1223.2	146.2	2.01	60.0	2592	296.6	6.9	30,419	95.59
2001	1146.8	145.8	2.02	61.1	2582	297.2	4.3	32,258	97.02
2002	1,236.1	149.6	2.07	62.7	2659	304.1	4.0	32,121	93.4
2003	1,348	155	2.13	64	2755	313	4.1	34,237	176.8
2004	1,360.4	159.1	2.20	66.7	2825	322.1	4.41	35,078	183.6
2005	1,486.2	166.4	2.27	71.0	2969	332.2	4.38	37,069	196.49

Figure 2-3: The trend of total CO_2 emissions from the energy sector.



There were significant changes in the emissions from 2000 to 2005. The total emissions varied from year to year depending on the fuel consumption, state of the economy and the government policy at the time. Other factors included increasing fleet of inefficient second hand vehicles and the poor transport infrastructure that leads to traffic jams at peak hours in urban areas, especially Kampala. These increase emissions in the transport sector. There was a general decrease of emissions in all subcategories apart from transport subcategory though there was gradual decrease in gasoline consumption but a notable increase in diesel consumption due to increased price of gasoline that led to a shift to importation of diesel vehicles by commuter transporters and also increased number of buses which ply long distances.

2.7.2 Industrial processes sector

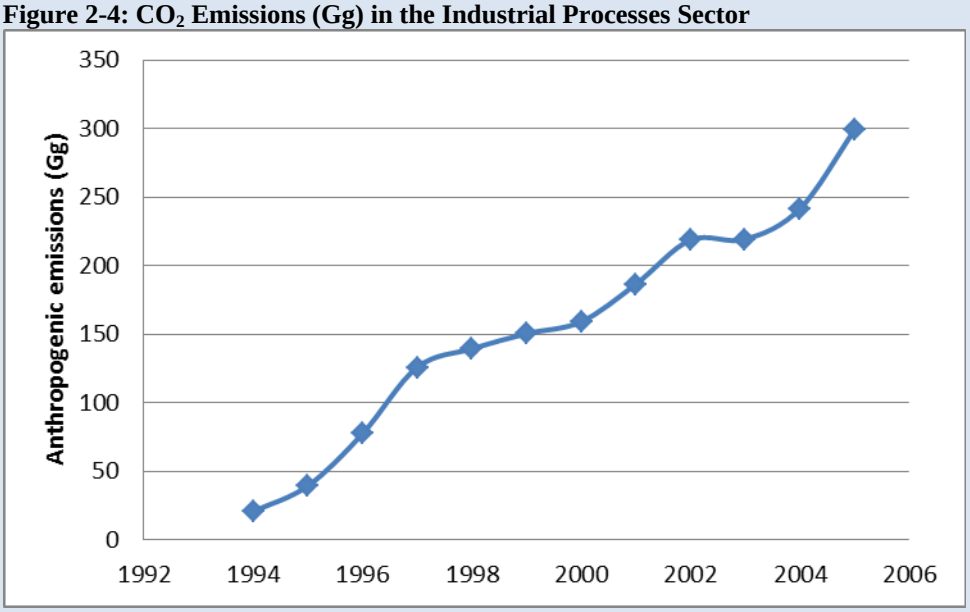
The trend in Industrial Process emissions are shown in Table 2.15. Figure 2-4 shows that there was a significant increase in CO_2 emissions from Industrial Processes. The CO_2 annual emissions that were at 21 Gg had reached 300 Gg by 2005. This was mostly from cement production.

Table 2-15: Industrial Processes GHG Emissions trend 1994-2005 Gg

Year	CO_2	SO_2	NMVOC
1994	20.8	0.0	0.8
1995	39.5	0.0	1.1
1996	77.5	0.1	1.3
1997	125.9	0.1	1.5
1998	139.5	0.1	1.4
1999	150.5	0.1	1.8

2000	159.2	0.1	2.0
2001	186.6	0.1	2.1
2002	218.8	0.2	2.8
2003	219.3	0.2	2.0
2004	241.6	0.2	2.7
2005	299.1	0.2	2.6

Figure 2-4: CO_2 Emissions (Gg) in the Industrial Processes Sector



2.7.3 Agriculture sector

The GHG emissions from the agricultural sector are mainly methane, nitrous oxide, carbon monoxide and nitrogen oxides. Their annual emissions over the 1994 to 2005 period are shown in Table 2.16.

Table 2-16: Agricultural sector GHG Emission trends (1994 – 2005)

Year	Quantity of GHG emitted (Gg)			
	CH_4	N_2O	CO	NO_x
1994	230.40	46.75	204.58	9.16

1995	235.87	47.52	208.05	9.37
1996	240.41	48.10	208.96	9.42
1997	248.12	48.90	208.69	9.17
1998	257.58	49.87	215.39	10.10
1999	263.38	50.91	220.67	11.48
2000	271.91	51.95	222.38	11.77
2001	280.47	53.11	220.09	11.30
2002	289.79	54.33	228.52	12.25
2003	299.83	55.59	233.40	12.69
2004	308.49	57.20	236.60	13.49
2005	319.59	58.22	240.64	14.94

Methane had the highest increase in emissions from 230 Gg in 1994 to 320 Gg in 2005, followed by CO emissions which increased from 205 Gg in 1994 to 241 Gg in 2005. On the other hand, N_2O emissions increased from 47 Gg in 1994 to 58 Gg in 2005, while NOx emissions increased from 9 Gg to 15 Gg over the same period(See Figure 2.5 and 2.6).

Figure 2-5: Trends of CH_4 GHG inn the Agriculture sector from 1994-2005

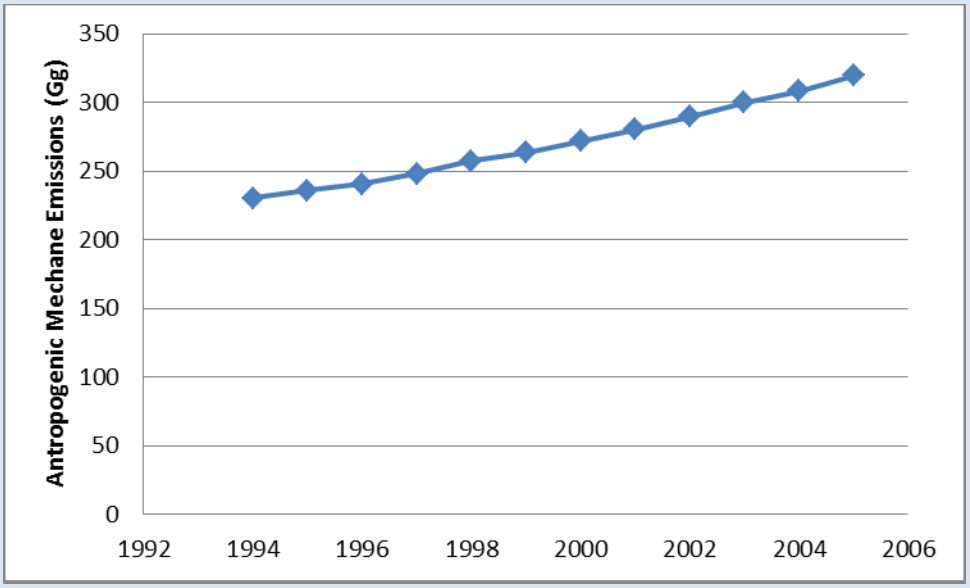
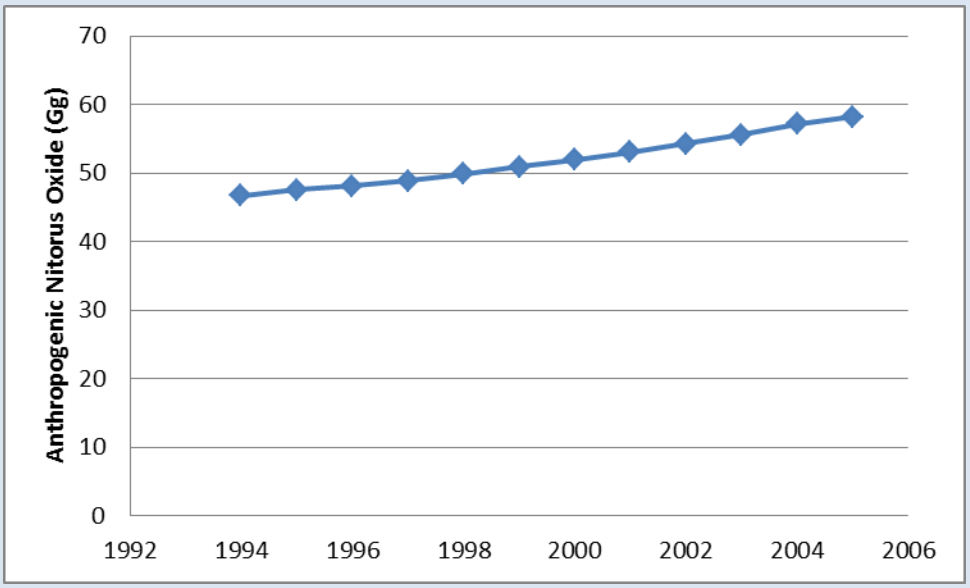


Figure 2-6: Trends of N_2O in the Agriculture Sector from 19194 to 2005



2.7.4 LULUCF Emissions Trends

From 1994 to 2005, total CO_2 emission in LULUCF steadily declined (Figure 2.8) while removals increased (Figure 2.9). Degradation of Tropical High Forests and woodlands outside gazetted areas has traditionally been the main source of emissions followed by clearing of forests for agriculture (forest to cropland conversion). Emissions due to forest degradation and deforestation continue to decline as area of forests and stock of wood (biomass) in these forests reduce. Non CO_2 emissions resulting from bush fires keeps fluctuating over time but has remained fairly the same. This is probably because the areas affected by these bush fires and biomass stock in the north and north eastern Uganda (areas mainly affected by wildfires) fairly remained the same from 1994 up to 2005.

It is too early to conclude on whether the high emission figures exhibited in 2005 (CO of over 4,000 tones and CH_4 of over 200 tones) were due to increase in wildfires or should be attributed to improvements in technology which detects wildfires – see Table 2-17. It is worth noting that without a mechanism in place to curb wanton burning of forests, emissions from wildfires could remain a significant source for some time to come.

In the long term projection, CO_2 emissions related to land use and changes in land use would continue to decline, emissions from wildfires would not decline as fast as those from LULUCF. With proper interventions on both the demand side of biomass (e.g., reducing heavy reliance on

wood fuel) and its supply side (e.g. afforestation) the LULUCF sector could turn from being a net emitter to a net remover of GHG.

Figure 2-2: LULUCF emission trends 1994 to 2005 (Gg)

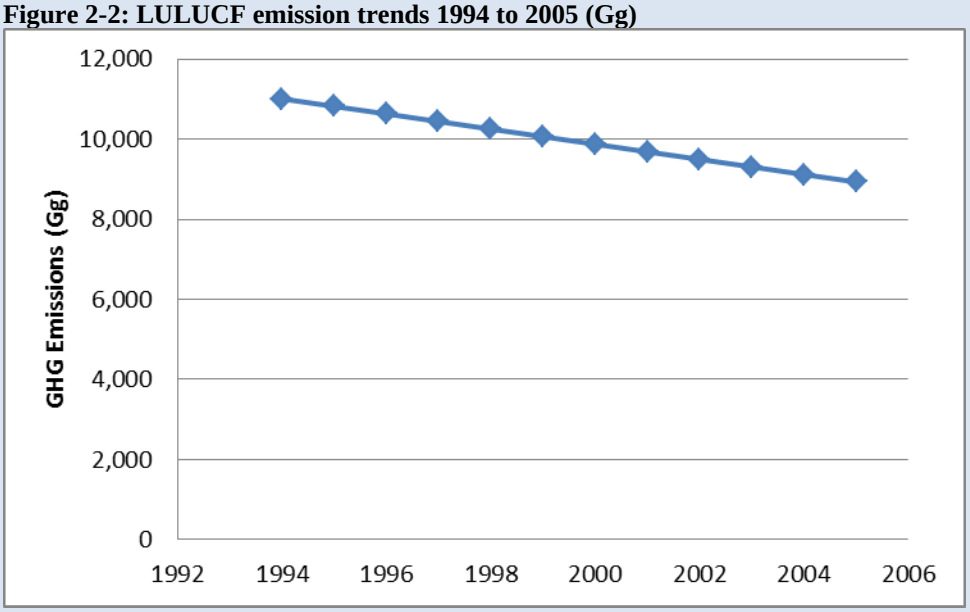


Figure 2-9: LULUCF removals (Gg) trends 1994 to 2005 (Gg)

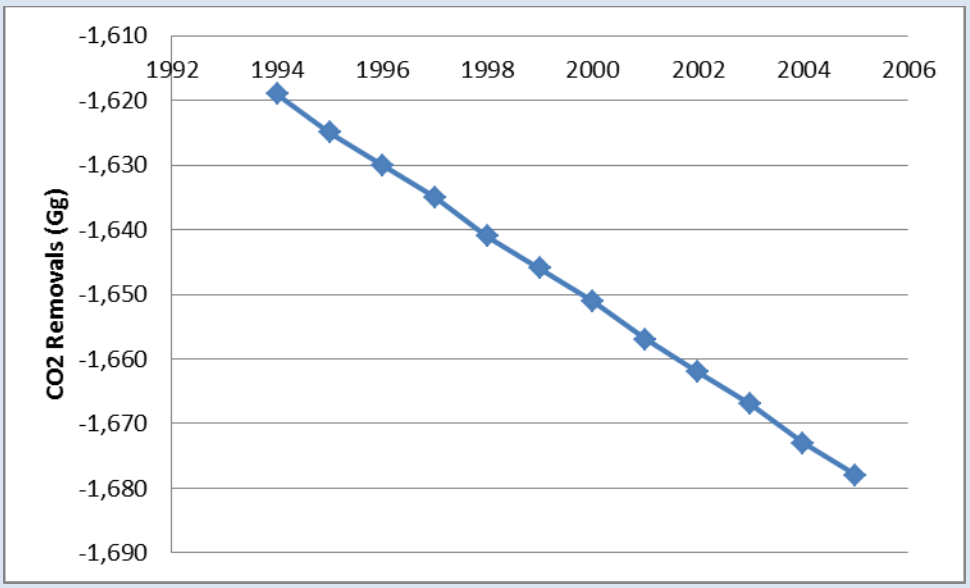


Table 2-17: LULUCF Emissions and sources 1994 to 2005

Year	CO2 Emissions	CO2 Removals	Annual CH4 emissions	Annual N2O emissions	Annual NOx emissions	Annual CO emissions
1994	11,009	-1,619				
1995	10,820	-1,625				
1996	10,631	-1,630				
1997	10,442	-1,635				
1998	10,253	-1,641				
1999	10,064	-1,646				
2000	9,875	-1,651	76	1	36	1,248
2001	9,686	-1,657	104	2	49	1,710
2002	9,497	-1,662	52	1	24	850
2003	9,308	-1,667	76	1	36	1,248
2004	9,119	-1,673	127	2	59	2,081
2005	8,930	-1,678	287	6	135	4,717

Notes: Emissions not available for years before 2000

2.7.5 Trends in Emissions from Waste

The waste sector Emissions increased by 71.9% between the year 1994 and 2005; by 38.0% from 2000 to 2005; and by 22.4% from 2005 to 2010. The emission trends for selected years are: 1994 (26.9Gg CH_4); 2000 (33.49 Gg CH_4); 2005 (46.23 Gg CH_4) to illustrate the trend lines of emissions from the waste sector. The trends indicate increase of emissions from 1994 to 2005; an indication of increased waste generation in urban areas due to the increasing urban population. The annual methane emissions from the waste sector between the years 1994 and 2005 are shown in Figure8.

Estimation of methane (CH_4) as a greenhouse gas emission from the waste sector by category was solid waste 80%; domestic/ commercial wastewater 11% and industrial wastewater 9% as shown in Figure 2-10 and Figure 2-11.

Figure 2-10: Methane emissions (Gg) by waste category in the waste sector (1994-2005)

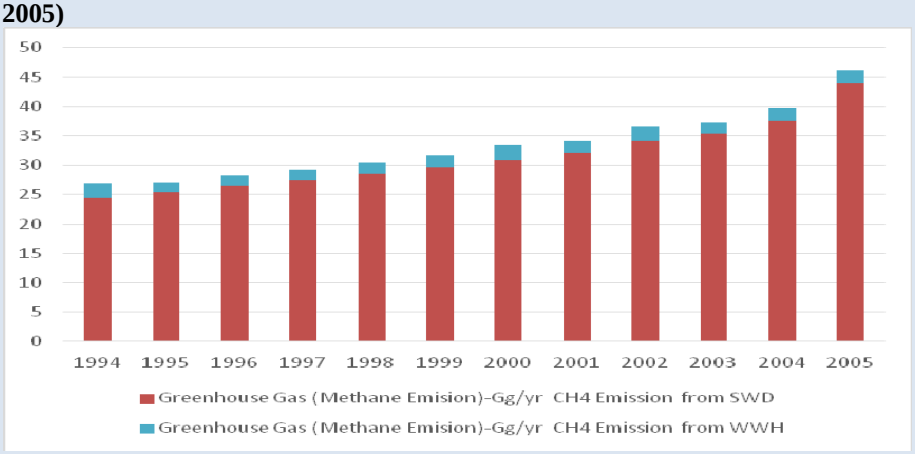
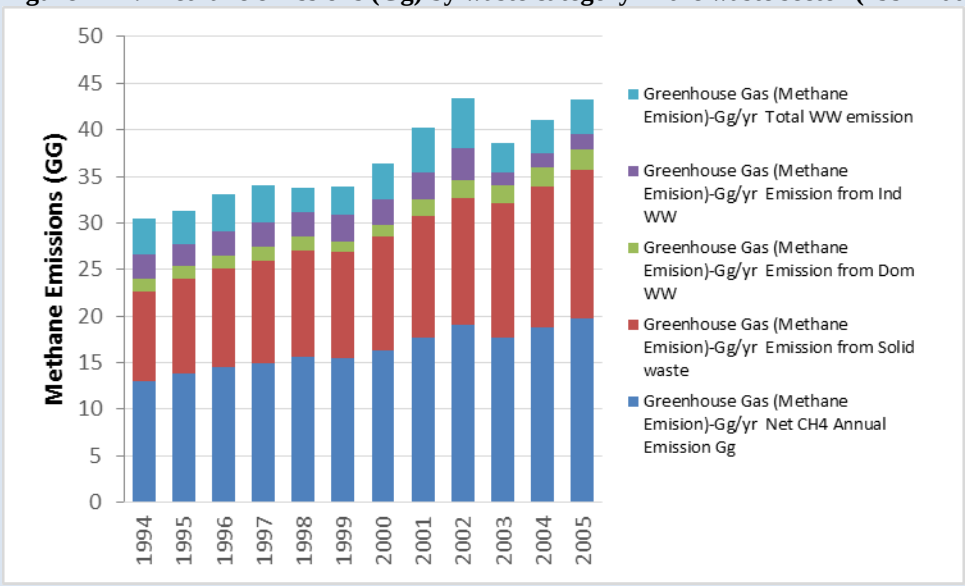


Figure 2-11: Methane emissions (Gg) by waste category in the waste sector (1994-2005)



The growing rates of waste generation especially in the urban areas are due to population increase and urbanization, which are generally the factors driving the increase in GHG emissions from the waste sector. The amounts of wastes generated by the urban centres pose increasing management challenges. Except for Kampala City where solid waste is disposed in a landfill, all other urban centres have over the years, been disposing solid waste in burrow pits instead of constructed landfills, with no control of methane emission. There is also no direct policy on methane mitigation from wastes.

2.8 Recommendations and Improvements

The experience in compilation of the GHG inventory for the INC and SNC shows that the country possesses a considerable high level of technical expertise on the source and sinks categories (forests, crops, livestock, energy, etc.) in many of the government, and non-government institutions. However, the following recommendations need to be considered to improve the process and the results:

- Several national organizations required to be actively involved in the process did not have the motivation. This was a challenge that exist needs a formal and institutionalized framework and planned process for compiling the GHG inventory and specifications for data collection, documentation and archiving ought to be adopted and operationalized. This could be backed by appropriate institutional and legal arrangements so that the tasks involved could be undertaken as routine activities among government and private entities prior to inventory preparation.

- To ensure accuracy and quality assurance/control of the inventory, rules of procedure for inventory preparation and manual(s) of sources, methods, data, emission factors and assumptions developed simultaneously with the compilation of the SNC (thanks to the support from the UNDP LECB Project) may be utilized by future teams. An Archiving System is a critical component of the inventory development process and is important for sustaining any National Inventory System. The SNC did not benefit from sufficient archives and this should be improved.

- The results of the key category analysis could serve as a contribution to the process of improving the greenhouse gas inventory such as applying more accurate or higher tier methodologies, collecting more detailed activity data, or developing country-specific emission factors.

Other specific recommendations are outlined in Chapter 6 on gaps, constraints and capacity and financial needs.

Chapter 3 : IMPACTS, VULNERABILITY AND ADAPTATION MEASURES

3.1 Introduction

World over, extreme weather events are increasing in frequency, intensity and severity. In Uganda the extreme events are mainly characterised by droughts, floods, landslides and heat waves. Unlike developed countries, developing countries lack adaptive capabilities and well established disaster management systems. In 2001, the Conference of the Parties approved the development of National Adaptation Programmes of Action (NAPA) for the least developed countries with the primary objective of supporting them identify the most vulnerable sectors and their immediate and urgent interventions. This chapter outlines the observed state of climate variability in Uganda and the long term climate model predictions of Uganda's climate. It also reports on vulnerability assessment and adaptation measures pertinent to Uganda.

3.2 Climate and climate variability

Uganda's key economic sectors such as agriculture, water resources, fisheries, tourism and health are dependent and sensitive to climate variability and climate change. Therefore, Climate Change (CC) has serious direct and indirect impacts on the social and economic development of Uganda.

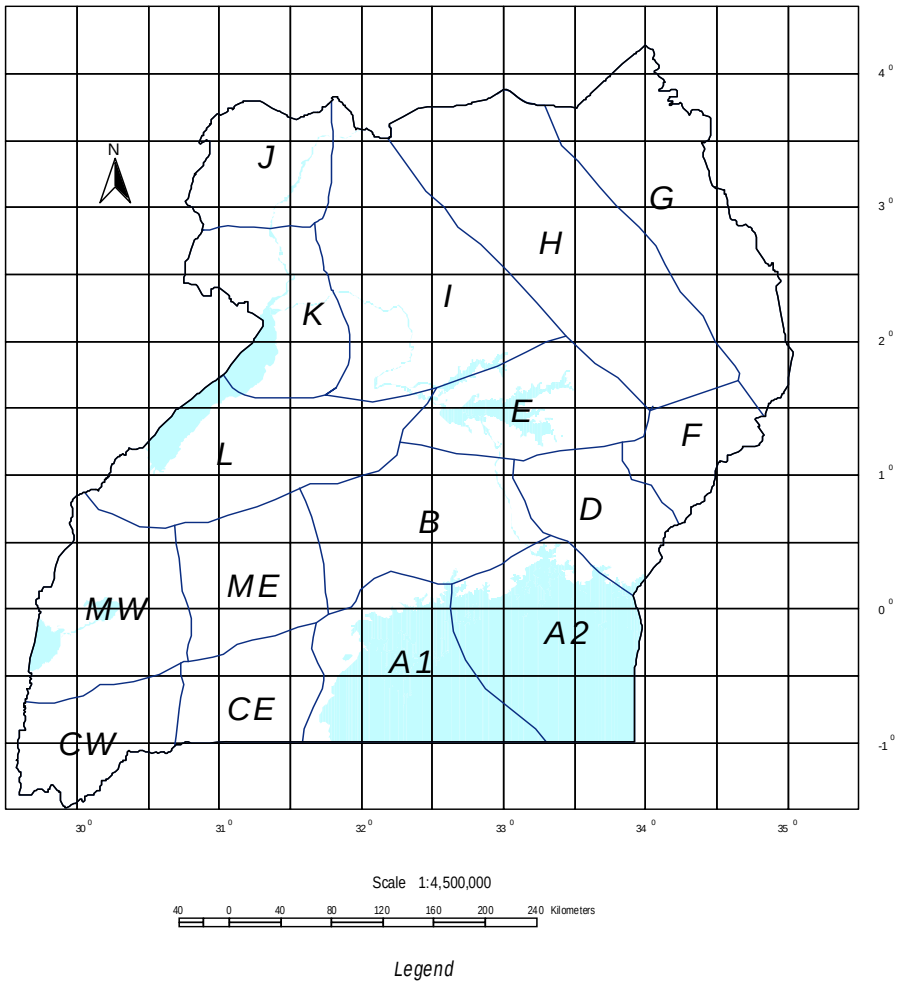
3.2.1 Rainfall seasonality, variability and trends

Rainfall in Uganda is seasonal and the timing, intensity, duration and relative importance of the seasons varies considerably across the country. Farmers have an idea, based on experience, of when rainfall is likely and when crops should be planted to be successful in a particular location. Similarly, meteorologists and other parties concerned with weather and the climate of the country as a whole ably describe in everyday language and to some extent in scientific terms, the variations observed across the country.

The analysis of weather and climate patterns in this report was based on the 16 climatological zones as delineated by Basalirwa in 1993 (see Map 3-1 for details)

These zones have proved to be useful for the presentation and analysis of various features of the hydro-climatic regimes of the country.

Map 3-1: The 16 delineated homogeneous zones of the country



3.2.2. Tele-connections (El Nino / Southern Oscillation – ENSO)

El Nino / southern oscillation (ENSO) is the principal mode of inter annual variability in the global tropics. To a first approximation, the ENSO can be viewed as a modulation of the global monsoon / trade wind system. This modulation is manifested in the modification and displacement of large-scale precipitation patterns and includes episodes of both floods and drought.

In Uganda, the potential impacts of El Nino and Lanina on the weather and climate patterns are most pronounced during the season September to December; it is to such an extent that El Nino is often equated to floods while Lanina is often equated to droughts during this period. Globally, the occurrence of moderate, strong and very strong ENSO events is shown in Table 3-1.

Table 3-1: Global ENSO events between 1960 and 2000

EL NINO EVENTS			LANINA EVENTS		
Moderate	Strong	Very strong	Moderate	Strong	Very strong
1965	1972	1982	1964	1975	1973
1969	1987	1997	1970	1998	1988
1986	1991		1971		
1992			1999		
1994			2000		

3.2.3 Seasonality and variability at the Zonal mean monthly rainfall patterns

In general, Uganda experiences two modes of rainfall seasons. The uni-modal with one long rainy season mainly from late March to about mid- October occurring in the Northern region of the country and bi-modal, March to May and September to November in the rest (western, central and eastern areas) of the country. Details of the mean annual rainfall patterns and the seasonal rainfall percentages are given in Figure 3-1 to 3-4.

There is also great climate variability between regions of the country from the driest regions like Karamoja in the Northeast to the wettest regions like north-western parts of Lake Victoria. Figures 3-1 to 3-4 illustrate patterns of zonally averaged monthly and pentad rainfall of the two models over a 30-year period (1961 - 1990) of four climatological zones. For pentad analysis, probability level series were developed for the mean, El Nino and Lanina years.

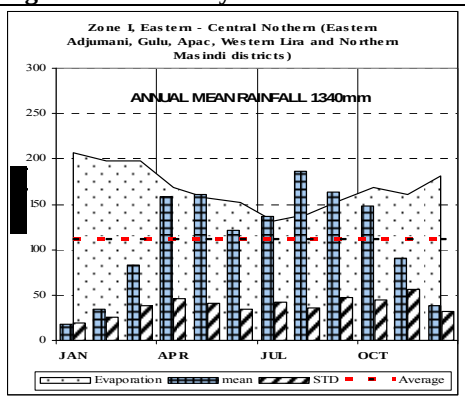
For purposes of the analysis, Uganda was broadly divided into four regions; namely:-

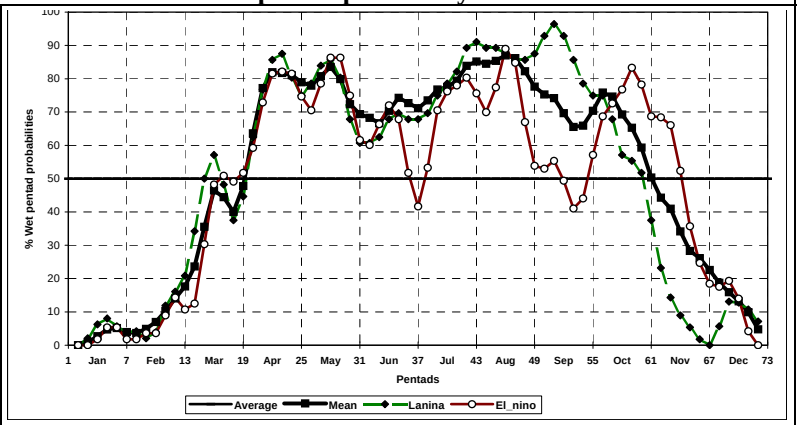
- Northern region -Zone H in northeast and Zone I in the northwest
- Eastern region - Zone F in Mt Elgon area and Zone D in the South East
- Central region –Zone B Part of Buganda sub-region and A2 in North West Lake Victoria Basin
- Western region –Zone CW in the South-western and CE in Eastern part of the region

Northern Region (Figure 3-1)

The rainfall season is strongly unimodal, from late March to late September with peaks in May and July for the Northeast and to late October with peaks in May and August for the Northwest. It also varies in amount across the same region with zone H having the lowest average amount of rainfall (745mm) and zone I with the highest average rainfall (1350mm). The monthly rainfall variability as measured by the standard deviation (STD) is relatively higher during the driest months (November to February). The impact of the El Nino phase of the ENSO cycle is to suppress the rainfall especially during the month of September thus breaking up the unimodal season into bimodal, with a secondary season from early October and extending to late November during El Nino. On the other hand, the Lanina phase forcing generally strengthens the unimodal rainfall pattern.

Figure 3-1: Monthly rainfall and STD for zone I and the % wet pentad probability levels for zone H



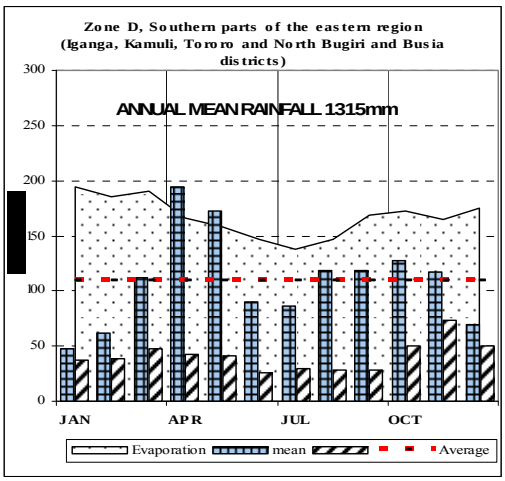


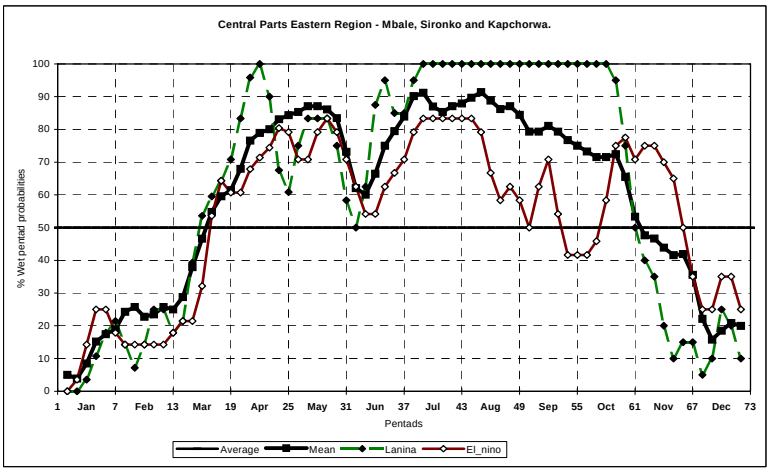
The Eastern Region (Figure 3-2).

The rainfall seasonal patterns are transitional. It is broadly unimodal over the Mount Elgon region, from late March to early November with peaks in May and August, while over the southeastern region; the season is bimodal, with the main season from March to May and a secondary moderate broad season from August to November. The rainfall variation is moderate with averages of 1330mm in the Mount Elgon Mountain region and 1315mm in the Lake Kioga and eastern region. The monthly rainfall variability is relatively highest during the driest months from November to February.

During the El Nino period, rainfall is suppressed especially during the period of mid-August to mid-October, thus breaking up the unimodal season into two seasons over Mount Elgon region, with a secondary season from mid-October extending to late November. On the other hand during the Lanina period the unimodal rainfall pattern is strengthened

Figure 3-2 Monthly rainfall and STD for zones D and the % wet pentad probability levels for zone H





The Central Region (Figure 3-3)

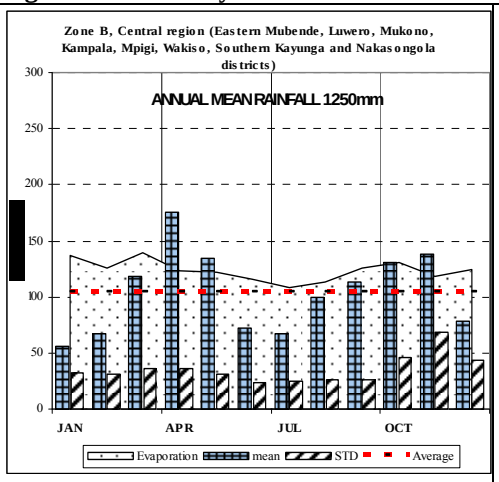
The rainfall seasonal pattern is strongly bimodal, from March to May and from September to mid-December with peaks in April and November. The annual average rainfall is 1250mm and 1440mm in Zone B and A2, respectively, in this region. There is a moderate variability in rainfall amounts over the region.

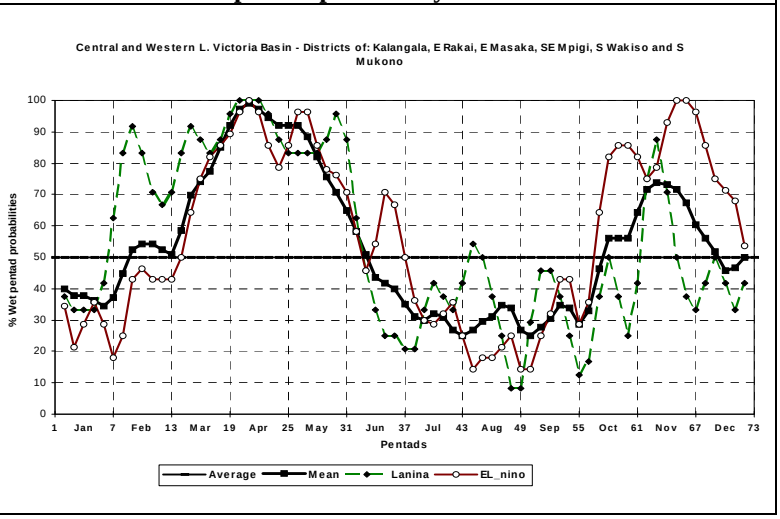
During the ENSO period, the variability is amplified. In the El Nino period, there is a dramatic increase in rainfall during the months of October and November. On the other hand, rainfall is suppressed and erratic during the lanina period.

Western Region (Figure 3-4)

In western region, the rainfall season is strongly bimodal, from March to May and from September to mid-December with peaks in April and November. The average rainfall in Zone CW is 1120mm while it is 915mm in the relatively dry parts of Zone CE. The monthly rainfall variability is highest during the driest months, from June to July.

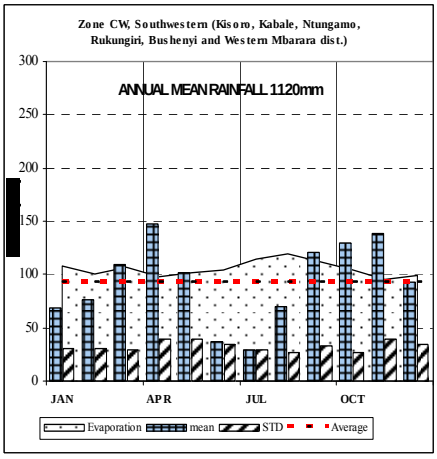
Figure 3-3: Monthly rainfall and STD for zones B and the % wet pentad probability levels for zone A1

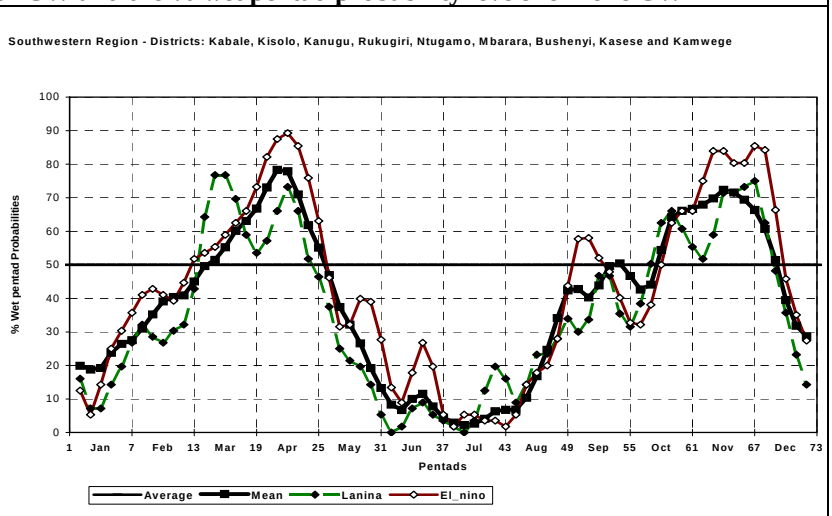




During the El Nino, the amplitude of bimodal season is amplified with increased rains during the September to December period. During Lanina rainfall is suppressed during the month of May thus prolonging the dry season from May to August.

Figure 3-4: Monthly rainfall and STD for CW and the % wet pentad probability levels for zone CW





3.2.4 Special climate change induced rainfall and height variability analysis of Lake Victoria basin

The Lake Victoria Basin ENSO based rainfall variability factors were analysed using 1961 to 1990 monthly rainfall series for about 50 stations obtained from the National Meteorological services of the traditional East African countries. The data for the lake's level as measured at

Jinja, at the outlet of the Nile River, were obtained from the Water Development Department of Uganda. The entire basin block rainfall amount was taken to represent the best approximation of the month to month lake recharge and thus the best tool for monitoring and evaluating the variability of the closely related lake levels.

The mean annual rainfall amount over the entire Basin was about 1317mm with the peak of March to May season having 513mm (39%) and the secondary season October to December, 378mm (29%). The remaining six months of the dry seasons, June to September and January to February, receive about 426mm (32%). On the other hand, the main lake height level season is between been April to June with a minor peak season November to January (Figure 3-5(a)). As expected the lake height levels were out of phase or lag the rainfall amounts by about one month which indicates a close correspondence between the two.

To evaluate the ENSO related rainfall and height level variability, composite standardized monthly anomaly series were developed for a 2 to 3 year ENSO cycle (Figure 3-5(b)). The rainfall anomaly series indicates sharp persistent suppression from June to September of a typical El Nino year prior to the now well-known October through to January enhancement of the second rain season. On the other hand, during a typical Lanina year the opposite happened, there was rainfall enhancement between June to September and suppression between October to about May of the post Lanina year.

The lake levels responded systematically with a lag of about one to two months, with the onset of enhanced rains in October the lake levels start increasing significantly from November. The positive anomalies were maintained for about one year fluctuating upwards and downwards in response to positive or negative rainfall anomalies. However with systematic significant negative rainfall anomalies setting in from October of the Lanina year the lake levels would start declining rapidly and negative anomalies would develop by April of the post Lanina year and be maintained for at least three months.

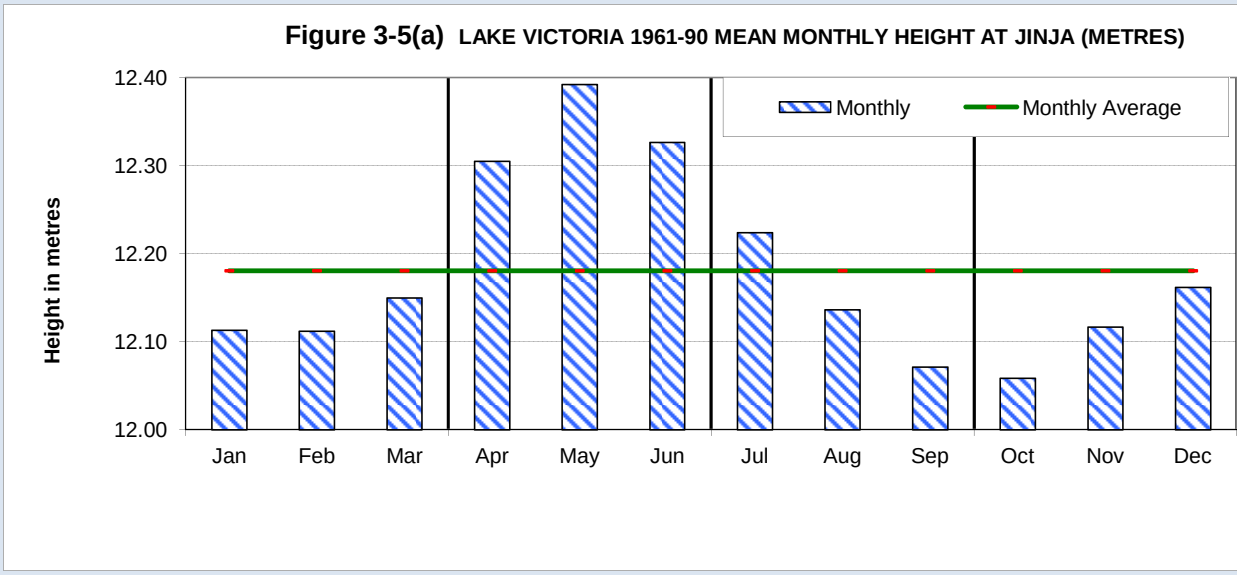
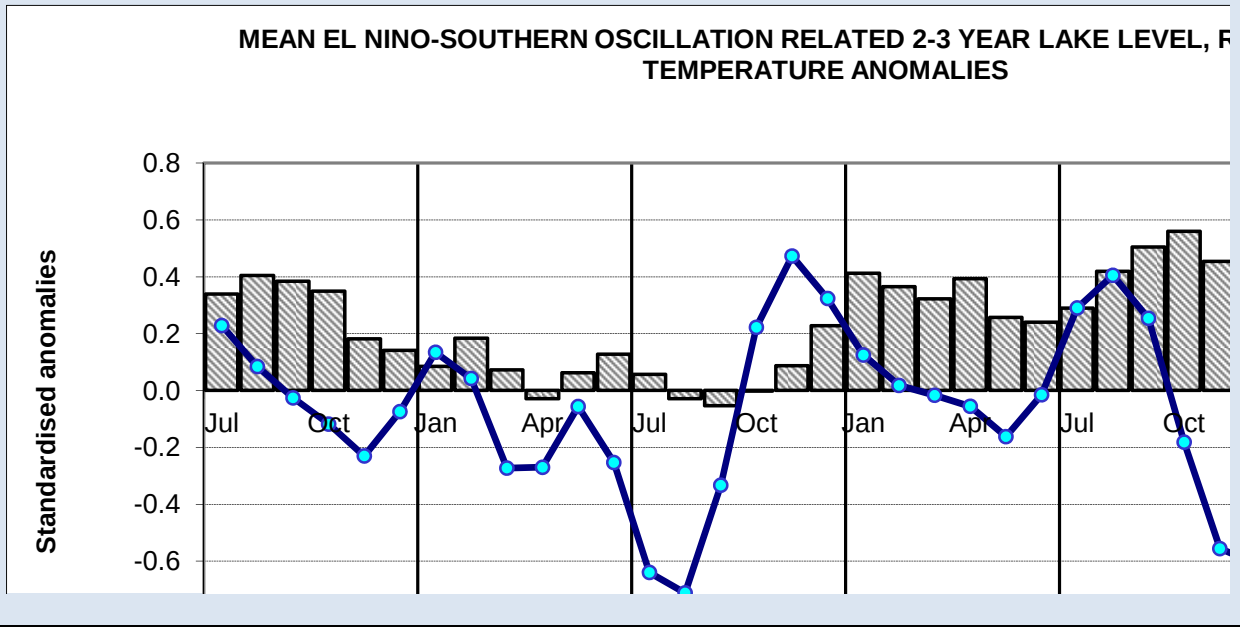


Figure 3-5(b): L. Victoria 2-3 year ENSO related Basin Height and rainfall anomalies



3.2.5 Time series/trend analysis on zonal rainfall series

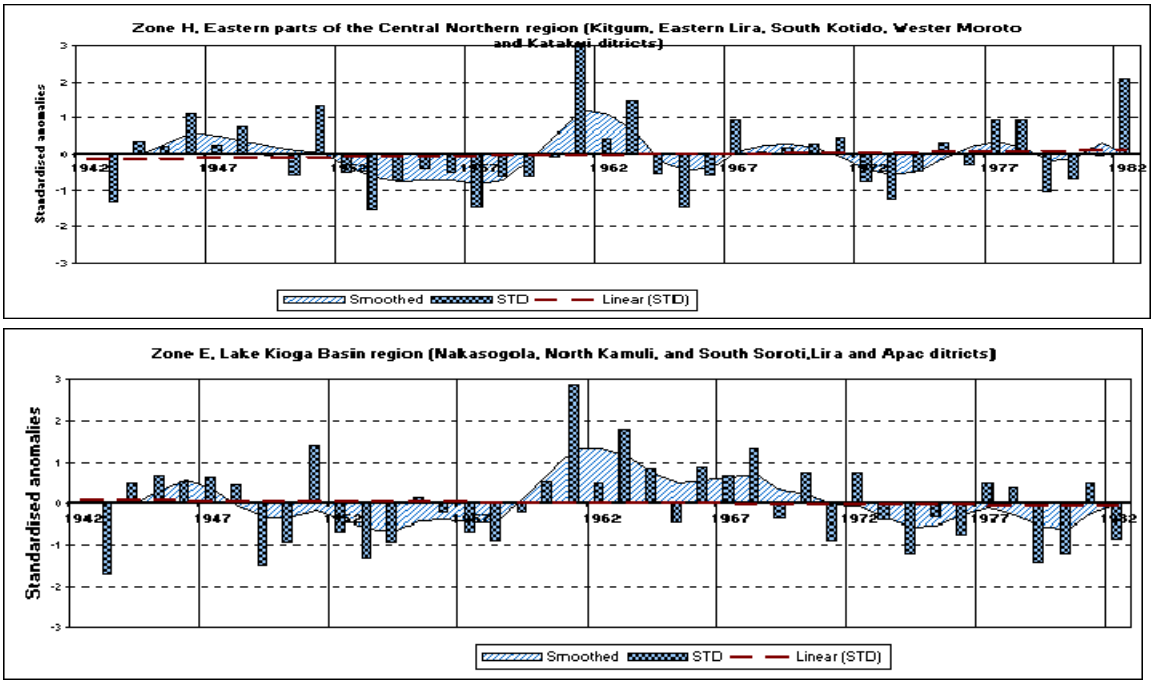
Time series analysis was carried out on annual rainfall data for the period with the best reliable data for eight representative zones of Uganda. These are: 1) Zone B- Central region, 2) Zone A1- Western lake basin; 3) Zone D- South-eastern region; 2) Zone A2- Eastern lake basin; 5)

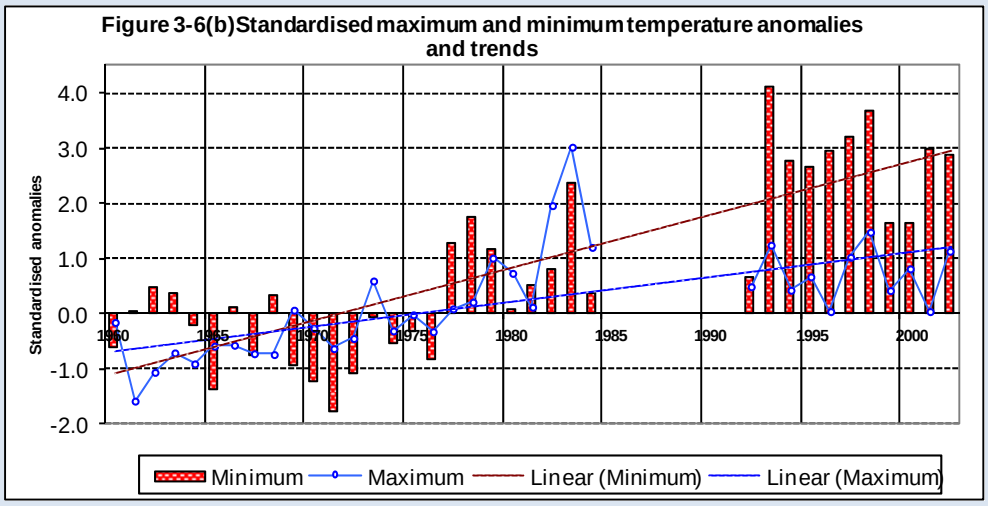
Zone H- Central northern region; 6) Zone E- Lake Kioga basin; 7) Zone MW- Central western region, and 8) Zone CW- South-western region. The analysis was in the form of annual standardised anomalies and trends over the forty year period. For simplicity, results are presented for Zones H, E, MW and CW (Figure 3-6(a)).

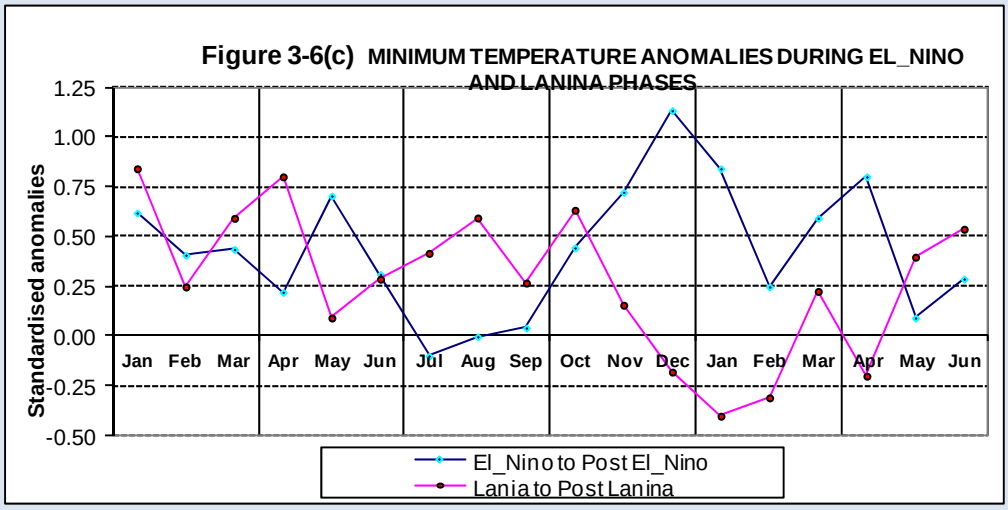
The results indicate a general pattern of annual to inter-annual variations, during certain periods, with years of normal to above normal or normal to below normal rainfall persisting for several years. In particular, the period from the late fifties to about mid-sixties was when almost the whole country experienced record heavy rains. On the other hand, during the period1943 to about 1957/58; most parts of the country, except the south-western and to a certain extent the central western, experienced normal to below normal rainfall. The trend analysis revealed no significant trend of either increasing or decreasing rainfall over the forty year period as the trend line was almost horizontal for almost all the zones analysed, with only the central western region indicating a moderate negative trend.

Time series analysis in the form of annual standardized temperature anomalies and trends was also carried out over the forty year period over the high ground southwestern region of Kabale (Figure 3-6(b)). The analysis showed significant temperature increases, especially the minimum from the early 1990s to 2000 and beyond (Figure 3-6(b)). Overall over a 30 year period, 1970 to 2000, the trend line indicates an increase of the minimum temperature as well as the maximum temperature. Significantly, the gradient for minimum temperature is greater than the one for the maximum temperature. The minimum temperature increases are most pronounced during the period October to April of the El Nino phase of the ENSO cycle (Figure 3-6(c)). During this phase positive temperature anomalies of over 1º C can occur while during Lanina negative anomalies of up to -0.4º C can occur.

Figure 3-6(a): Time series trend analysis for zones H, E, MW and CW







3.2.6 Droughts and floods

Drought is a phenomenon of devastating effect to the social economic profile of any country that derives its livelihood from activities generic to water resources. Droughts are classified as Hydrological, Meteorological or Agricultural depending on the context under consideration. The important variable in Hydrological droughts is availability of water in rivers, lakes, reservoirs and underground water storage. On the other hand, in meteorological, it is rainfall, while in Agriculture it is soil moisture content to sustain crop growth. In this section, an attempt is made to describe the drought events that have occurred in Uganda using a stochastic approach on the time series of the annual rainfall sequences.

3.2.6.1 Monthly seasonal rainfall occurrence probability maps

The probability of occurrence of three defined ranges of rainfall amounts for the two main rainfall seasons of the country of March - May and September – November was used to assess drought occurrence. March to May is the main stable rainy season over most parts of the country. During the season, the probability of normal range of rainfall was generally over 80% except over the extreme north-eastern areas where the probability dropped below 70% (Figure 3-7). The probability of below normal rainfall[3] was low, around 10% over most parts of the country except over the extreme north-eastern areas where it were up 20%. The probability of above normal rainfall[4]is also low, just around 10%, over most areas of the country.

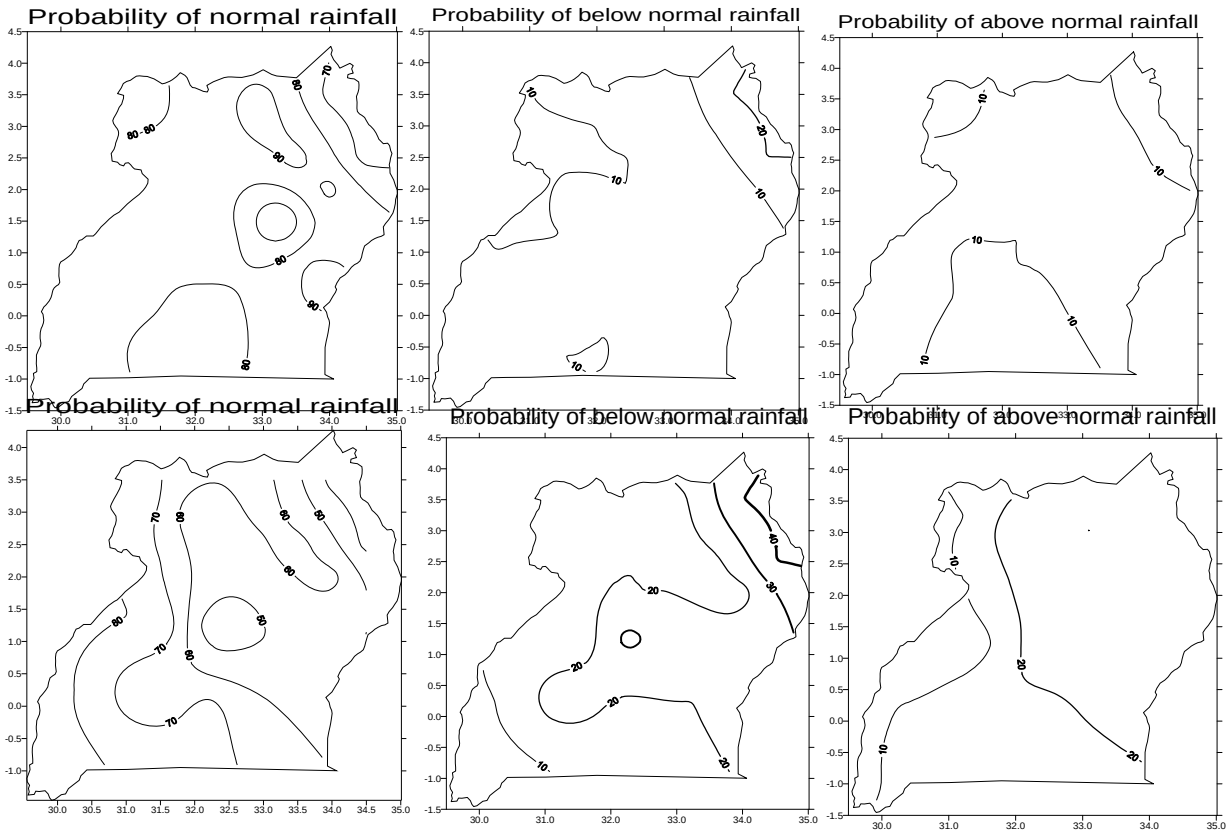
The season October to December had been the most variable season. The probability of getting the normal range of rainfall was between 70 to about 80% over the western areas where the main rainy belt for this season is centred but dropped to around 50% over most areas of the eastern region and extending into the central parts of the country (Figure 3-7). The probability of below normal rainfall was fairly high, over 20% over most parts of the eastern region and to above 40% over the north-eastern areas. The probability of above normal rainfall was also fairly high (over 20%) over most parts of the eastern areas. It has been demonstrated that the variability during this season was mainly driven by the variability of the ENSO cycle.

The high variability of rainfall during this season was reflected into high incidences of droughts and floods especially over the eastern areas of the country and over the North-eastern in particular. Quite often the droughts lead to famine conditions due to the wide scale crop failure and or poor performance.

[3] The below normal rainfall is taken to be below 75% of the long term (preferably 30 years) mean rainfall amount

[4]The above normal rainfall is taken to be over 125% of the long term (preferably 30 years) mean rainfall amount

Figure 3-7: Probabilities of normal, below and above normal categories for March to May (above) & September to November seasons (below)



3.2.6.2 Drought duration analysis

In view of the seasonality of the rainfall, the drought duration was analysed for two periods:

i) April-October, thus picking up the dry period between the first and the second rainy season.

ii) October-April, which picks up the dry season between the second and the first rainy season.

The sample results for the rainfall thresholds of 50mm and at the non-exceedance probability of 0.5 (Figure 3.9) reveal that the drought duration for the period April to October is most pronounced over the southwestern region of the country. At the threshold of 50mm, it takes up to about three months (18 pentads) to realise the accumulations. On the other hand, during the period October to April, the drought duration is most pronounced over the north-eastern region of the country where it takes up to four months (24 pentads) to accumulate 50mm. It should be noted that the drought duration increases/decreases with increasing/decreasing threshold rainfall amounts and levels of non-exceedance probability.

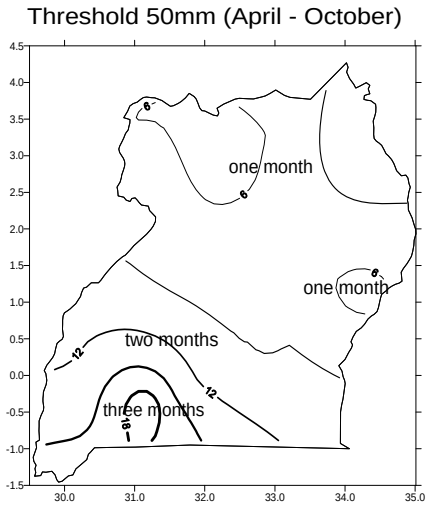
Results of ENSO episode impacts are minimal during the April to October period but quite significant; especially over the northern region during the October to April period. During a typical Lanina year, there is a tendency for an early cessation of the second rainy season, thus an early onset of extended drought conditions/duration. On the other hand, during a typical El Nino year, there is a tendency for the second rainy season to be extended, November/December, thus reducing the drought duration.

3.2.6.3 The 1951-1999 Decadal frequency of occurrence of droughts and floods within Four representative zones (zones I, D, B and CE) and their overall mean.

Figure 3-9 gives the graphs for two of the four zones, CE and D, and the overall mean of the four. Most of the zonal trend lines, and for the overall mean, indicate only weak to moderate trends. It is only over the south western zone where the trend for wet conditions appears to be strongly negative while the trend for dry conditions over the eastern areas appears to be moderately negative. In summary the graphs reveal wide spatial and temporal variability between the episodes of wet/very wet years and dry/very dry years as well as between wet and dry decades. This is reflected in wide variations in the spatial and seasonal to inter-annual variations in the severity and duration of droughts and flood conditions. Furthermore, as with the analysis of seasonal rainfall amounts, the eastern region has been shown to indicate the highest number of incidences of dry years/drought episodes.

Finally, the mean graph for the four zones indicate an overall moderation of the frequency of occurrence of the droughts and floods since there is, during certain decades and over certain zones, a strong negative relationship between the decadal frequency of ENSO events (El Nino and Lanina) and the occurrence of floods and droughts. This results in a balancing up or cancelling of opposite events; this is more evident between the southwestern and the southeastern zones especially during the decade 1971-80 where the flood/drought ratio was 4/1 against 2/6.

Figure 3-8 Maximum Drought Duration at 0.5 non-exceedance probabilities at thresholds of 50mm



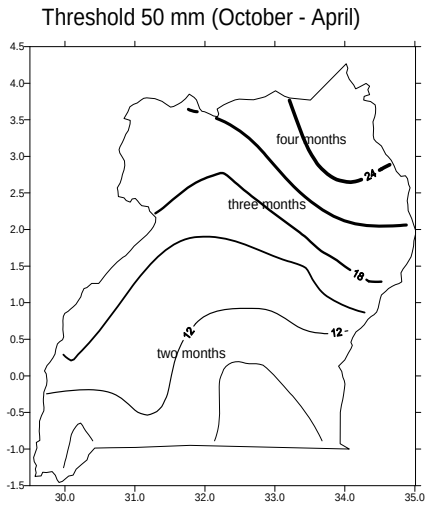
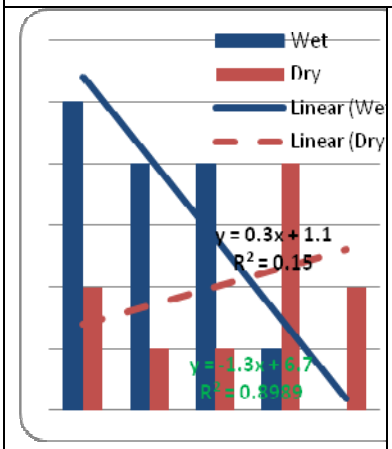
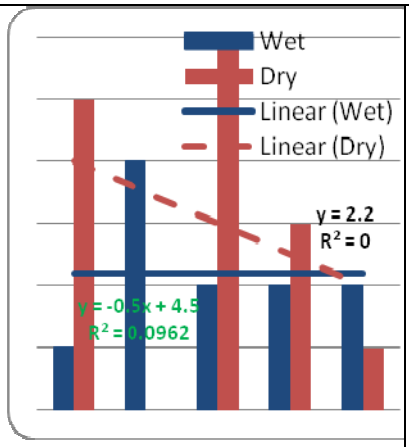
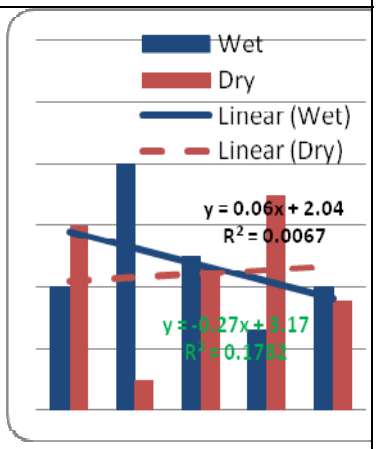


Figure 3-9 Decadal frequency of occurrence of droughts and floods for two (zones CE and D) of the four zones and the overall mean of the four







Zone CE	Zone D	Zones I,D,B&CE mean

3.2.6.4 Detailed analysis of the evolution of rainfall anomaly patterns over the country during the period of extreme ENSO variability of 1997-2002

The years 1997 to 2002 were characterized by very wide variations in the Sea surface temperatures (SSTs) of the Equatorial Pacific Ocean, which is the center of El Nino/Lanina

development. 1997 witnessed the development of the strongest 1997/1998 El Nino of the century; however, this was followed by a strong Lanina of 1998/99 with Lanina conditions persisting up to 2000. The year 2001 was a transitional year (near normal or neutral) from Lanina to the moderate El Nino conditions of 2002/3.

The wide variations in the Equatorial Pacific Ocean reflecting El Nino, Neutral and Lanina conditions were to a great extent reflected accordingly in the wide variations of the rainfall patterns over the country especially during the season October to December. The seasonal (October to December) geographical anomaly maps Figure 3-10 give a more vivid picture of the strong impact of the ENSO cycle, especially for the century El Nino of 1997/98 and the strong Lanina of 1998/99. The strongest El Nino of the century of 1997 resulted into one of the worst widespread record floods witnessed by the country especially over the eastern region. The moderate El Nino of 2002 also accordingly resulted into moderate floods also centered over the eastern areas of the country. On the other hand during the 1998 Lanina the season October to December instead witnessed rainfall suppression (negative % rainfall departures) especially over the south-eastern region of the country, which was the opposite of 1997. This clearly demonstrates that the eastern region experiences the most pronounced impact of the ENSO forcing. Finally, during the near normal year of 2001 no wide variations were reported over most parts of the country.

Figure 3-11, which indicates the % rainfall departures for the season March to May for the same years, confirms the fact that there are no characteristically consistent wide scale anomalous rainfall patterns specific to El Nino, Lanina and near normal years during the season March to May in Uganda. However this does not rule out short term, weeks to a month, significant variations.

3.2.7 Conclusions and recommendations

The impacts on the weather and climate of Uganda due to climate variability and change are mainly reflected in seasonal to inter-annual rainfall variability and change as reflected in variations or shifts in the seasonal rainfall onset, duration, cessation, intra-seasonal dry spell occurrence and rainfall intensity, thunderstorms, lightening, hailstones. The extreme impacts lead to floods and droughts and often to famine.

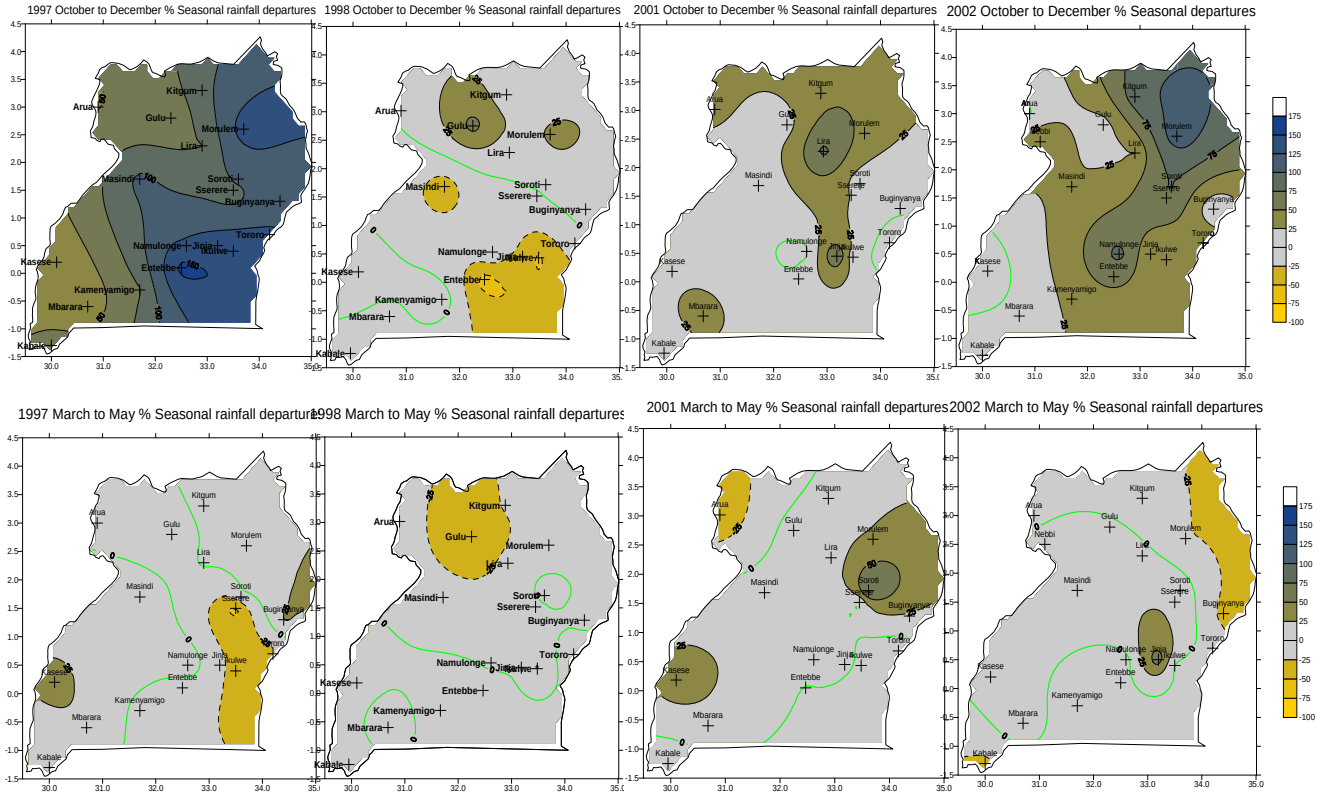
The floods related impacts lead to secondary impacts of landslides, soil erosion, silting of dams and drainage channels, bursting of dams and river banks, water logging in low lying valleys and wetlands, water leaking, outbreaks of epidemics in animals and crop diseases and pests, etc. On the other hand, drought related impacts lead to secondary impacts including degraded grazing and agricultural lands and, overall environment; leading to desertification. Furthermore, there can be drying up of water ponds, reduced surface water, river flows and underground water levels, increased wild fire outbreaks, dust-storms etc.

Overall, the extreme climatic events in Uganda were strongly linked to El Nino and Lanina which are predictable. Therefore the ENSO related predictions should form the core lead information in planning the vulnerability assessment and adaptation risk management.

Subsequent sections of this chapter outline vulnerability assessments of Uganda's socio-economic sectors

Figure 3-10 October - December seasonal anomaly maps for 1997, 1998, 2001 & 2002 (above)

Figure 3-11 March - May seasonal anomaly maps for the years 1997, 1998, 2001 & 2002 (below)



3.3 Projected changes in climate parameters

3.3.1 Introduction

Climate Change is expected to induce multiple effects on livelihoods, animal and plant health, environment as well as on ecosystem stability and resilience. These effects are increasingly being recognized as significant factors contributing to poverty in Uganda because of their implications to agriculture and food security, water resources including ecosystems goods and services as well as its direct and indirect effects on human health.

Most of the General Circulation Models predict mean annual temperatures increment all over Uganda. This is likely to increase the severity and frequency of droughts, heat waves in the country. However, predictions of these models need to be refined in order to be used to support decision making process at fine scale, because of the models coarseness.

3.3.2 Materials and methods

The climate projections were conducted using the protocol developed by the AGMIP group. Twenty models were used to project climate for three periods namely near future, mid and end of century for two Representative Concentration Pathways (RCP) of 4.5 and 8.5 using free programming language and software environment for statistical computing and graphics display. The script used in the projection was developed by AGMIP team in collaboration with the Goddard Institute for Space Studies of the National Aeronautics and Space Administration (NASA) of the United States of America. The projections are made using archive content based on global climate projections from the World Climate Research Program's (WCRP) Coupled Model Inter-comparison Project phase 5 (CMIP5) multi-model dataset. The CMIP5 is developed to provide a comprehensive framework for coordinated climate change experiments and formed the Fifth Assessment Report (AR5) of the United Nations Intergovernmental Panel on Climate Change (IPCC).

Station monthly historical data sets for the 16 climatologically homogenous rainfall (CHR) zones were obtained from the Meteorology Department. This information was used to adjust the daily data sets for the 16 CHR zones obtained from NASA's Modern Era- Retrospective Analysis for Research and Applications (MERRA). MERRA[5] is NASA's climate model data repository and data sets are produced using their 4-Dimensional Variation (4D-Var) assimilation system. The period 1980-2009 was considered as the reference period because of the availability of complete MERRA climate data sets.

3.3.3 Summary of key findings

This study projected climate parameters for the fourteen (14) climatologically homogeneous zones of Uganda. Twenty General Circulation Models were downscaled for two 30 years-periods (Mid-Century, and End Century) and two (2) Representative Concentration Pathways (RCP) (4.5 and 8.5).

[5] http://gmao.gsfc.nasa.gov/research/merra/intro.php

3.3.3.1 Temperature

There are variations in the magnitude of change in minimum and maximum temperatures from one model to the other, all models however show temperature rise in all the Climatologically Homogenous Zones of Uganda. The ensemble mean shows an increment range of Tmax and Tmin for the RCP 4.5 and 8.5 for Mid and End Century; respectively. Projected Tmax ranged between 1 and 1.5^{o}C, 1.7 and 2.2 ^{o}C; 1.7 to 2.1^{o}C; 3.2 and 3.9 ^{o}C for RCP 4.5 and 8.5 for Mid and End Century; respectively. Projected Tmin ranged between 0.8 to 1.8 ^{o}C; 1.7 to 2.5^{o}C; 1.4 to 2.1; and 1.2 and 2.3^{o}C; for RCP 4.5 and 8.5 for Mid and End Century; respectively. These Projections of Tmax and Tmin ranges are presented in the table below. Generally ΔTmax < ΔTmin for the majority of the zones.

Table 3-2: Projected Maximum and minimum temperature ranges and increments

MAXIMUM TEMPERATURE							
Mid century				End century			
RCP = 4.5		RCP = 8.5		RCP = 4.5		RCP = 8.5	
Range	ΔTmax ^{o}C	Range	ΔTmax ^{o}C	Range	ΔTmax ^{o}C	Range	ΔTmax ^{o}C
1.0 to 1.5	0.5	1.7 to 2.2	0.5	1.7 to 2.1	0.4	3.2 to 3.9	0.7
MANIMUM TEMPERATURE							
Mid century				End century			
RCP = 4.5		RCP = 8.5		RCP = 4.5		RCP = 8.5	
Range	ΔTmin ^{o}C	Range	ΔTmin ^{o}C	Range	ΔTmin ^{o}C	Range	ΔTmin ^{o}C
0.8 to 1.8	1.0	1.7 to 2.5	0.8	1.4 to 2.1	0.7	1.2 to 2.3	1.1

3.3.3.2 Rainfall

The majority of the models predict an increment in rainfall with varied magnitude of precipitation increase. However, some of the models projected a decrease in the amount of rainfall for some of the CHR zones. The ensemble means show an increment for all the CHR zones. The ensemble mean rainfall amount is predicted to increase significantly and consistently for CE, F and L climatologically homogenous for all scenarios. Zone CE covers the area extending about 150km from the western shores of Lake Victoria into central western region while zone F covers the Mount Elgion region and Zone L extends from Mount Rwenzori to the southern parts of Lake Kioga.

Table 3-3 shows that the range for the reference rainfall pattern is 462.4mm while that for the mid-century is 527.1 which implies an increase of 74.8mm between the two while the increase between the mid and end century patterns is 10.0mm. This implies the greatest change in the intensity and frequency of extreme weather events is likely to take place between the current and the mid-century period

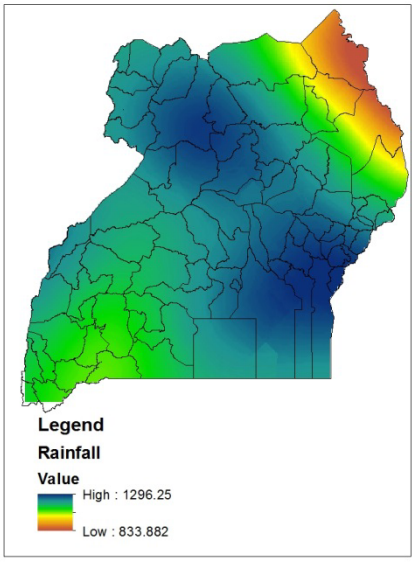
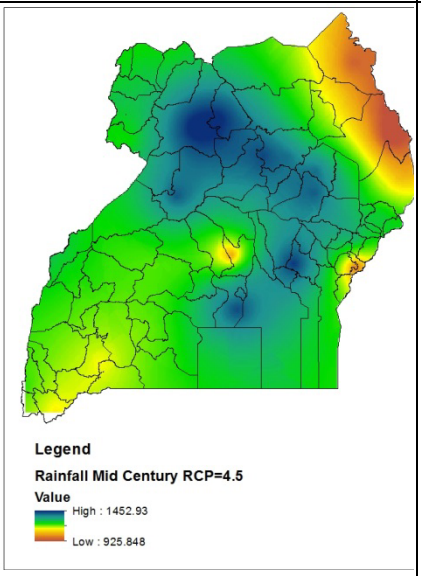
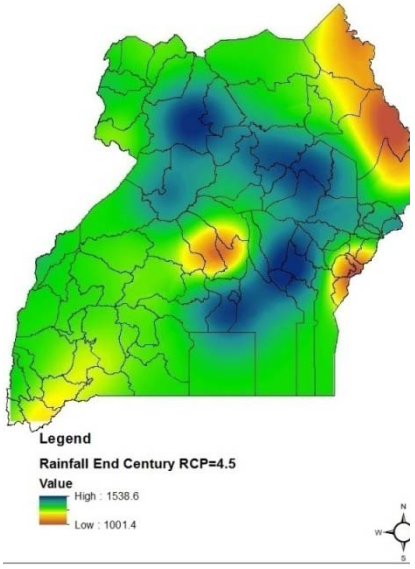
Table 3-3: Rainfall amount ranges for the current and the projected mid-century and end century patterns

RAINFALL FOR RCP = 4.5								
Current (2000)			Mid century			End century		
High mm	Low mm	Range mm	High mm	Low mm	Range mm	High mm	Low mm	Range mm
1296.3	833.9	462.4	1452.9	925.8	527.1	1538.6	1001.4	537.2

3.3.3.3 Conclusions

Based on the model results, it can be concluded that a clear, temperature and rainfall change has been detected. Most of the models consistently agree in temperature increment for all the CHR and the majority of the models agree that rainfall is going to increase and most particularly for CE, F and L homogenous zones for all scenarios.

Map 3-2 Rainfall amount ranges for the current and the projected mid and end century

Current	Mid-century	End-century
		

3.4 Vulnerability of agriculture, food security, and forestry sectors to climate change and climate variability

3.4.1 Introduction

Using data and information obtained from both the review of secondary data and outputs from the climatology and the modelling experts, an assessment of the vulnerability of agriculture, food security and forestry sectors to climate change in Uganda was done. This section, presents the findings of the assessment.

3.4.2 Major climate hazards vulnerability in Uganda and their impacts

Climate Risk screening for agriculture sector (crop, livestock and fisheries), was done in a one day workshop of 80 district production officials with the aim of identifying the major climate change hazards and their impacts on the agricultural sector. It was generally accepted that climate is currently posing threats to the agricultural sector in Uganda. Evidence and signs were given as: Increasing temperatures, frequent droughts, flooding, prolonged dry spells, hailstorms, landslides, lightening, pests and disease epidemics for livestock and crops, and shifts in rainy seasons. It was noted that in some years rains start late and end early especially for the first season. In the second season rains start a month late and continues into January and February, coinciding with the harvesting of the second season crop, thus causing pre-harvest and post-harvest losses.

The common climate related hazards/risks identified by Local Government officials are summarized in the **Error! Reference source not found.** below:

Table 3-4: Hazards/disasters incidences and their impacts on livelihoods in Uganda by region.

Region and Climate related hazard	Impacts on livelihoods
Rwenzori: Landslides, floods	Loss of fertile soil, increasing, semi-displacement of people due to floods and landslides. Mountain icecaps receded by 40% of 1955 cover – the melting causes flooding.
Northern and Teso Regions: Floods and resulting water logging	Cause pre-harvest losses to various crops; especially cassava, sweet-potatoes, simsim and ground nuts. Increase in water-borne diseases which leave people food insecure and malnourished

Karamoja Flush floods, Conflict and ethnic violence, mainly due to droughts	Increased fungal diseases leading to food insecurity, Livestock diseases leading to heavy losses Increased tribal conflicts. Tick-borne diseases increase, tsetse belt expansion, dust storms. Livestock migrations and cattle rustling,
Elgon: Landslides, floods	Increased deforestation as farmers forced to Higher levels. Species loss.
South-Western: Droughts, floods, land slides	Crop diseases. Dairy cattle yields fall due to heat stress. Increase in malaria cases and dysentery
Kampala: More intense rain, inadequate waste disposal,	Increased risks of floods leading to traffic jams and loss of property, increased incidences of diarrhea and dysentery, and encroachment on wetlands
Lake Victoria: Prolonged droughts.	Declining lake water volumes due to increased evaporation leading to reduced hydropower generation and affecting community livelihoods generally.

3.4.3 Vulnerability of Crop Subsector to Climate Change

The impact of climate change on yields of various crops was analyzed using secondary data. The findings, as indicated in the (Table 3-5) and Figure 3-12 below, were that all crop yields at farm level are still lower than the potential given by research despite the efforts put in by the Government to increase productivity while the trends are variable.

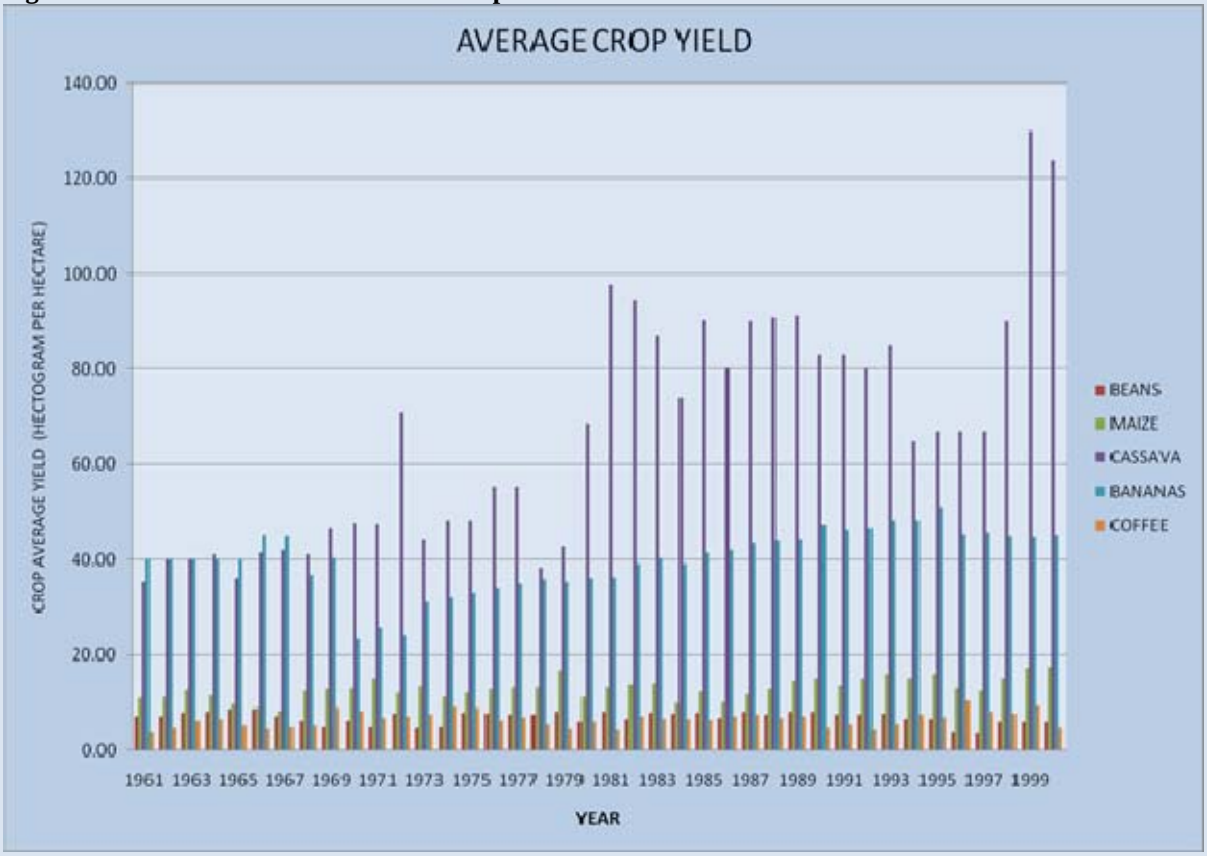
Table 3-5: Yield Gap of Selected Crops (Kg/ha)

Crop	Yield at Farmers field	Research Station Yield range	Yield Gap (kgs/ha
Maize	550	5,000-8,000	810-1,350
Beans	360	2,000-4,000	460-1,020
Bananas	1,870	4,500	140
Coffee	370	3,500	850

Source: DSIP

The main causes were identified as declining soil fertility due to soil degradation. This is driven by poor farming practices, over-cultivation and low input use by farmers. Other causes of the yield gap were identified as weather variability, and pests and diseases.

Figure 3-12 : Yield Trends for Various Crops from 1961 to 1999.



Source:

The crops considered in this analysis are those most widely grown in Uganda, and many are vulnerable to the projected rising temperatures and increasing rainfall variability. When listed in the order of their sensitivity they are: Arabica Coffee, robusta coffee, maize, bananas, beans, sorghum and cassava.

Coffee: Coffee is the main foreign exchange earner for Uganda. Rising temperatures and erratic rainfall has increased the risk of disease and pest infestations on the crop. Robusta coffee has become more vulnerable to red-berry disease, while arabica coffee is more vulnerable to coffee berry and leaf rust diseases.

Maize: Maize is vulnerable to water stress during poor rains as well as afrotoxin contamination when the harvesting period coincides with off-season rains.

Banana: these are less vulnerable to increasing temperatures than coffee but the impact of pests and diseases on the crop is significant. The most common are Banana Bacterial Wilt, Banana Weevils and Nematodes and Black Sigatoka Disease.

Beans: Beans are vulnerable to fungal and viral diseases during the periods of excessive rain fall, especially when they coincide with the flowering and pond formation growing stages. They are also often attacked by aphids in times of water stress.

Cassava: grows well at temperatures much higher than the current, but the crop is also vulnerable to pests and diseases especially the Cassava Mosaic, cassava brown streak and aphids. It is also highly vulnerable to water logging. The level of crop their sensitivity is summarized in (Table 3-6) below:

A cost-benefit analysis established that food and cash crops in Uganda are constantly threatened by epidemic pests and diseases which are both foreign and indigenous. Some of the epidemics include the coffee wilt, locusts, armyworm, quelea birds, variegated hoppers, whitefly, cassava mosaic and cassava brown streak virus. The endemic/pandemic pests and diseases include aphids, Banana weevil, nematodes, potato blights, Bacterial wilts and viral infections that seriously reduce crop yields. Average crops losses, due to pests and diseases, are 10-20% during the pre-harvest period and 20-30% during the post-harvest period. At times, losses up to 90% occur; caused by epidemics or diseases in perishable horticultural crops. For example, the current losses due to Banana Bacterial Wilt disease are as high as 94% in some areas such as Mbale, causing losses to the tune of U$34 million in 2005 alone.

Table 3-6: Sensitivity of crops analysed to climate change

Crop	Vulnerability/exposure	Risks	Sensitivity
Coffee:	Rising temperatures and erratic rainfall	Disease and pest infestations	Very high
Maize:	High humidity, poor drying during wet/very wet conditions-post harvest losses;	Afratoxin contamination	High
	Degradation of land and rising temperature	Termites attack and maize stock borer	High
Bananas	Droughts and increasing temperature	Increased incidences of Pests and diseases	High
Beans	Excessive rains	Viral and bacterial diseases	Low

Cassava;	Prolonged dry spells	Pests and diseases	Low

3.4.4 Impact of Drought on Agriculture and Food Security cited in NAPA 2007

A number of impacts have been felt in the agriculture sector due to drought. These were vividly described during the NAPA process in Uganda in 2007. These are summarized below;

i. Shortages in rural and urban water supply due to the 1991 drought forced people and animals to migrate in search of scarce water pasture and food. This provoked conflicts among communities especially between Teso and Karamoja regions.

ii. The prolonged drought that persisted from August 1991 throughout 1992 adversely affected both yields and quality of coffee (CMBL annual performance report 1991/92). The report states that total coffee production during the 1990/91 was 108,264 MT. During the physical year 1991/92, this declined to 96,031MT, registering a change in production of 11.3 MT. Furthermore the rising temperatures and erratic rains have increased the risk of coffee pests and diseases.

iii. Banana yields in 1990/91/92 were on average 5.6 tonnes per hectare, lower than 1970's which was on average 8 tonnes/ha. Reduction in yield was mainly due to soil degradation, poor farming practices and the presence of black sigatoka viral diseases. While bananas are less vulnerable to increasing temperatures than coffee the potential impact of pests and diseases are significant:

iv. Maize production declined in 1988, 1989, 1990 and 1991 due to dry spells. The 1991 production estimates were lower than 1990 by 14% due to the abnormal dry spells, together with maize streak virus (MAAIF reports 1992)

v. Erratic and poorly distributed rains/prolonged drought conditions of 1996 affected crop production in north-eastern (Karamoja) and eastern districts of Uganda, resulting in an overall 55 percent reduction in cereal production, causing critical food gaps) Table 3-7. The cereal shortfall resulted into a rise in prices beyond the purchasing capacity of the average consumer. As a result, a large number of people resorted to forests for survival on game meat, wild fruits, tree leaves and sell of firewood. Some migrated to Kenya for water and pasture. Cattle became undernourished. A total of 341,030 people were recommended for food aid

Table 3-7: Estimated drought-affected people in need of food aid per District in 1996

No.	District	No. of people	No.	District	No. of people
1	Moroto	51 450	5	Mbale	1 400
2	Kotido	40 330	6	Kumi	37 300
3	Tororo	150 000	7	Soroti	34 800
4	Pallisa	25 750			
	Overall total number of people affected				341 030

3.4.5 Identified impacts of floods/heavy rains on agriculture and food security

Very wet and wet conditions in Uganda are usually associated with Elnino episodes, which usually result into flooding and water-logging in lowland areas as well as landslides in high land areas Table 3-8.

Table 3-8: Identified Impacts of Floods/Heavy Rains on Agriculture and Food Security

No.	Nature of impact
1	During the very wet and wet conditions of 1961/62, 1997/98 and the most recent 2007, Uganda experienced damages and losses due to flooding and water logging. There was destruction of Infrastructure (roads and bridges), disrupting transportation of food to the affected regions. People were displaced and their livelihoods were negatively affected. The areas most vulnerable and affected by floods and water-logging in Uganda are the Lake Kyoga and Lake Victoria basin, areas along the Albertinile and most low lying areas in the valleys of highland areas of Eastern and South-western Uganda. During the 1997/98 El Nino in Uganda, the following impacts were registered (UNFCCC,2002): • About 525 people died and over 11,000 were hospitalized and treated for cholera • About 1,000 people were reported to have died in flood related accidents; • About 150,000 people were displaced from their homes; • Damage to trunk and rural roads infrastructure estimated at US $400m was reported; About 300 hectares of wheat were destroyed in Kapchorwa district; Tea estates were flooded making tea picking difficult; Coffee exports dropped by 60 per cent between October and November due to disrupted transport systems

2	According to FAO study report of 1997, in 1993 & 1994 seasons, farmers received a bumper harvest of maize due to favorable rains. The study noted that due to poor storage capacity farmers were forced to release maize onto the market immediately after harvest when prices were lowest, the price of maize dropped to $40 per ton, or less and farmers reduced their area under this crop in the following years probably to the level of 1992 production.

3.4.6 Impact of Climate Change on Forestry Sector

A similar assessment on the forest sector in Uganda revealed impacts shown in Table 3.9.

Table 3-9: The factors that affect the forestry sector:

	Nature of impact
1	Increasing land fragmentation and human encroachment on forests
2	Increased charcoal burning and sale of firewood
3	Over-grazing resulting from Increase in overstocking in the cattle corridor (Kiruhura, Ntoroko, Isingiro and parts of Mbarara)
4	High incidences of forest and bush fires which resulted in habitat loss; Wildlife deaths thus affecting ecotourism and the associated revenue

3.4.7 Adaptation options and practices

This section outlines various possible positive adaptation measures which households could employ to adapt to climate variability and change in Uganda. These include those necessary to restore the resilience of the ecosystems and their productivity, restore the degraded soils/land, forests and increase the productivity from crops as well as livestock. Table 3-10 provides a summary of the proposed adaptation options. Two of these are expounded on below.

3.4.7.1 Soil and Water Conservation

Also, the cost benefit analyses findings showed that the government has to address the current situation of the soil and water conservation structures because failure to do that implies continued worsening of the productivity of the sector. In a number of areas, farmers are making no efforts to put up such structures and consequently runoffs, mudslides and floods are causing a lot of damage to the existing crops as well as the soils. An example is Mt Elgon slops where instead of practicing better farming methods, trees have been cutoff. In Teso and Acholi sub regions, no efforts of controlling effects of floods are in place. In Kigezi sub-regions wher

terracing has been practiced, terraces are no longer effective in controlling runoffs. It is important that interventions are made not only to halt the worsening situation but also to reverse it for the betterment of majority of the rural poor who are dependent on agriculture

Through extensive and intensive agriculture extension services, farmers should be sensitized, mobilized and encouraged about soil and water conservation practices. Through formulation of relevant policy and by-laws, farmers can be compelled to implement the recommended structures. In this regard the government will be compelled to invest heavily into climate change adaptation measures that will help sustain agriculture sector.

3.4.7.2 Response to Epidemics

A critical adaptation measure is to build an enabling environment for rapid response to control the epidemics whenever they break out. Assessing and building the capacities of the staff with the necessary knowledge and skills will the help the country become more effective in controlling pests and diseases. In addition, interventions should include setting up mechanisms for pest and diseases surveillance, forecasting, diagnosis and prompt control.

The worst that should happen is to scale down activities of the pest and diseases control program. This will have adverse effect on both the crop and animal sub-sectors. The minimum that minimum required is to maintain the current scale of activities of the pest and disease control. This however should be done knowing that the climate change effects' demands have already overtaken the current level of intervention.

Clearly, additional funding that can allow advancement of the current activities in areas of research and dissemination of the findings is required. Such funding may be supporting targeted intervention like the zones most hit. The ideal (if funding allows), should scale up all the activities of the pest and disease control. This will reduce the impact of the climate change to the agricultural sector. This will allow the sector meet target of reducing crop losses from the current 50% to 10%.

Table 3-10: Adaptation options and practices

	Target areas/Adaptation option	Practices to change/adapt to include
1	Soil and water conservation Heavy rains cause soil erosion and leaching. High temperatures and drought conditions cause wind erosion and loss of soil nutrients. The level of exposure to soil erosion is facilitated by poor farming practices, loss of vegetative cover and deforestation	• Application of on-farm soil and water conservation structures to control run-off • Harvesting excess ground water to be utilised during the dry periods. • Planting dense vegetation cover to reduce velocity of surface water run-off and increase infiltration. • Application of agronomic practices such as strip cropping, mixed cropping, fallowing and mulching; contour farming
	Organic Farming: Organic farming practices aim at enhancing soil biological processes to improve soil fertility and structure; and also create soil organic matter in forms that are more effective at producing soil carbon	• Increasing the proportion of soil vegetation cover which promotes the soil's micro-organisms that stabilize soil carbon. By ensuring that soils are always covered by vegetation prevents soil from being exposed to processes that accelerate GHG emission thus loss of soil nutrients eg. nitrogen. • Appropriate tillage soil management techniques that build soil fertility and structure. • Where soils are prone to erosion, zero tillage is recommended to minimize mineralization, oxidation and erosion • Integrating crop and livestock systems to encourage use of animal manure in crops farming. Semi-intensive zero-grazing; integrated organic pest management, crop rotation, trap cropping; integration of pest repellent crops on the farm; use of organic pesticides/concoctions;
	Conservation Agriculture Conservation Agriculture can take many forms, but all forms are an attempt to more efficiently and effectively utilize natural resources	• Among many other techniques, CA includes "no till" practices to preserve the soil, • Favors organic manures over chemical, • Discredits mono-cropping, and includes mulching. • All of these practices contribute to the greater health of the local ecosystem with the added

	goal of increasing yields
Forest restoration	• Integrated watershed management to enhance resilience watershed vegetation, and forests. This also reduces vulnerability to storm and landslides. • Preservation and promotion of indigenous species*:* This will result in both increased conservation of natural habitats and increased incomes for households. • Afforestation to restore forests and ecosystems biodiversity that is lost (like return of birds, more insects for crop pollination, mushrooms and wild fruits),and regeneration of vegetation cover. Water Catchments and other fragile areas will be protected from human induced degradation through slowed surface runoff. • Agroforestry to encourage the presence of trees in cooperation with crops to stabilize erosion filters and to improve water supply, and increase soil quality through nitrogen-fixation. Trees also facilitate carbon sequestration, yield of fruit, tea, coffee, oil, fodder and medicinal products, in addition to the usual crop harvest. Trees will also provide micro climate of cooling and shading to crops such as coffee, reducing their vulnerability to high temperatures.

3.4.8 Conclusions and Recommendations

The vulnerability assessment of the agriculture sector in Uganda reveals that agriculture in Uganda is highly vulnerable to climate change and the national food supply relies on adaptation that is successful. The low level of income, high poverty levels, and high population is affecting the ability of most households to adapt to climate change. Access to land plays a strong role in on-farm diversification; as a result, land pressure in more densely populated areas such Mt. Elgon Region, Albertine region and South-Western Uganda increases vulnerability to impacts of climate change, enhances further deforestation and degradation. Successful implementation of the recommended adaptation options to climate change will require the following:

- Increased support to agricultural research for further breeding of crops that are disease, drought and high temperature tolerant as well as other technologies. Research should also identify alternative livelihoods for those in areas that are adversely affected by climate change such as Karamoja and Elgon areas where the flood and/or drought risks are high.

- Adaptation responses proposed may locally be influenced by ecosystems and social and cultural beliefs unique to the area. It is, therefore recommended to first pilot some of the recommended adaptation options to test the adoption opinions of local people and then scale up. This should include gender mainstreaming.

- Adoption of the recommended climate change adaptation options requires a strong agricultural extension and advisory services system that links technologies developed by agricultural research to farmers. The current extension and advisory services in Uganda is not strong enough. It is therefore recommended that the Government strengthens the linkage between agricultural research, agricultural extension and advisory services and farmers to facilitate technology transfer and adoption of climate change adaptation strategies.

- The current National Early Warning System is week and dissemination of climate information to farmers is not effectively done. It is therefore important that this system is strengthened, so as to improve on the timely production, dissemination, and use of climate information that responds to the needs of decision makers, farmers and other stakeholders.

- Provide necessary technical and financial support to the concerned government department and agencies, namely meteorology and climate change, for the development of the national climate datasets and information and monitor weather in environment and climate change

- It is recommended that enforcement of bye-laws and ordinances becomes mandatory in each district to stop people from encroaching on wetlands and forest reserves and ensuring that soil and water conservation measures are part and parcel of every farmers ' farming practices.
- More research and promotion of alternative sources of fuel and energy.
- There is need to build the capacity of Technical Staff in local governments and communities across the country and create awareness about climate change and environmental conservation.
- Climate change perspectives should be mainstreamed into the agricultural and forestry sector policies, plans and programs as well as natural resource management services.
- Sharing of knowledge and information related to climate change adaptation between scientists, researchers and other actors should be facilitated. The adaptive choices should meet the locally specific challenges of increasing temperatures and changing rainfall patterns and intensities, as well as deteriorating agro-ecosystem services.
- It will be important to promote village credit services and savings to enable farmers easy access to loans to acquire climate change adaptation technologies.

The conclusion is that identification and dissemination of adaptation options and enabling of their adoption should require national efforts. There is need to establish policies and investment strategies that address large scale and long term threats to agriculture, forestry and livelihoods- this would mean improving communication between researchers, extension workers and farmers.

3.5 Vulnerability and adaptation of the health sector to climate change

3.5.1 Introduction

Human resource is a valuable national asset as the productivity of any country depends on it. This value could drastically be reduced by ill health. Hence, a sizeable percentage of the national budgets is often spent on development and provision of health services. The health sector is heavily affected by climate variability and climate change; hence the need to develop mechanisms for the sector to combat the associated adverse effects. Indeed, it has been observed that the long-term good health of populations depends on the continued stability and functioning of the biosphere's ecological and physical systems, often referred to as life-support systems.

3.5.2 Potential Impacts of climate change on the health sector

Extreme weather events directly have caused death and injury, and also had substantial direct and indirect health impact on specific categories of people with low adaptation capacity.' These impacts such as often lead to population displacement, ecological change, impairment of the public health infrastructure, psychological and social disorder and also reduced access to health care facilities. The most vulnerable include the rural and urban poor, the sick, elderly, children, the orphans and pregnant women. In Uganda, these are often communities in highland, wetland ecosystems, and pastoral communities. The most adverse impacts of climate change in Uganda are summarized in Table 3-11. These are mainly related to:

- ***Floods, landslides and thunderstorms:*** These have both direct impact on human health such as injury and death, and also the indirect effects like outbreak of water borne diseases like cholera; typhoid and dysentery that not only pose serious health problems to the population but also strain health services. This is more pronounced in the most vulnerable communities. An example is the floods of 27th April 2003 that rendered many people in reclaimed wetland areas homeless and caused extensive damage to their property. The El Nino of 1997/8 also inflicted heavy casualties with about 525 reported deaths and 11,000 people hospitalized for cholera infections.
- ***Droughts:*** Dry conditions frequently come with dry and dusty air that favour respiratory diseases. Also droughts lead to crop failure and hence scarcity of food with increased food prices that are unaffordable to many thus leading to poor feeding and nutrition ailments. This can spill over to negatively affect economic productivity of the population during the next favorable climatic season thereby slowing down poverty eradication efforts.
- ***Increased global mean temperatures:*** In Uganda, the increased mean temperatures have shifted malaria belts to the areas south of the country like Kabale that previously had no malaria incidence. This has required the Ministry of Health to make substantial inputs to fighting malaria in such areas that begun to experience malaria outbreaks due to low resistance.

Table 3-11: Summary of the potential impacts of climate change on the health sector.

Type of impact	Implication of the impact	Health effect
Direct Impacts: Mediating process/ Health outcome	Exposure to thermal extremes especially heat waves	Altered rates of heat and cold related illness especially cardiovascular and respiratory diseases
	Altered frequency and/or intensity of extreme weather conditions (floods, storms etc)	Deaths, injuries and psychological disorders, damage to public health infrastructure
Indirect impacts due to	Effects on ranges and activity of vectors	Change in geographic ranges and incidence of vector – borne diseases e.g. a 1.2.^{o} C increase in

disturbances of ecological systems	and infective parasite	temperature is shifting potential malaria risk areas from the traditional tropical to temperate zones
	Altered local ecology of water – borne and food – borne infective agents	Changed incidences of diarrhoeal and other infectious diseases
	Altered food (especially crop) productivity due to changes in climate , weather, and associated pests and diseases	Regional malnutrition and hunger with consequent impairment of child growth and development especially in vulnerable communities
	Fresh water vulnerability	Injuries, increased risk of various infectious diseases (due to migration, overcrowding, contamination of drinking water), psychological disorders
	Levels and biological impacts of air pollution including pollens and spores	Asthma and allergic disorders, other acute and chronic respiratory disorders and deaths
	Social, economic and demographic dislocations	Wide range of public health consequences e.g. mental health, nutritional impairment, infectious diseases, civil strife, psychological impacts, human insecurity & violent conflict

Source: WHO, 2001

3.5.3 Disease outcomes that are susceptible inter alia to environment

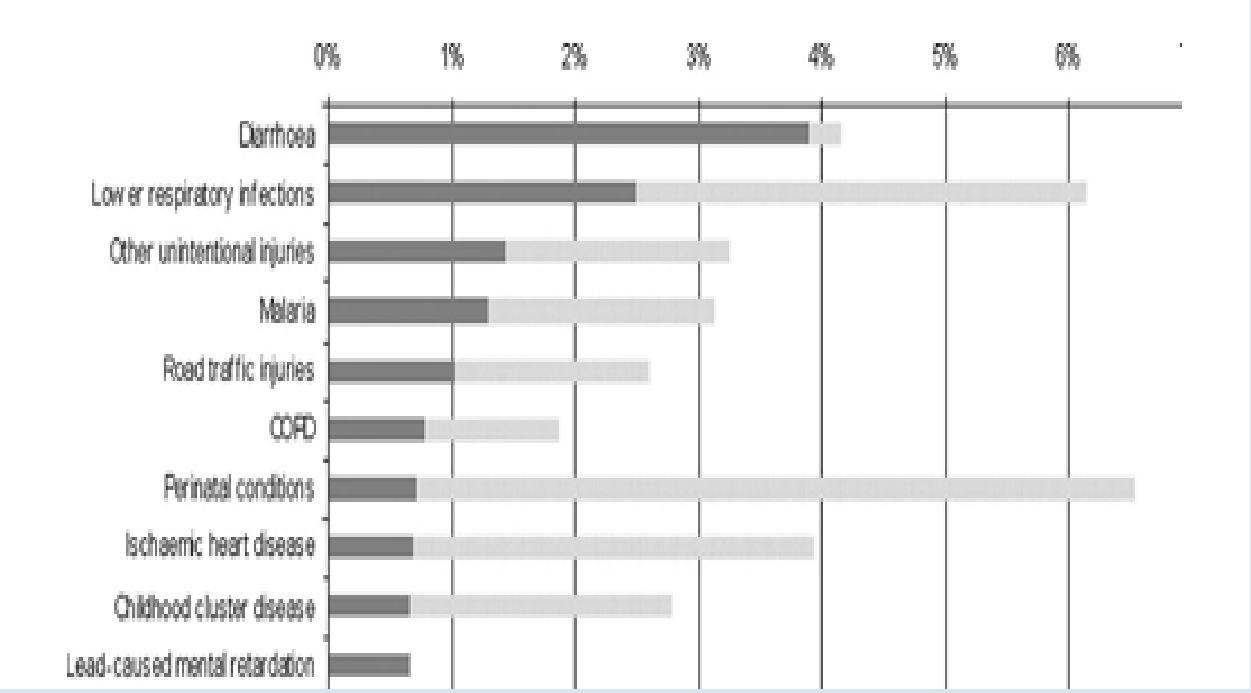
Figure 3-13 shows that there are many disease outcomes that many vector-borne diseases have a strong environmental component e.g. strong seasonality to malaria in some parts of Africa.

Almost 25% of global disease burden is explained by environment:

- 94% diarrheal
- 42% malaria
- 41% lower respiratory

The young are particularly vulnerable**;** children under age 14 are 44% more likely to die as a result of environment-related illnesses than general population.

Figure 3-13: Shows diseases with largest environmental component.



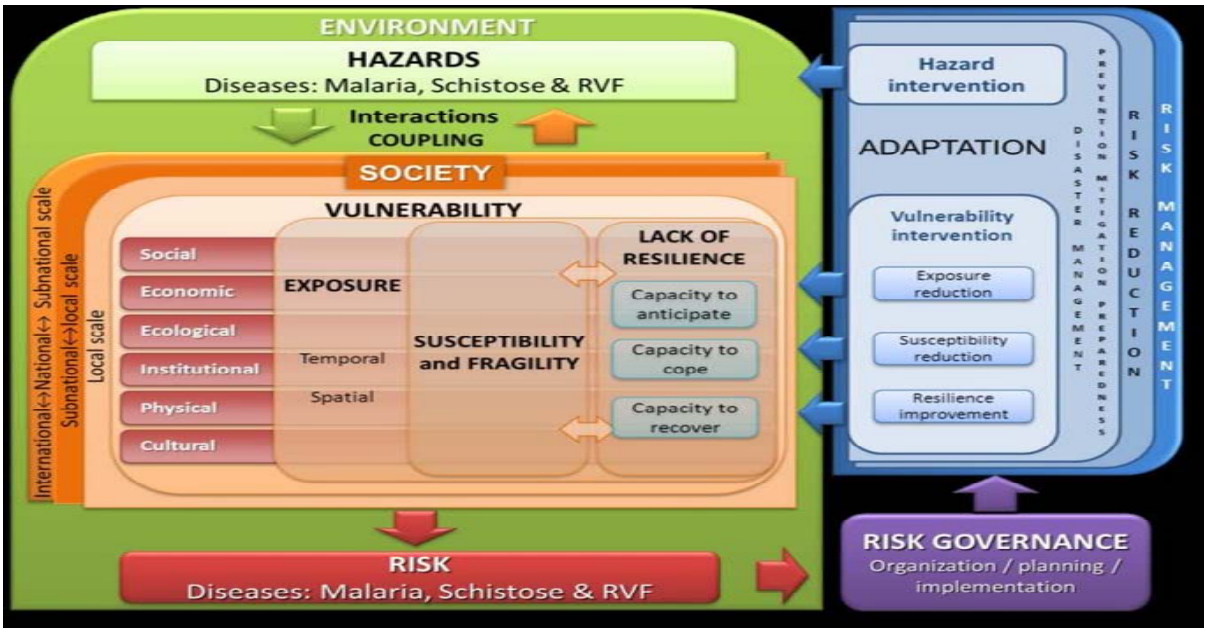
Source: Prüss-Üstün and Corvalán (2007). Data are for 2002

Environmental, including climate, change-driven variations in the distribution and epidemic potential of infectious diseases, particularly Vector – borne diseases (VBDs), are a source of major concern, worldwide. Disease pathogens and organisms involved in their transmission (vectors and intermediate hosts) have co-evolved under particular environmental conditions. VBDs are therefore expected to be sensitive to changes in environmental conditions, such as an increase in ambient temperature or changes in the timing and levels of rainfall..

Changes in the distributions of infectious diseases, especially those enabling contact between pathogens and large host populations with little or no premonition immunity (thereby greatly increasing epidemic potential), could quickly overwhelm health and/or veterinary services, with potentially catastrophic consequences.

Figure 3-14 illustrates the linkages between environmental factors, vulnerability/risk to climate sensitive diseases and adaptation in public health.

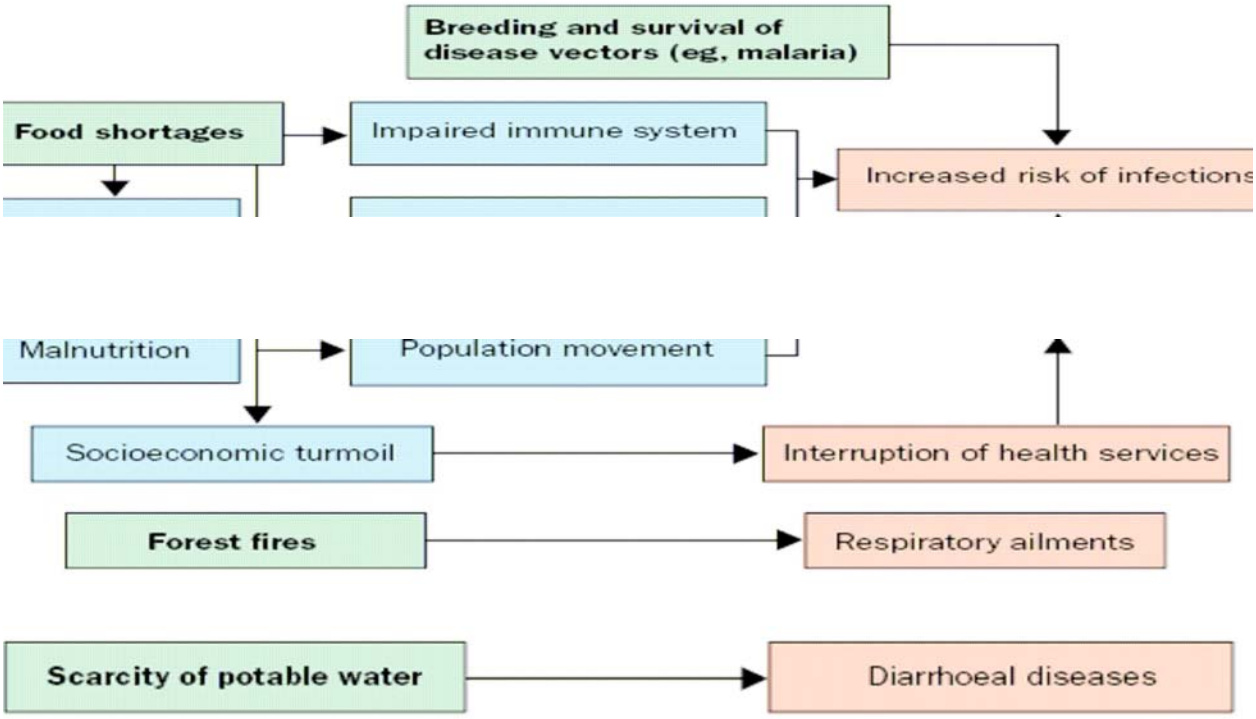
Figure 3-14: Framework links to disease risks, vulnerability and adaptation



Source: www.healthyfutures.eu

Environmental change effects Figure 3-15 potentially therefore include greatly increased disease burdens, particularly among the poorest members of society in the developing world where health facilities are already most over-stretched and least resilient. Ultimately disease outcomes will depend on many, often inter-related, factors, including levels of immunity, the effectiveness of vector control programmes, the abilities of health and veterinary services to respond to warnings of outbreaks, and long-term trends in population densities, socio-economic conditions and processes such as urbanization.

Figure 3-15: Potential health effects of drought



Source: Kovats, Bouma, Hajat, Worral, Haines. Lancet 2003; 362:1481.cet

3.5.4 Vulnerability of Uganda's health sector

Although the assessment period was set as 1960 to 1990, compilation of detailed disease data from the HMIS/MOH started from year 1999, with establishment of an Integrated Health Management Information System for the health sector.

The events of the last decades have clearly demonstrated the magnitude of the impacts of adverse effects of climate change on the people and economy of Uganda. Uganda has experienced an increase in the frequency and intensity of extreme weather events with serious consequences on the health sector.

Major health impacts identified in Uganda were outbreaks of water-borne (e.g. cholera, Hepatitis E, dysentery) vector-borne diseases (e.g. malaria), injuries, loss of lives, loss of livestock, food insecurity and malnutrition,

Climate Sensitive diseases and other illness that have greatly been influenced by climate variability and change in Uganda were noted as Malaria, Schsistosomiasis, Hepatitis E, Cholera and other diarrhoeal diseases.

3.5.4.1 Infrastructure damage, loss of human and animal life, damage to crops and ecosystems.

A typical case of a severe and intense weather event was the 1997/98 Elnino . The following impacts were recorded:

(a) Damage to agriculture and crop failure resulting into food insecurity and malnutrition,
(b) Damage to infrastructure: roads, health facilities, homesteads which affect health service delivery,
(c) Landslides: The landslides such occurred recently in Bududa District, had severe direct & indirect public health impacts. The weather conditions also affected the road network by destroying bridges thus jeopardizing the distributions of drugs and other supplies to the affected areas
(d) Floods and landslides caused injuries, loss of lives and displacement of communities.
(e) The weather conditions also affected the road network by destroying bridges thus jeopardizing the distributions of drugs and other supplies to the affected areas.
(f) Attempt to resettle the affected communities from Bududa to Kiryandongo met a lot of resistance, and caused a lot of physical and Psychological stress.
(g) The following prolonged Lanina brought drought that resulted in crop failure and death of livestock with serious impacts on agricultural production. Food scarcity resulted into nutritional insufficiency with serious health consequences as a result of food insufficiency, malnutrition and negative effects of the national economy;
(h) There was also disappearance of medicinal biodiversity, on which about 60% of Uganda's population derived its herbal treatment.

Mt. Elgon (Mbale) Slides, 2010

Source: Jesse Allen, NASA Earth Observatory image; March 2010.

Source: Red Cross 2010;

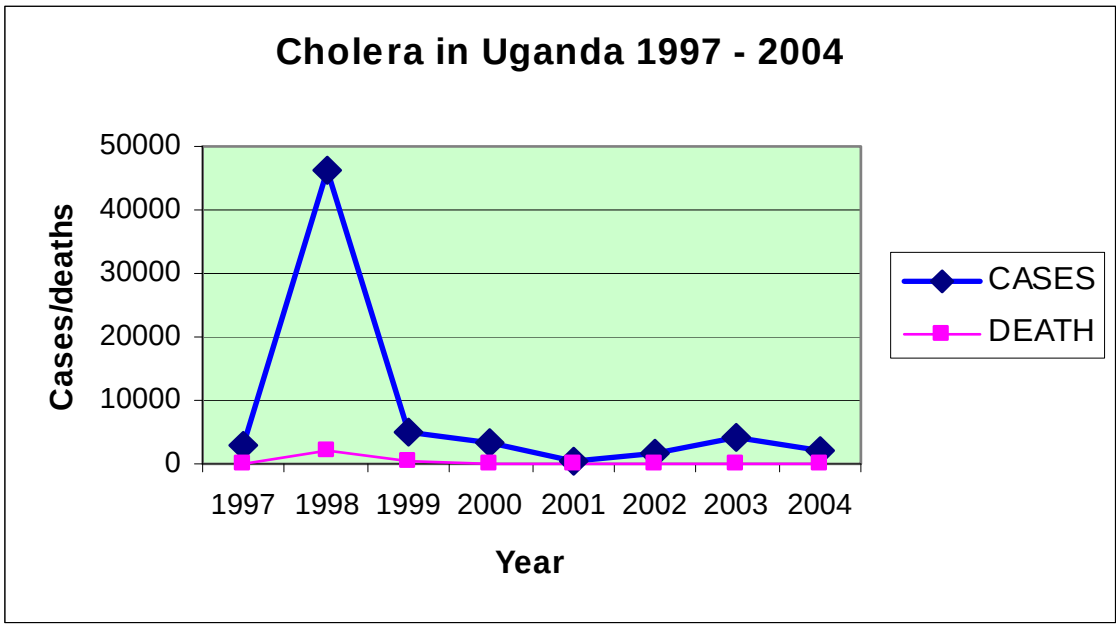
3.5.4.2 *Disease outbreaks*

Serious disease outbreaks have been recorded in Uganda recent past. These have included:

a) Cholera

The 1997/98 Elnino weather phenomenon triggered off a cholera epidemic in many parts of the country. Flooding led to contamination of water sources and outbreaks of sanitation related diseases e.g. Hepatitis E and Cholera. From 1997 – 2002, about 4.3% of those who contracted cholera died. (Figure 3-16)

Figure 3-16: Line Graph showing cholera trends 1997-2004

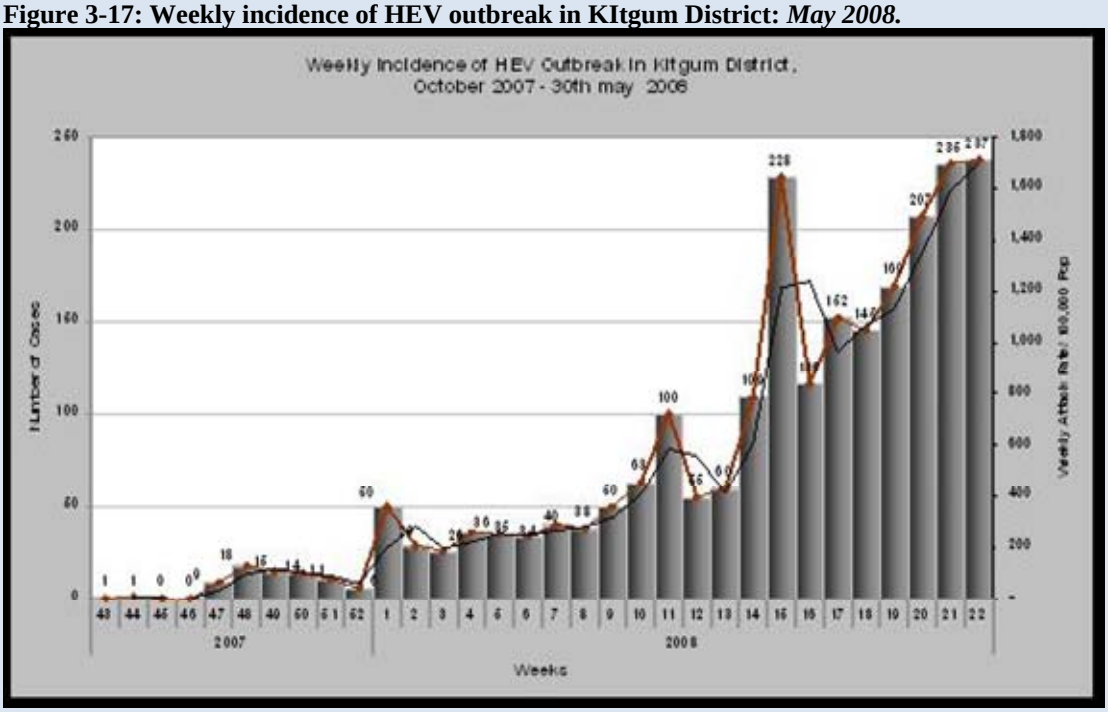


Source: HMIS, MOH

b) Hepatitis E

There was an outbreak of diarrhoea due to Hepatitis E virus following the floods and pollution of water sources in the districts of Eastern Uganda. It should be noted that Hepatitis E was previously not a major public health concern in Uganda.

Figure 3-17: Weekly incidence of HEV outbreak in KItgum District: *May 2008.*



Source: HMIS, MOH

Fig 3-17, shows Kitgum District hepatitis E weekly incidence. A gradual increase in the hepatitis E incidence since the epidemic started. The district continues to register more and more cases of hepatitis E cases with the highest peak of 237 cases in week 22. Moreover, the cases continue to increase as enrollment of new sub counties reporting hepatitis E cases is undertaken. This is a challenge as most sub counties are not yet implementing the interventions equally as compared to other sub counties.

Table 3-12: Statistics of Cases of Hepatitis E Epidemic in Kitgum District, 31 May 2008.

Weeks	New Cases	Cumulative Cases	New deaths	Cumulative deaths
15 (7-13 April 08)	228	967	4	21
16 (14-20 April 08)	116	1083	3	24
17 (21-27April 08)	152	1235	1	25
18(28 April–04 may)	145	1380	1	26
19(5 May-11 May)	169	1549	5	31
20(12 May-18 May)	207	1756	3	34

21(19 May-25 May)	235	1991	4	38
22 (26 May-1 June)	237	2228	4	42

Source: HMIS, MOH

c) Malaria

There were also outbreaks of vector borne diseases especially malaria with a marked shift from lowlands to highland areas which were previously malaria-free Figures 3-18 and 3-19. Temperature rise and vector spread resulted in the increase in malaria prevalence in originally malaria free zones, particularly in the highland ecosystems of southwestern and northeastern Uganda.

Figure 3-18 Total Cases from 2001-2010 (National level)

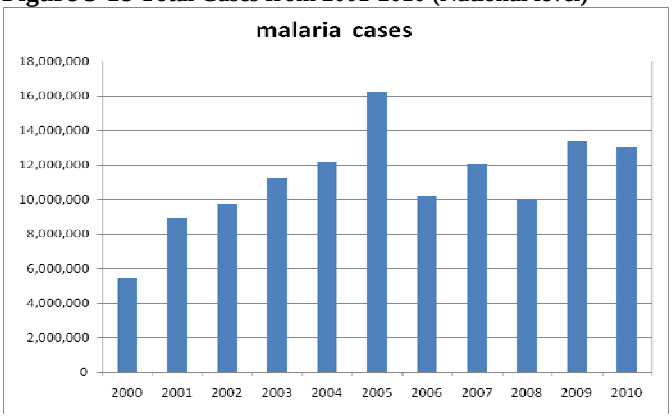
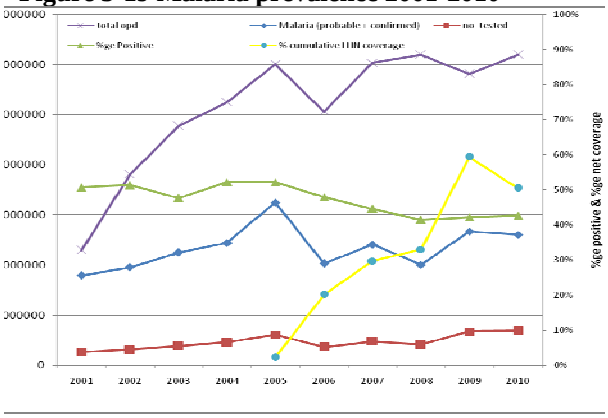


Figure 3-19 Malaria prevalence 2001-2010



Source: HMIS, MOH (HMIS 80% reporting)

d) Highland malaria in Uganda

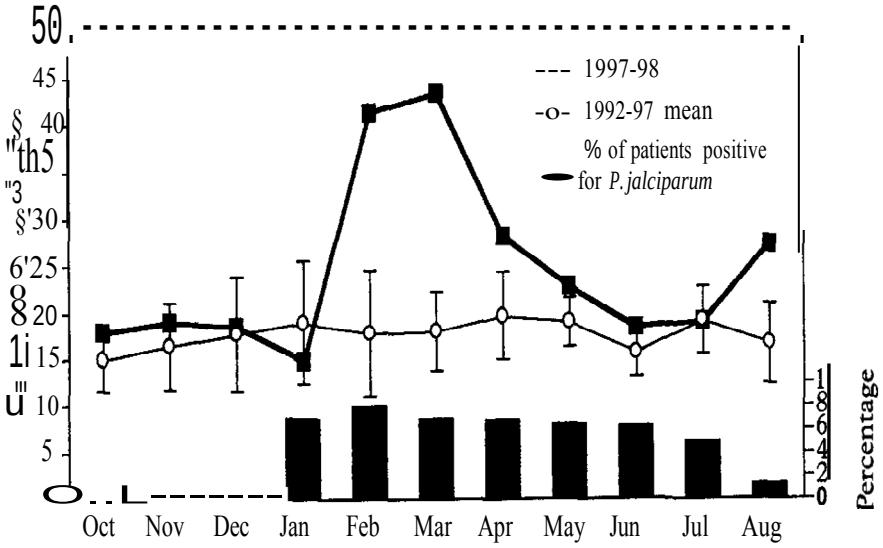
Studies carried out in Uganda (World Meteorological Organization, 1997; KILIAN et al. (1999) demonstrated an association between weather variables and entomological transmission parameters. Their data suggest that this epidemic was precipitated by excessive rainfall from mid-October 1997 through January 1998 which was attributed to a strong El Nino event. A similar asspciation has been found a similar association between rainfall and malaria case reports in a site to the north of the study area. In East Africa, El Nino, the warming phase of the Southern Oscillation, typically produces heavier than normal rain- fall and higher temperatures from December through March.

In the south-west of the country, an area at elevated altitudes which normally only experience moderate-to-low malaria transmission and hence epidemic prone, the situation reached epidemic proportions putting considerable stress on the health service providers. This

increase of Plasmodium falciparum infections were attributed to increased and prolonged rains during October-December 1997 caused by El Niiio Southern Oscillation (EN-Oscillation).

Figure 3-20 shows changes in the estimated incidence of malaria from October 1997 through August 1998 relative to the 5-year mean (1992-97), and the proportion of malaria patients positive for *Plasmodium spp.* in Kabale region of Uganda.

Figure 3-20: Estimated changes in incidence of malaria October 1997 through August 1998 relative to the 5-year mean (1992-97)



Source: Abt Associates' Uganda IRS Project, July 2012

3.5.4.3 Population groups most vulnerable to the health impacts of climate change.

The populations at highest risk include those living at the edge of their physiological tolerance range where adaptation capacity may be limited, namely:

- The rural and urban poor
- The sick, elderly, and children
- The orphans
- Pregnant women
- Persons with disabilities
- Communities in highland and wetland ecosystems
- Pastoral communities

3.5.5 Health sector adaptation

Clearly, adaptation must be a priority to protect the people of Uganda from further suffering. Several options have been identified; including policy interventions, regulatory measure and international commitments.

3.5.5.1 Policy & regulatory framework

Health sector policies and programmes in Uganda have gradually undertaken to mainstream climate change; including the Health Policy of 2000 and the Health Strategic Plan II (2005/06 – 2009/10)

The First National Health Policy and the HSSP I and HSSP II did not specifically address climate change. The NHP II and the HSSP III have provided for specific policy and interventions for climate change impacts in the health sector.

The Environmental Health, Health Promotion and Disease Prevention Cluster focuses on improving the environmental health factors. Poor hygiene and other environmental health factors which are often linked to disease and poverty are the major causes of ill health in Uganda.

One of the Strategies and key interventions in the HSSP III has been to mainstream climate change and improve adaptation within the health sector through:

a. Developing guidelines on mainstreaming climate change in the health sector to improve adaptation to climate change impacts.

b. Sensitizing staff at the MoH and local governments on climate change and adaptation.

c. Development of early warning systems and dissemination of weather forecasts to health managers to improve preparedness and response.

d. Coordinate climate change response interventions in health sector and collaborate with relevant line ministries and agencies

3.5.5.2 Positions of the WHA and the WHO on climate change

Internationally, the World Health Assembly (WHA) resolution (2008) calls on the WHO and its members states to make stronger commitment to protect health from climate change. During the 62nd WHA, WHO presented a work plan and actions to address issues of Climate Change in the health sector. The Uganda delegation supported implementation of the WHO Work plan and actions whose objectives include:-

- Awareness raising

- Engagement in partnerships with other UN Organizations and sectors other than the health sector(multi –sectoral approaches)
- Promotion and supporting the generation of scientific evidence
- Strengthening health systems for coping adapting to the health impacts

3.5.5.3 The Uganda National Adaptation Programme of Action (NAPA, 2007)

The Government developed a multi –sectoral National Adaptation Programmes of Action (NAPA) to climate change as a quick channel of communicating and implementing urgent and immediate adaptation needs including those for the health sector.

3.5.5.4 Steps made towards implementation of these strategies include:

The following briefly outline Uganda's efforts to implement these policies.

a. The health sector participated in the development of a multi-sectoral National Adaptation Programme of Action (NAPA) in 2007. Projects on community water and sanitation, vectors, pests and disease control had been identified within the NAPA and awaited funding.

b. Epidemic and Disaster Preparedness and Response - the division in charge of this in the Uganda Ministry of Health has continued to use the Integrated Disease Surveillance and Response (IDSR) strategy adopted from World Health Organization in 2000.

c. Policy and regulatory framework: The Ministry of Health had representatives on the multi-sectoral National Climate Change Policy Committee (NCCPC) to advise the minister responsible for environment and line ministries on climate change policy issues. This committee shall spearhead formulation of climate change policy.

d. Malaria control programme (IRS, ITNS, Home Management of Fevers, Intermittent Preventive Treatment, prevention of malaria during pregnancy, malaria epidemic preparedness and response) have been started to contain malaria

e. Emergency hygiene and sanitation guidelines have been developed and disseminated

f. Control of diarrheal diseases program has been established

g. Disease surveillance and monitoring has been enhanced

h. Capacity building and training (human and logistical) are continuously undertaken

3.5.5.5 *Specific Health sector Programmes*

The following specific health sector programmes have been instrumental in the adaptation measures of Uganda:

(a) **Epidemic and Disaster Preparedness and Response:** The Health Sector capacity to respond to these outbreaks and epidemics had been strengthened through Integrated Disease surveillance.

(b) **Environmental Hygiene and Sanitation Promotion**; with particular emphasis on health education and promotion. This has been found to be a strong tool towards adaptation to climate variations and health impacts especially for Emergency situations.

(c) **The Malaria Control Programme**. The MCP has been promoting prompt and effective malaria case management at the health facility, community and household levels. An example of direct programs linking climate change to health interventions is the Highland Malaria Control Programme in Kabale District (HIMAL) which is strongly linked to weather forecasting and predictions.

3.5.5.6 *Multi – Sectoral linkages for delivery of health services*

For Uganda to implement the recommendations articulated in the National Development Plan (NDP) and to achieve the health related MDG targets, the multi – sectoral approach has been adopted. Functional linkages and collaborative mechanisms in the delivery of health services in the county have been established with other sectors of the socio-economy. These multi – sectoral linkages spell out roles & responsibilities of key stakeholders in addressing cross – cutting issues in the delivery of health services with some related to climate change.

3.5.6 Cost-Benefit Analysis of Adaptatiomn in the Health Sector

The cost benefit analysis established that mainstreaming of climate change in some of MoH projects, programs and activities has happened but to a limited extent. Should the policy makers feel that climate change is not an issue and decide otherwise, then the listed impacts of climate change as already pointed out will have a far much higher likelihood to occur and will have adverse effect (very severe). An example could be stopping distribution of Long Lasting Treated Mosquito Nets (LLN). The likelihood of having a malaria epidemic in some areas like Kigezi sub-region will be very high and may have many children and pregnant women die due to the same. By all means, Uganda should not think of removing the so far gained ground on adaptation to climate change in the health sector. Doing every effort to maintain the so far gained ground can only make the country manage but for a while. This is because climate change continues to erode the gained grounds. However, with limited scaling up of the mainstreaming, one can halt/reduce the likelihood of occurrence of effects of climate change and make them less severe whenever they occur. With the availability of resources both financial and human, the ideal

would be to have comprehensive mainstreaming of climate change in all the projects, programs and activities. This will involve review of existing policies and structures to implement the said policies. This way, the halting of the likelihood of occurrence and reversing the adverse effects can easily occur.

3.6 Vulnerability and adaptation of the water, wetlands, fisheries, and biodiversity sectors to climate change

3.6.1 Water resources and wetlands

Two areas were considered in the vulnerability assessment of water resources in Uganda; the water balance of Lake Victoria and the ground water.

3.6.1.1 The vulnerability of the water balance of Lake Victoria to climate change

Lave Victoria is considered very important in the hydrology of the Nile. Because of this, several attempts have been made to determine the water balance of Lake Victoria. Most findings have stated that the outflow from the lake dominates the flow in the Albert Nile and Bar el Jebel (in the Sudan) and determines the seasonal and inter-annual variability in the extent of the Sudd wetlands. Furthermore, it accounts for much of the low flow in Egypt before reservoir storage became available. The outflow from the lake is also the major source of hydropower in Uganda and determines the potential availability of hydropower for projects downstream of the currently operating Kiira and Nalubaale hydropower generation facilities in Uganda.

Figures 3-21 shows extracts of the clear seasonality of the lake levels. The seasonal variation in rainfall on the lake follows the bimodal pattern of the rains with the 'short rains' in October-December and the 'long rains' from February to May. This results in storage gains from March-May and again in November-December, with storage losses during the rest of the year. The same pattern, although less pronounced and with routing delays in the rivers, applies to the catchment inflow. Evaporation is almost constant over the year, with slight increase in losses towards the end of the dry seasons. As the combined outputs are almost constant over the year, variations in storage are mainly a function of the seasonal rainfall as well as the seasonal to inter-annual variations. Under natural conditions, the outflow would have varied along with changes in the storage/water level ratio, but regulation by the Owen Falls Dam now results in an almost constant average monthly outflow, although there is some daily and weekly variations determined by changing electricity consumption (Figure 3-22).

Figure 3-21: Variation in the key components of the Lake Victoria water balance (mean monthly values for the period 1953-78).

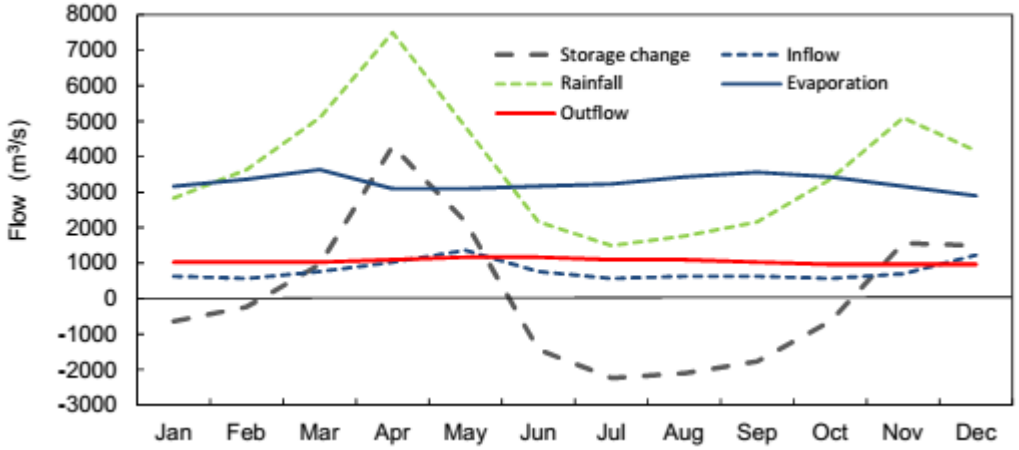
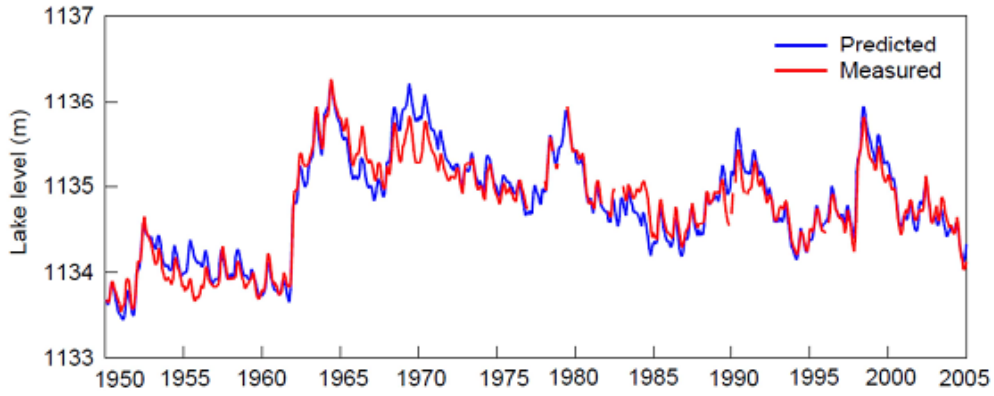


Figure 3-22: A comparison of estimated (blue line) and observed (red line) water levels in Lake Victoria based on data from the LVEMP study (LVEMP, 2002).



3.6.1.2 Groundwater demand assessment and its vulnerability to climate change

In estimating the groundwater demand it was assumed that boreholes, shallow wells, protected springs, and gravity flow schemes all represent groundwater usage. It was necessary to quantify current and future demand on groundwater resources for planning and management purposes. The assessment took cognisance of the fact that water demand can be satisfied from various sources, depending on availability, costs, quality, historical preference, and so on. While making the National Water Resources Assessment, it was assumed that all domestic water demand in rural areas, as well as in towns not supplied by the national utility, National Water and Sewerage Corporation, is and will be met by groundwater.

Clearly, all the sources of ground water mentioned above are sensitive to climate variability and change especially in terms of prolonged drought periods or floods at the given location or region. The case of a dried up borehole in Masaka in 2005 because of a prolonged drought was a viv manifestation of this.

DRIED BORE HOLE MASAKA 2005

As indicated earlier, Global Circulation Models (GCMs) suggest that mean temperatures will rise by 0.3 to 0.5°C per decade in Uganda. They also predict an increase in annual rainfall of 10-20% during the 21st century and a change in the seasonal distribution of rainfall, which will increase from December to February and decrease from June to August. The major impact is expected to be an increase in the frequency of intense rainfall events resulting from increased water vapour in the atmosphere, as a consequence of higher evaporation rates over the oceans. Rising temperatures will particularly affect the semi-arid areas because deficits in atmospheric moisture vapour pressure at the planetary boundary layer cannot be met by water stored in the soil. This will change conditions in the drier north-eastern and south-western areas but are of less concern around Lake Victoria. The impacts of climate change will depend on the vulnerability of the systems exposed to the changes and how much they depend on a predictable climate. Vulnerable areas in the water sector, identified in the National Adaptation Programme of Action, are the water levels of Lake Victoria and the flows in the Nile River, water quality and human health particularly on the shorelines of lakes near urban areas or river mouths, hydroelectric power, and the over-exploitation of groundwater by agriculture.

3.6.1.3 Water dependency and adaptation needs

The National Development Plan distinguishes between the primary growth sectors, complementary sectors, social sectors and enabling sectors of the economy, each of which requires water. Those that are heavily influenced by water availability have been considered in brief situation analyses with the aim of making a first approximation of impact of changes in the availability of water resources on these sectors. The national importance of the sectors was assessed through their contribution to the Gross Domestic Product (GDP), exports, livelihoods/employment and food security. The risks posed by climate change were assessed by relative frequency of negative impacts, their intensity, their geographical extent and the potential damage that could be caused. Coping capacity is based on the preparedness and capacity for adaptation in each sector. Although these attributes are very hard to compare, a general tendency may appear that can inform resource allocation among sectors for climate change adaptation. The primary growth sectors considered in this analysis were crop

production (including irrigation), livestock, fisheries and aquaculture, forestry, and tourism Table 3-13. Complementary sectors included lake transport and energy production. Social sectors were health and nutrition, water and sanitation, and floods and droughts. Lastly, the enabling sectors included water resources management, meteorology, and environment and disaster management.

Although many assumptions had to be made in this comparison, the results (Table 2-13) are probably realistic in general terms. Agriculture, for example, had the highest score in relation to national importance (which is well known as most of the population lives on the land) but is exposed to greatest risks from climate change and is low-ranked in terms of coping capacity. It is top-ranked as a priority for adaptive measures, suggesting that Uganda's Directorate of Water Resources Management should prioritise assistance to agriculture as this will add most value to the development of Uganda. Agriculture is followed by energy, livestock, and fisheries and aquaculture, while lake navigation and forestry were given the lowest scores.

A similar comparison was made for the social sectors (Table 3-14), in which 'floods and droughts' while of national importance was left out as economic criteria cannot easily be applied to these activities. A significant feature is that the score for water and sanitation was rather low. For the cross-cutting sectors such as water resources management, meteorology, environment and disaster risk management (Table 3-15) it is clear that decentralised operations are at a weak level and the intensity of field measurements has decreased in recent years.

Table 3-13: A preliminary assessment of productive sectors and their relative importance in a national context and their capacity to adapt to climate change.

		Primary growth sectors					Complementary sectors	
		Agriculture	Livestock	Fisheries & aquaculture	Forestry	Tourism	Navigation	Energy
National importance	GDP	High	Medium	Medium	Low	Medium	Low	High
	Export	Low	None	Low	Low	High	Low	Low
	Livelihoods/ employment	High	medium	High	Low	Medium	Low	Low
	Food security	High	High	High	None	None	None	None
	Score	10	7	8	3	8	4	7
Risk from Climate Change	Frequency	High	High	Low	Low	Low	Low	Low
	Intensity	High	Medium	Low	Low	Low	Low	Medium
	Geographical extent	High	Medium	Medium	Low	Low	Low	High
	Damage potential	High	Medium	High	Low	High	Low	High
	Score	12	9	7	4	6	4	9
Coping Capacity	Preparedness	Low	Low	Low	Low	Low	Low	Low
	Adaptation potential	Medium	Medium	Low	Low	Low	Low	Low
	Score	5	5	6	6	6	6	6
Priority		27	21	21	13	20	14	22

Table 3-14: A preliminary assessment of social sectors and their capacity to adapt to climate change

	Risk from Climate Change					Coping Capacity		
	Frequency	Intensity	Geographical extent	Damage potential	Score	Preparedness	Adaptation potential	Score
Health & nutrition	medium	medium	high	high	10	low	low	6
Water and sanitation	low	medium	low	low	5	low	medium	5
Floods	medium	high	low	high	9	low	medium	5
Droughts	medium	medium	high	high	10	low	medium	5

Table 3-15: A preliminary assessment of institutional sectors and their capacity to adapt to climate change

Enabling sectors	Staff capacity	Cross-sectoral cooperation	Decentralisation	Data collection and information
Water resources management	High	Water Policy Committee	Low: catchment management under development	Medium: but number of field operations decreasing
Meteorology	High	Provides data to many sectors	Low	Medium: but network has only 17% of required instruments
Environmental and ecosystem health	High	National Environment Management Authority (NEMA) cooperates with several specialised agencies	NEMA represented in several districts	Medium
Disaster risk management	No permanent staff	Inter-ministerial Policy Committee; National Platform of Disaster Focal Points	Low	Medium; through other relevant agencies

These assessments were then given a score for each category by giving the terms "high", "medium" and "low" a score of 3, 2 and 1 points, respectively and then summed to give a total (Table 3-16).

Table 3-16: Relative scores between sectors where water resources occurrence and accessibility play a major role

Sectors	National importance	Risk from Climate Change	Coping Capacity	Total (priority)
Agriculture	10	12	5	27
Energy production and distribution	7	9	6	22
Livestock	7	9	5	21
Fisheries & aquaculture	8	7	6	21
Tourism	8	6	6	20
Navigation	4	4	6	14
Forestry	3	4	6	13

The clear message from all the assessments is that the water sector, which includes water resources management and the provision of water, will play a significant part in adapting to climate change through strategies that will keep all sectors of the economy productive and function effectively, and to minimise the losses and negative impacts from floods and droughts.

Moreover, the design of any interventions in Uganda within the water sector, must take into account wetlands which are the immediate reservoir of water. Indeed, wetlands must be prioritized because they form a very large network that controls large volumes of water and its

movement; both vertical and horizontal.

3.6.1.3 Adaptation Measures in the Water Sector

The following adaptation measures are proposed in this sector:

i. Government of Uganda should reaffirm its commitment to maintaining the current wetlands estimated to cover 11% of the country and direct all encroachers to voluntarily vacate wetlands;
ii. Support all efforts being implemented by NEMA and the Ministry of Water and Environment to remove all encroachers from wetlands and hold politicians interfering with the exercise personally accountable;
iii. Provision of more funding to NEMA and the Wetlands Management Department to Operationalize the EPF and also carry out a nationwide sensitization, physical wetlands boundary demarcation and restoration and gazettement of all vital wetlands; and
iv. Cancellation of all land leases and titles in wetlands so that the NEMA and the Wetlands Management Department can work with the Ministry responsible for Lands, Justice and Constitutional Affairs to identify, isolate and hold the perpetrators individually accountable, as well as, withdraw these titles and leases from their holders.

3.6.2 Adaptation Measures in the Fisheries Sector

The following adaptation measures are proposed in this sector:

- Conserve water, particularly during droughts through careful use and good agricultural management practices;
- Harvest rain water and store for future use;
- Strengthen and re-orient fisheries research institutions to take into account climate change.
- Refocus research into pests and plant and animal diseases, taking into account likely emergence of new pests and diseases as a result of climate change;
- Take climate change considerations into account in the fishery sector planning process; and
- Strengthening capacity of the Department of Meteorological to enable it provide timely and accurate weather and climate information to support adaptation to adverse effects of climate change.

3.6.3 Biodiversity

Uganda's biodiversity is faced with many threats - most of which are human activity geared. For example, the major drivers of deforestation are pressure from the growing population leading to conversion of forest into agricultural and grazing land and over-harvesting for firewood, charcoal, timber and non-wood forest products. It is estimated that the country is losing its biodiversity at an annual rate of 1 percent due to 1) habitat loss; 2) lack of certain types of biodiversity information; 3) threats from the development of the oil industry; and 4) alien invasive species, among others. The threats have led to a continued loss and degradation of Uganda's biodiversity thereby affecting livelihoods, economic growth and human well-being. The annual contribution of forest based biodiversity is estimated to have decreased from US $5.097 million in 2005 to US $4.405 million in 2010 mainly due to deforestation.

Some of the results are that the key forest biodiversity species, like the four primates, two other mammal species, six bird species, and two butterflies are listed in the IUCN Red Data Book of 2008 to be globally threatened with extinction. Four species of mammals (Chimpanzee, l'Hoest monkey, elephant, leopard), one species of birds (Grauer's rush warbler) and one species of butterfly (Cream-banded swallowtail butterfly) are listed as ''vulnerable''. Four species of forests birds (Nahan's francolin, African green Boradbill, Flycatcher and Forest ground thrush) are classified as ''rare''. The Uganda red collobus monkey and Kibale ground thrush are categorized as ''intermediate'' species since not enough information is available about them.

The following adaptation measures are proposed in this area:

- Conserve the habitat, particularly during droughts through careful use and good management practices

- Strengthen and re-orient the conservation practice through research to take into account climate change.\

- Refocus research into pests and animal diseases, taking into account likely emergence of new pests and diseases as a result of climate change.

Chapter 4 : MEASURES TO MITIGATE CLIMATE CHANGE

4.1 Introduction

Based on the level of economic and social development outlined in Chapter 1 and greenhouse gas emissions levels reported in Chapter 2, Uganda's contribution to global warming and hence climate change is minimal. Yet, climate change vulnerability and impacts are a stark and ever increasing reality as outlined in Chapter 3. In response, Uganda is generally keen to cooperate with other Parties to the United Nations Framework Convention on Climate Change (UNFCCC); in accordance with the principle of common but differentiated responsibilities and respective capabilities. This chapter presents an analysis of the country's mitigation options and measures in place that, with support, Uganda would implement.

4.2 Mitigation assessment

The mitigation assessment reflects on the country's emission levels and trends and explores how options to reduce GHG emissions and enhance sinks influence emissions. In this report, GHG emissions projections from 2005 to 2035 following a business-as-usual scenario and mitigation scenarios in the key sectors of energy and transport, agriculture, LULUCF and waste were made. The next sections highlight the major assumptions made, the trends obtained and the proposed mitigation strategies.

4.2.1 Mitigation assessment in the energy and transport sector

4.2.1.1 Energy sector sscenarios and modeling

Two scenarios were developed to assess developments in the energy and transport sector – Business-as-Usual and Mitigation Scenario. In the Business-as-Usual scenario, it was assumed that there would be steady growth in the economy accompanied with increasing energy demand and high population increase. Furthermore, it was assumed that most industries will be inefficient, small or medium scale. In the Mitigation Scenario, it was assumed that the ongoing government policy to increase efficiency in all sectors of the economy would result in reduction in energy consumption and consequently reduce greenhouse gas emissions in the energy and transport sectors. This was justified by the government policy that promotes blending and switching to better fuel. It was assumed that ethanol blending in the transport sector would start in 2020 and biodiesel would follow thereafter in 2025. Industries that use fuel oil for thermal energy generation will be encouraged to switch fuel through use of agricultural wastes depending on the availability and accessibility.

The future drivers of emissions in the energy and transport sectors will include economic development, population growth rates and changes in household size. Efficient end-use

equipment will reduce the energy demand and consequently GHG emissions. There is rapid growth in the transport sector due to the increasing fleet of used vehicles. The rate of future emissions in this sector will be based on growth rates of used motor vehicles and other parameters such as fuel switching, improved efficiency of vehicle imports and infrastructure.

The most important fuels in the Business-as-Usual scenario are: charcoal used in residential, commercial and institutional source categories; fuel wood used in residential, commercial, institutional, manufacturing and construction; jet kerosene fuel solely used in aviation; gasoline and diesel used in transport while energy industries use diesel fuel. In this scenario, the agricultural residue is largely used in the residential sub-category.

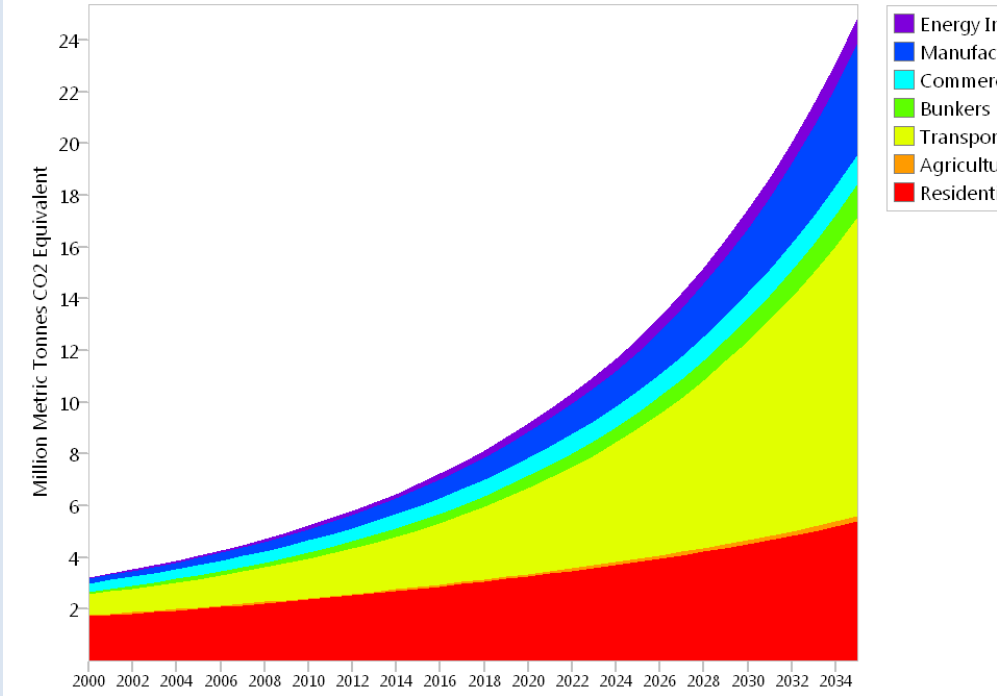
The Linear Energy Analysis and Planning (LEAP) software that was to be used for forecasting of energy is based on an econometric model where the main drivers are growing GDP and income. However, the development of energy prices, income and income elasticity, the nature of the Uganda economy and lack of data made this unfavourable. The end-use model was preferred as the future energy demand could easily be forecasted with the help of specific growth rates, and does not require much data. It is also preferred for countries with unsteady or rapid development. Other drivers included were: household growth, population growth, agricultural growth, industrial and commercial growth, and the development of energy intensity.

4.2.1.2 Mitigation assessment in the energy and transport sector

The Business-as-Usual scenario showed that the transport sub-category shall be the largest and fastest growing contributor of GHG emissions followed by residential, manufacturing and construction sub categories. Under this scenario, the total GHG emission was estimated to increase from 3.2 million $mtCO_{2e}$ in the base year (2000) to 24.9 million $mtCO_{2e}$ by the year 2035. Figure 4-1 shows the trend of increase in GHG emissions by source categories in the energy and transport sector.

The projected contribution to the total GHG emissions from the energy industry, manufacturing and construction source categories will, respectively, increase from 4% and 11% in the base year to 5% and 22% of the total GHG emissions by 2035. There will be a slight decrease in the contribution by the transport sector from 64% to 61% over the same period. The contributions of emissions due to residential and agriculture sub categories will decrease from 8% and 4% in 2000 to 3% and 1% by 2035, respectively. The increase is expected to be more pronounced after 2020; when petroleum and gas will be playing a major role in Uganda's economic development.

Figure 4-1: The trends of GHG emission by source categories



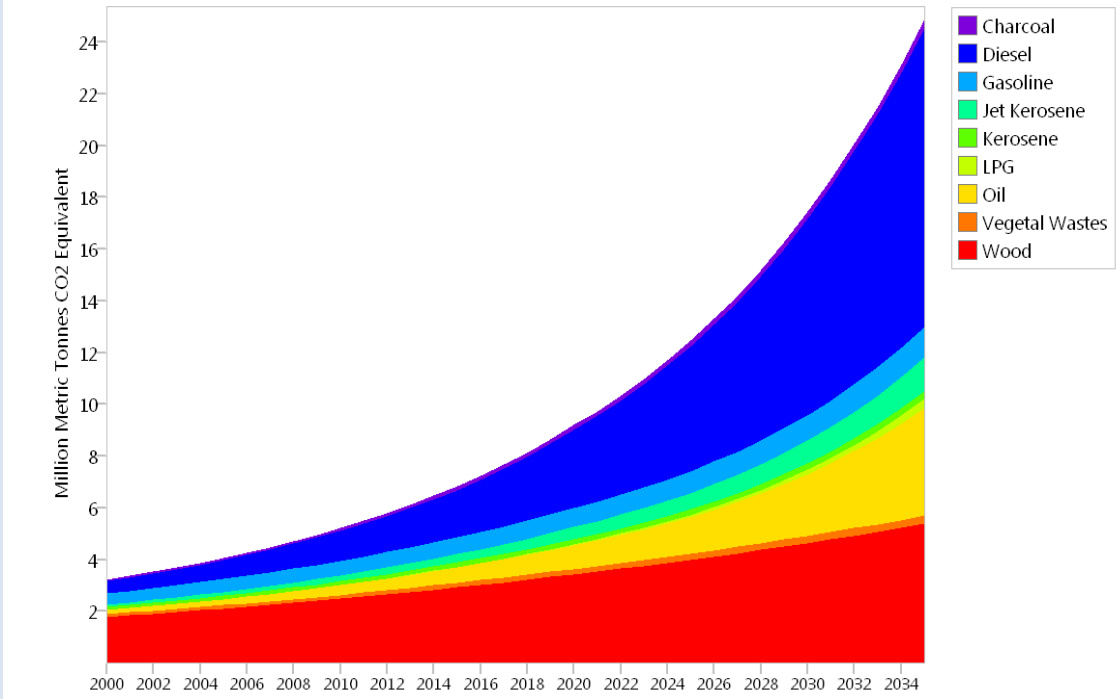
In this scenario, it is projected that emission from LPG will increase from 4.4 thousand $mtCO_{2e}$ in the base year to 380.3 thousand $mtCO_{2e}$ by the year 2035; that is about 80 folds. The demand was projected to increase in the residential and manufacturing source categories because of its low carbon intensity. Figure 4-2 shows the trends in emission by different fuels in the energy sector. The emissions from the use of diesel and fuel oil will increase from 482.8 thousand $mtCO_{2e}$ and 142 thousand $mtCO_{2e}$ in the base year to 12.038 million $mtCO_{2e}$ and 4.316 million $mtCO_{2e}$ by the year 2035, respectively.

The increase in the use of gasoline, kerosene, wood fuel and agricultural residues will be about three folds. The contribution of diesel and fuel oil to the total GHG emissions was projected to increase from 15% and 4% in the base year to 46% and 17% in 2035, respectively. It is only wood usage contribution to the total GHG emissions that was estimated to decrease from 55% in 2000 to 22% in 2035.

In the Mitigation scenario, it was projected that by 2035 transport sub category will dominate the total GHG emission (Figure 4-3). The total GHG emissions will increase from 3.230 million $mtCO_{2e}$ in the base year to 20.977 million $mtCO_{2e}$ in 2035. There will be a general overall

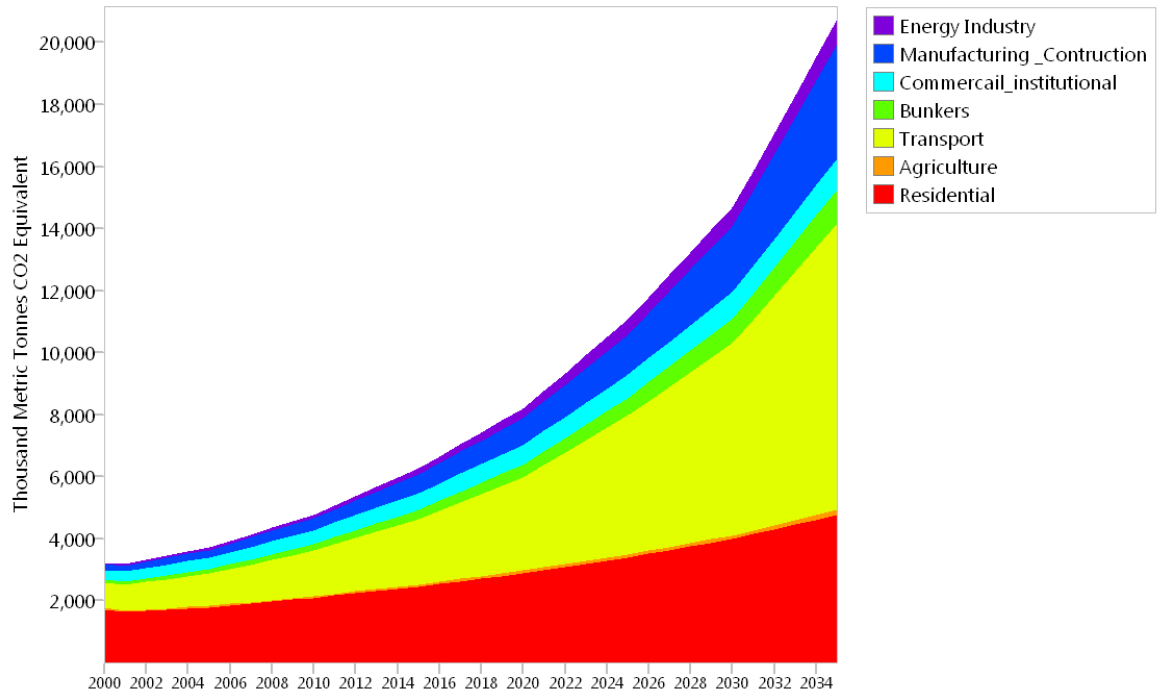
increase in the efficiencies from about 5% in 2000 to 20% by the year 2035. Blending with ethanol shall take a shorter lead time than biodiesel. Ethanol blending was projected to start by 2020 to be followed by biodiesel after 2025.

Figure 4-2: BAU Scenario; GHG emission by different sources of fuels in energy



The contribution of the transport, manufacturing and construction sub categories was expected to increase from 25 percent and 6 percent in the base year to 44 percent and 18 percent by the 2035, respectively. Energy industry's GHG emissions were projected to increase from 1% to 4% over the same period. Contribution of the residential as well as commercial and institutional source categories was expected to reduce from 53 percent and 10 percent in 2000 to 24% and 5%, respectively, by 2035.

Figure 4-3: Mitigation source categories



The upward trend of GHG emissions by fuels used in different source categories is shown in Figure 4-4. Diesel is increasingly a major source of energy and its contribution to GHG emissions is projected to increase from 15% in 2000 to 44% by 2035. Likewise, fuel oil's GHC, emissions was projected to increase from 4% in 2000 to 17% by 2035. However the gasoline and biomass emissions will decrease from 13% and 55% to 4% and 24%, respectively, over the same period. Figure 4-5 and Table 4-1 show the differences in emissions between the two scenarios.

Figure 4-4:The projected emissions by different fuels used in source categories

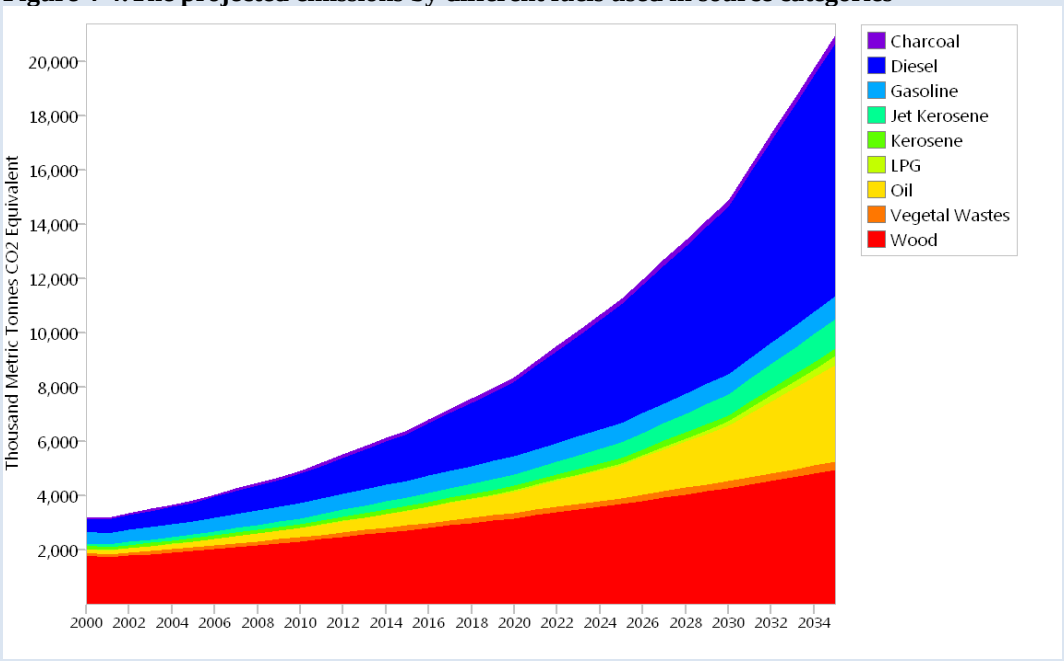


Figure 4-5: The differences in emissions between the scenarios

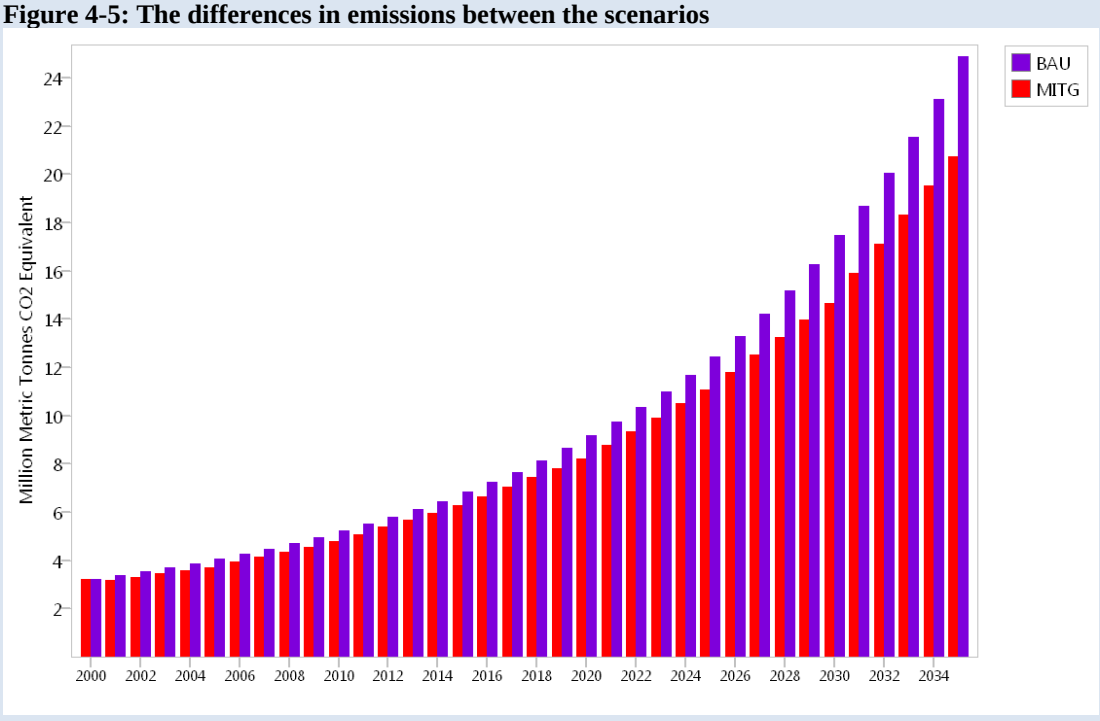


Table 4-1: The emissions for different scenario Thousand Metric Tonnes CO_2 Equivalent

	Base Year	BAU Scenario	Mitigation Scenario	
Subsector	2000	2035	2035	% Change
Energy Industry	48.2	980.2	264.0	73.0
Manufacturing _Construction	187.0	4310.9	2896.4	32.0
Commercial_/ institutional	318.9	1140.8	1004.7	11.9
Bunkers	96.4	1296.7	1104.0	14.9
Transport	812.9	11555.3	9035.8	21.8
Agriculture	48.3	209.0	159.9	23.5
Residential	1719.0	5384.5	5003.0	7.0

4.2.1.3 Mitigation measures in the energy and transport sector

Mitigation options can be considered on two sides - the supply side and end-use side. Key options on the supply side include:

- Use of better technologies such as Adam Retort kilns for charcoal production;
- Increasing use of hydropower as a clean energy supply;
- Wider use of solar energy for low power electricity using photovoltaic systems and larger plants using steam or organic fluids in future;
- Accessing clean electricity energy supply through the East African Power Pool;
- Increased co-generation from sugar cane factories as well as production of ethanol for blending or direct use in the transport sector. Ethanol can also be used in the household sector;
- Develop biodiesel fuel from plants such as cotton, castor oil seeds or other non-edible crops;
- Use of agricultural crop residues in some industries such as cement, bricks and tiles, and oil processing;
- Exploitation of geothermal potential.

The options on the end-use side may be divided into the various sub categories. At the household level, the options include:

- Managing the increasing energy demand in all sectors of economy can be made through increased energy efficiency measures;

- Fuel switching in the households from biomass to electricity and biogas;
- Use of low capacity PV systems as solar home systems;
- Use of solar water heaters in residential subsectors;
- Wider use of energy saving bulbs.

In the Industrial and Construction Subcategory, the options include:

- Fuel switching from oil fuel to biomass;
- Institute energy management measures including installation of more efficient equipment and adoption of better technologies.

In the Commercial and Institutional Sub-category, the options are:

- Fuel switching;
- Use of higher efficiency technologies and/or equipment;
- Adoption of better energy management practices.

In the Transport Sub-category, the options are:

- Blending gasoline with ethanol or use of 100% ethanol vehicles as well as use of 100% biodiesel or blending;
- Use of hybrid cars;
- Impose import restrictions on motor vehicles through inspection, coordinating road freight and promoting freight trains;
- Mandatory inspection (and hence maintenance) of vehicles;
- Use of rapid mass transit systems including building dedicated lanes for rapid mass transit systems.

In the Agriculture and fisheries sub-category, the options are; use of biodiesel blending in the short and medium term and pure biodiesel as the fuel for the future.

In the Energy Industry Subcategory, the options include:

- Place more hydropower plants on line;
- Use heavy fuel thermal plants where hydropower is insufficient;
- Use combined gas turbine power cycles;
- Ensure use of modern technologies with high energy system efficiencies.

4.2.2 Mitigation assessment in the agricultural sector

4.2.2.1 The Ugandan context: sources of GHGs

As presented in Chapter 2, methane (CH_4) and nitrous oxide (N_2O) are the main anthropogenic GHGs emitted from the agricultural sector. The major sources of these gases are domestic livestock and agricultural soils. Methane is mainly emitted from domestic livestock as a by-product of the digestive process of enteric fermentation and from manure management. Nitrous oxide is generated mainly by inefficient animal waste management systems under pasture range and paddock and direct N_2O emissions from cultivated organic soils through the de-nitrification process which takes place under oxygen stress in moist and oxygen depleted conditions.

4.2.2.2 Mitigation options in the agriculture sector

Figure 4-6 and Figure 4-7 show possible Business-as-Usual (BAU) and Mitigation (MT) scenarios in the Ugandan agricultural sector.

Figure 4-6: N2O emissions scenarios with mitigation options

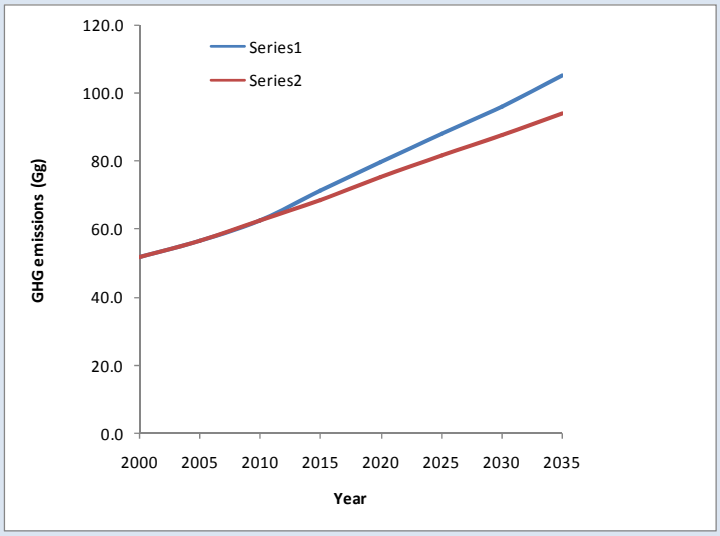
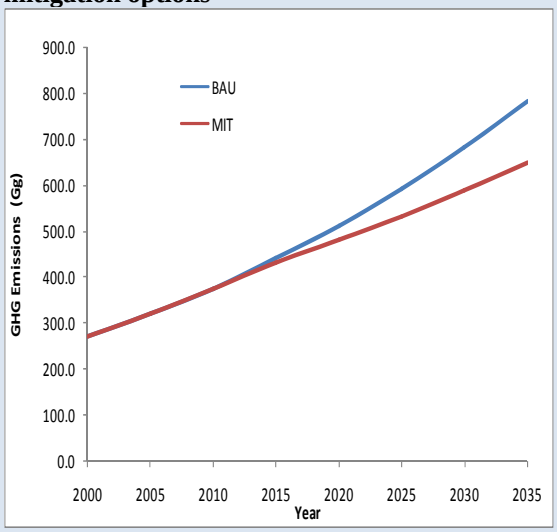


Figure 4-7: CH4 emissions scenarios with mitigation options



Regarding CH_4 emissions, the assumptions under the BAU scenario are: (i) livestock numbers will continue to increase exponentially and continue to be dominated by indigenous breed stock; (ii) minimum improvement in quality of livestock feeds (especially pastures) and animal health; (iii) minimal initiatives for improved manure management systems; and (iv) increase in paddy rice production. The BAU scenario emissions are 272 Gg of CH_4 in 2000 and are projected to be 511 Gg by 2020 and 782 Gg by 2035.

Under the mitigation scenario, the assumptions are (i) 20% of livestock is managed under intensive systems with improved breed quality leading to improved feed, fodder and pasture quality which are more digestible, and improved animal health; (ii) 10% of livestock farms under intensive management systems adopt manure management practices that include biogas production and utilization. Under this scenario, projected emissions are; 480Gg of CH_4 by 2020 and 647Gg by 2035. This scenario will reduce CH_4 emissions by 10% by 2020 and 17% by 2035.

For N_2O, the BAU scenario assumptions are: (i) increased area of organic soils will come under cultivation due to the need to provide food for a rapidly increasing population; (ii) pasture range and paddock management system will continue to be the dominant livestock management system; and (iii) increase in use of nitrogen fertilizers without deliberate measures for their efficient use that minimizes leaching and volatilization. Under this scenario, 52 Gg of N_2O were emitted during 2000. Under this scenario, N_2O emissions are projected to increase to 80 Gg by 2020 and 105 Gg by 2035.

The mitigation scenario assumes that a number of measures will be taken to stem out the N_2O emissions by 2035. Such measures include: (i) a 30% adoption of minimum tillage practices on cultivated land, including organic soils; (ii) 20% of livestock is managed under intensive systems; and (iii) 15% increase in fertilizer use accompanied by measures to ensure their efficient use through precision planting techniques, especially among commercially oriented farmers. Under this scenario, it is expected that N_2O emissions will increase to 75 Gg by 2020 and 94 Gg by 2035. This will be low compared to the BAU scenario where N_2O emission will reduce by 6% by 2020 and by 11% by 2035.

4.2.2.3 Mitigation priorities in the agriculture sector

The following mitigation priorities are already identified and outlined in the Uganda National Development Plan.

- **Domestic livestock** – Management practices that focus on improving efficiency and productivity of domestic livestock that also reduce methane emissions on per unit of product basis. In general terms, producers could increase efficiency and productivity of their domestic livestock operations and hence reduce methane emissions through improved pasture management, good herd health programmes, genetic improvement, strategic feed supplementation and efficient marketing of livestock and livestock products.

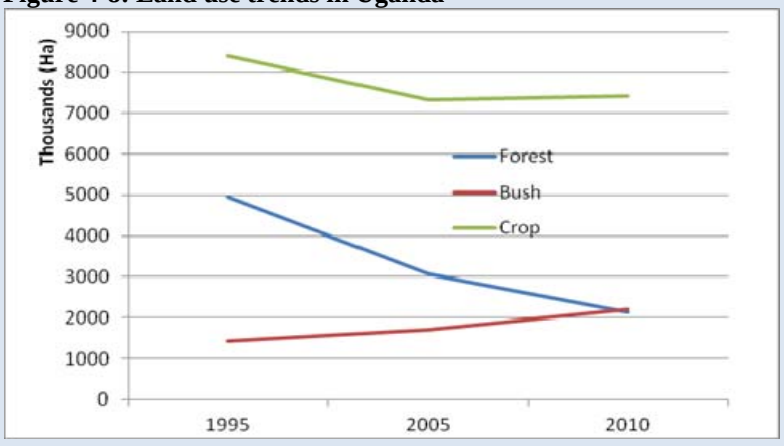
- **Livestock manure** – Manure management practices that minimize escape of N_2O and CH_4 into the atmosphere should be emphasized, especially where concentrations of livestock are high under intensive systems. This should include practices that improve storage, handling and anaerobic digestion of the manure such as biogas production, composting and recycling of livestock manure. These not only enhance livestock productivity, integration with cropping and energy supply systems but also facilitate the reduction of N_2O and CH_4 emissions to the atmosphere.
- **Cropland use** – Application of appropriate sustainable land management practices that enhance productivity while minimizing GHG emissions, including minimum tillage, efficient use of fertilizers and manures, and promotion of low-carbon crops such as upland rice.

4.2.3 Mitigation in LULUCF

4.2.3.1 Forest degradation and deforestation in Uganda

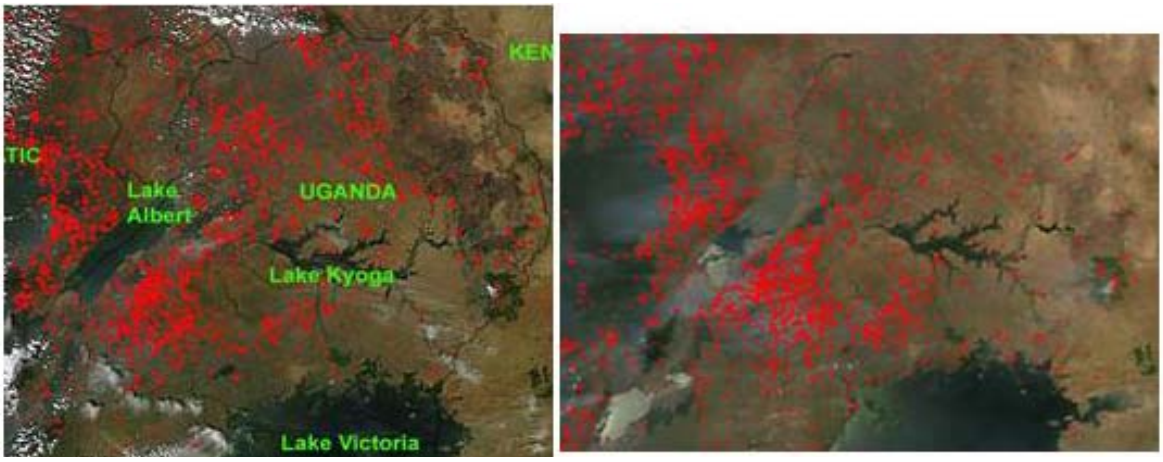
A preliminary analysis of land use / cover trends in Uganda shows that area under forest is decreasing while that of crop land is increasing. Large chunks of forests are also being degraded into bush and cropland (Figure 4-8). Past evidence shows that between 1995 and 2005, the highest levels of degradation were outside protected areas and in the woodlands and Tropical High Forests of Kibale, Kagadi, Kyangwari (NFA 2005). Most of this was mainly due to agriculture expansion.

Figure 4-8: Land use trends in Uganda



Fires may be major sources of degradation of land cover in Uganda. About 30% of central Uganda is burnt during the dry months of December to February as evidenced by MODIS satellite imagery (Map 4-1). The fires are commonly seen in the woodlands of central Uganda (Mubende, Hoima, Masindi) and northern Uganda. In 2005, it was estimated that emissions from fires were in the range of 4,000 Giga grams of CO and about 450 Giga grams of CH_4. Unfortunately, these fires did not only take place in farmland areas but also in woodlands and Tropical High Forests of Elgon, Rwenzori, Bugoma and Budongo. The impact of these fires on the vegetation depends on intensity and frequency.

Map 4-1 Wild fires as seen on MODIS satellite imagery



4.2.3.2 Drivers of forest degradation and deforestation

The drivers (factors that lead to deforestation and forest degradation) are categorized as proximate (direct drivers) and indirect drivers. Proximate drivers of deforestation and forest degradation are human activities and actions that directly impact forest cover and result in loss of carbon stocks. In Uganda, the leading proximate drivers are subsistence agriculture and high rate of biomass extraction (for timber, charcoal and commercial fuel wood). Of recent, establishment of commercial farms, infrastructure, urban development and mining are in some areas increasingly reducing the forest cover.

Indirect drivers are underlying processes that affect the proximate drivers to cause deforestation or forest degradation. They are "complex interactions of social, economic, political, cultural and technological processes" and they act at multiple scales. For example, at a global scale, FAO predicts that there is need to increase production of cereals by 49 percent and that of meat by 85 percent to cater for the projected increase in demand by 2050. Most of this will be in LDCs where land is still available. At national level, weak forest sector governance especially

institutions and lack of cross-sectoral planning and coordination and weak law enforcement are critical underlying drivers of forest degradation and deforestation.

Local circumstances like high population growth and urbanization translate into increased charcoal demand indirectly causing deforestation and forest degradation. The situation is amplified by lack of alternative fuels and/or lack of affordable efficient cook stoves. Cultural beliefs like bush burning, poverty, low literacy rates, high demand of low priced primary commodities like maize are indirect drivers of deforestation in places like Kibale District. Thus, mitigation in LULUCF lies not only in increased law enforcement and afforestation but also in managing direct and indirect drivers of forest degradation and deforestation which fall outside the realm of the forestry sector.

4.2.3.3 Interventions

More often than not, addressing the underlying factors is crucial to determine whether direct driver interventions will succeed. One way to address indirect drivers is to promote good practices through creation of consumer awareness locally and internationally. This entails protracted campaigns with credible facts and figures to create awareness of the negative environmental and social impacts of business-as-usual practices and where possible use round table negotiations for remedy.

Uganda needs to build institutional capacity of all key government agencies that directly or indirectly manage the forestry sector. The institutional capacity of local governments should go beyond developing by-laws and ordinances that control vices like bush burning but also have capacity to curb bush burning. The success of implementing these proposals would require multi-sectoral planning and coordination.

Below are some of the needs for capacity enhancement:-

- To build a Forestry Monitoring Information System (FMIS);
- Support NFA to continue maintaining the Geographical Information and the associated forestry inventory data;
- Support FSSD to implement the forest produce tracking that feeds information to the FMIS and help the private sector develop forest management plans.

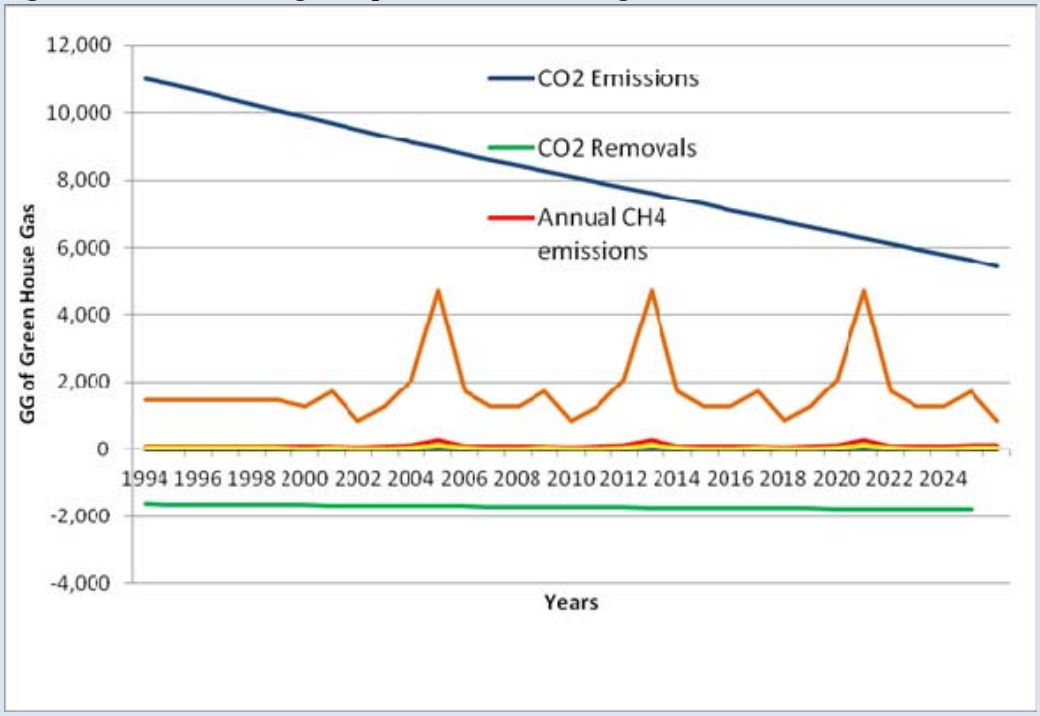
Some of the efforts so far include:- MEMD planning to implement a biomass energy strategy with the biomass energy communication strategy; and establish a biomass energy information system. It has been proposed that UBOS includes assessment of energy consumption in the housing and population census. NEMA and UIA had been urged to contribute to the biomass energy information system by providing information from energy audits of industries and

planned investments. Thus the biomass energy information system would be an integral part of the FMIS.

Once the indirect drivers are addressed, it would be possible to effectively reduce the effect of proximate drivers. Some of the proposed interventions include;

- Subsidizing or help start improved technologies (quality) of wood to charcoal transformation;
- Subsidizing or help start technologies (quality) / innovations that will lead to switching from wood fuel;
- Subsidizing or help start efficient, clean cooking stoves (quality). Use carbon financing POAs for Small artisanal manufactures as a strategy to subsidize this intervention;
- Subsidizing or help small holder afforestation programmes.
- Incentives (tax holidays) to encourage use of green forest produce (e.g., charcoal) or disincentives (e.g. moratoria, fees) to discourage use of green forest products.

Figure 4-9: BAU and mitigation paths for LULUCF Uganda



The proposed interventions are meant to help the forestry sector in Uganda stop being a major contributor to GHG emissions. Under the business as usual approach (BAU), forestry is expected to remain a net emitter up to late 2030s. With the proposed interventions, the sector could become a major GHGs sink as early as 2025.

Most of the proposed interventions are in harmony with existing country policies, regional and country – level plans and even international climate negotiations and protocols. For example, most of the activities proposed under the REDD+ initiatives are in line with what is being proposed here.

4.2.3.4 Examples to learn from (reversed trends in degradation):

A series of biomass inventories throughout Uganda from 1993 up to 2006 showed that where deforestation happened as a result of agriculture expansion, the trend was that biomass (forest cover) gradually reduced to almost zero before it regained to a level where biomass supply was in equilibrium with the local needs such as supply of fuel wood, construction poles, fruits etc. The big difference, however, was that woody biomass formation and species composition changed from natural to woodlots and scattered trees of exotic or naturalized species. This is the well-known phenomenon of decreasing and expanding trend in forest cover found in many developed countries called an inverse J-shaped curve over time.

Putting the forest transition curve into Uganda's context, many major charcoal producing areas especially the woodlands of central Uganda and some islands on Lake Victoria may be considered to be in the early forest transition stage which is characterized by having forest cover that is greater than 15 percent and rate of deforestation is increasing.

However, a few areas like Bushenyi and some isolated areas in central regions may be considered to be in post transition stage where the biomass supply is in equilibrium with demand. In such areas, trees are considered as a crop and are thus established for commercial purposes.

What is happening in areas like Bushenyi and neighbouring Rwanda is evidence that with proper interventions, attitude and perhaps change of mind-set, deforestation in parts of Uganda may eventually be reversed and possibly up to the stage when biomass starts to increase again.

4.2.4 Mitigation in the Waste sector

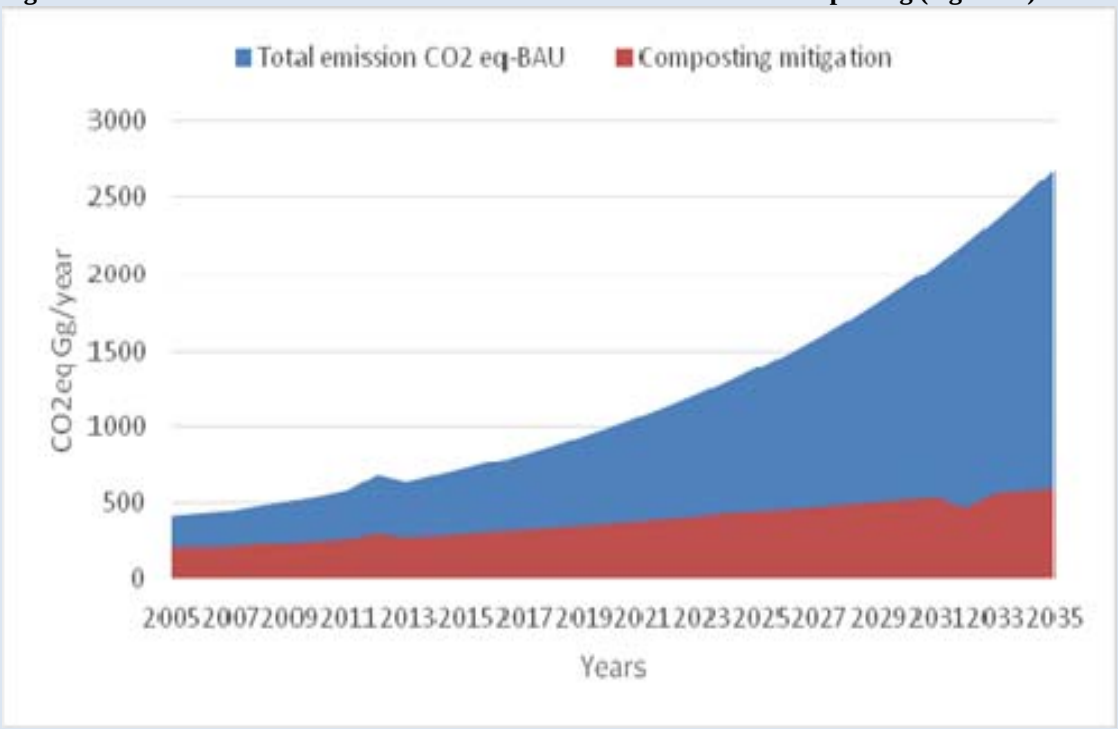
It is well established that if biodegradable solid wastes are composted under controlled conditions with sufficient aeration, only a fraction of potentially available carbon as GHG is released to the atmosphere. Relating this decrease to the total anthropogenic carbon dioxide emission, this is approximately 13% of the total global emission. Thus, total carbon emissions from landfills can be significantly reduced by diverting the biodegradable components of

municipal solid waste away from landfills and converting them to soil conditioner through aerobic composting.

In Uganda, currently between 45% and 75% of solid waste generated in municipalities is composted. It is expected that this will increase from 10 to 15% as more municipalities are set up. Uganda being an agricultural country implies that composting is the ideal choice so that apart from GHG mitigation, any biodegradable organic matter is not wasted but used to improve soil fertility while at the same time locking the carbon in soils.

If composting is taken up by the urban councils with gradual increment in the amount of solid wastes composted, reduction in GHG will be realised. Figure 4-10 shows GHG emission scenarios displaying the business as usual situation and when composting is taken up by urban councils of Uganda.

Figure 4-10: Annual emission time series scenarios with and without composting (GgCO2e)



Estimates of reduction of GHG emission from the waste sector when composting would have methane emissions reduce by 25% in 2005, 57% in 2015, 69% in 2025 and 78% in 2030. Sustained composting would over time reduce on solid waste disposal by about 90-95%.

Quantifying mitigation costs and potentials for the waste sector is a challenge due to gaps in data. Current uncertainties with respect to emissions and mitigation potentials could be reduced by more coordinated data collection, standardized data analysis, field validation of models, and consistent application of life-cycle assessment tools. However, global data is available and projects the cost of composting by 2030 at US$20/tonne. For Uganda, cost estimates for composting could start from assessment of the current composting projects that are supervised by NEMA in eleven municipalities of Uganda.

4.3 National mitigation strategy

4.3.1 Background

The country has been making efforts to develop and promote relevant strategies to mitigate climate change, although there is a clear priority on adaptation. Evidence of these can be found in the recently approved Uganda National Climate Change Policy (UNCCP). In addition, Uganda as a party to the Kyoto Protocol, has made every effort to accommodate projects to control, prevent or reduce anthropogenic GHG emissions (which are not regulated by the Montreal Protocol) in all relevant sectors, especially energy, transport, industry, agriculture, forestry and waste management.

Several other projects have been or are underway within the realm of mitigation. These have included:

- Elaboration of Uganda's NAMA Framework supported by the African Development Bank;
- Preparation of NAMA projects under the UNDP LECB project;
- Elaboration of a LEDS also within the UNDP LECB project.

4.3.2 Mitigation strategies within the NCCP

Error! Reference source not found. outlines the mitigation strategies that the government of Uganda has lined up within the National Climate Change Policy and Implementation Strategy.

Table 4-2: Summary of Mitigation Strategies for Uganda as outline in the National Climate Change Policy

Sector	Strategies
Forestry	• Promote sustainable silvi-culture; for example, by mandating that commercial timber be produced from renewable planted woodlots • Provide financial support, technology transfer and provision for capacity building, especially to forest-dependent communities • Provide incentives for farmers to establish commercial woodlot plantations,

	including peri-urban plantations • Implement a system for supporting research and regular data collection and monitoring the status of the forests in terms of areal extent, distribution, plantation species introductions andbiodiversity
Land Use and Land-Use Change	• Demarcate areas reserved for industrial use and other land development • Strengthen urban development authorities by providing funds to enhance their ability to enforce regulations • Promote human resource development in land management
Reduced Emissions from Deforestation and Forest Degradation+ (REDD+)	• Conserve the existing forests and implement REDD+ programmes to access additional funds from carbon markets • Set up mechanisms to regulate the implementation of REDD+ projects and the set up equitable benefit sharing schemes
Wetlands	• Demarcate wetlands and mandate their conservation in watershed areas • Ensure that only sustainable economic activities are carried out within wetlands
Agriculture	• Enhance the delivery of meteorological services and disseminate meteorological information and guidance to farmers • Promote and encourage conservation agriculture as well as ecologically compatible cropping systems and agricultural practices • Promote the sustainable management of rangelands and pastures through preparation and implementation of integrated rangeland management plans to avoid soil and land degradation
Energy Generation	• Promote investment in clean energy generation under public–private partnerships • Promote, encourage and incentivise co-generation by industries in the production of heat or steam and electricity from renewable biomass • Provide tax incentives and other benefits to private sector companies that invest in cleaner energy generation • Promote the use of alternative renewable energy sources such as solar, biomass, wind and bio fuels as well as their associated technologies • Develop hydroelectric and geothermal power systems and integrate them into the East African Power Pool in the medium term
Energy Utilisation	• Promote the development of energy conservation and efficiency projects in all sectors; for example, promote the use of stabilised bricks and efficient brick kilns in the building sector

	• Enforce building codes with the aim of reducing energy consumption and encouraging designs that maximise the use of natural daylight in buildings • Promote the use of energy-efficient technologies such as compact florescent lamps and other commercially viable high-efficiency lamps • Promote efficient firewood/charcoal stoves, solar and LPG cookers, also address the high upfront costs of acquiring these technologies through household subsidies or tax waivers • Reduce deforestation by providing alternative clean energy sources and efficient appliances for energy use, management and conservation
Transport	• Improve road infrastructure, equipment and traffic management in urban areas especially Kampala to reduce traffic congestion • Promote public–private investment and provide incentives for low-carbon and low-cost public transport such as bus rapid transit and other means of mass transport like trams • Promote private-sector investment in the bio fuel industry, covering the whole bio fuel chain from cultivation to fuel processing • Establish national standards for emissions and implement a strict vehicular emissions standard in tandem with measures to gradually phase out old inefficient motor vehicles.
Waste Management	• Promote the development of waste-to-energy programmes for converting municipal solid waste into energy for domestic and commercial use • Promote the sorting and composting of waste • Promote the trapping of methane for use as energy instead of flaring the gas to waste • Promote the gasification and incineration of large quantities of waste to generate thermal energy or electricity • Promote the use of human waste in production of biogas for cooking and lighting in institutions such as schools and hospitals, leaving the solid by-product to be used as fertilizers.
Industry	• Promote new technologies in cement processing industries • Improve the efficiency of lime kilns • Promote alternative fuels for lime kilns

Chapter 5 : CONSTRAINTS, GAPS AND RELATED FINANCIAL, TECHNICAL AND CAPACITY BUILDING NEEDS

5.1 Introduction

This chapter presents the constraints, gaps and related financial, technical and capacity building needs identified during the preparation of the Second National Communication for Uganda. It proposes how these can be tackled in order to enhance the national capacity to undertake adaptation to and mitigation of Climate Change (CC) in Uganda. The chapter also provides information on financial resources and technical support provided by bilateral and multilateral institutions for implementing activities relating to climate change.

5.2 Constraints in the Preparation of the National Inventory

During the preparation of the Second National Communication, a number of challenges were experienced with respect to the preparation of the national greenhouse gas inventory. These included data-related barriers and human capacity shortcomings.

5.2.1 Data-related Challenges

Preparation of national communications on a continuous basis relies on availability of reliable data. Data availability, access and formats were major barriers to the smooth compilation of the inventory. In a number of cases, the required data was simply not available. Even the limited available data was in several cases, not in a form and quality that is easy to process because it was not appropriately captured. For example, data is reported in percentages and rates and not in real figures and counts. The data is not segregated. In addition, several data items were, in most cases, projections rather than actual.

To overcome these constraints, there is need to:

- Coordinate the creation of an inventory database system covering all aspects of the inventory; from activity data to emission factors. The data, wherever captured, processed or archived, should be in the most relevant and understandable format. These databases should also be available to the general public, organizations and individuals who may need to use the data for planning and research.

- Institutionalize continuous research into improvements in the databases

Specific attention needs to be paid to the energy sector where there is no information on the amount of petroleum fuel consumed because there is no dependable data on the total number of motor vehicles on the road. The data available is just the number of vehicles imported. This means that it is not possible to attribute specific GHG emissions to the usage of petroleum/gasoline in transport. There is need to establish ways in which data on the number of motor vehicles in the country and the amount of petroleum products consumed is collected and included in the preparation of mitigation programmes.

5.2.2 Human capacity needs

The major gaps in this area are:

- Limited opportunities for capacity building and training of technical staff and researchers. There is need for a critical mass of technical staff and researchers to be charged with gathering information, preparing and periodically updating the databases.
- Lack of technical expertise in climate change modeling and research methodology used in the inventory process.
- Lack of a specific institution that is responsible for coordinating the preparation of the inventory for future communications, to ensure consistency and accuracy as well archival which would facilitate timely preparation of future communications and reports.

The major remedies are:

- Conduct training of personnel in the collection and management of GHG and related data, including data interpretation, storage and updating of databases
- Create CC modeling capacity using the most appropriate models and modeling software and equipment
- Put in place an institution, with all the required structures, to be responsible for preparing Uganda's GHG inventory for future national communications and reports.

5.3 Barriers in Vulnerability Assessment and Adaptation

Uganda must have sufficient adaptive measures today and in the future. To achieve this, a number of challenges need to be addressed. First, there is need to have the capacity to plan and design different approaches for the different adaptation needs. This is because there is no adaptation approach that can meet the needs of all adaptation activities. Planners and program designers must choose the approach that best fits any particular situation. Uganda lacks the institutional capacity for carrying out comprehensive vulnerability and adaptation assessments in key ministries. Part of the problem lies in data availability, but professional competencies remain an important aspect of the problem. Secondly, there are limitations in financing V&A activities; especially due to small budgetary allocations, usually blamed on the lack of financial resources

in government and low levels of donor support. Last, but not least, the changes in climate are barely predictable on the basis of current knowledge. More long term studies need to be a continuous process.

The solutions to the challenges are well known. There is need to train a large pool of experts in the area. Further collaborative arrangements need to be devised to fill the knowledge gaps. In addition, community engagement in vulnerability and adaptation assessments could also add-value to mostly favored top-down approaches. Last but not least, key risk and impacts assessment work is needed in the affected sectors to update work carried out using previous generation climate and impacts models. For example, in forestry, the lack of a consistent forest inventory on a national scale is a significant gap. Such an inventory would provide a benchmark against which to monitor changes in forest distribution, structure, growth, biomass, and carbon sequestration.

During the preparation of the second national communication, specific barriers were identified in the vulnerability assessment and adaptation in the agriculture, forestry, health, water, wetlands and fisheries sectors.

5.3.1 Crop Agriculture and Livestock

The major needs of the agriculture sector in Uganda are:

- Increased commercialisation of agriculture, and reduction on the reliance on subsistence farming, since increased crop and livestock production provides for both household consumption and income generation
- Better and cheaper farming practices and technologies, which are climate friendly. These will ensure that the crop and livestock farmers will have guaranteed produce all year round, unaffected by the unpredictable rainfall and weather patterns. Such technologies include usage of irrigation technology and utilizing the ground water resources.
- Increased spending on the agricultural sector since it is very crucial for promoting better farming practices and land use. Increased budgetary allocations to the sector will greatly facilitate the implementation of adaptation and mitigation programmes.
- Sensitisation of farmers to grow and rear climate resilient breeds or varieties. These will need less monitoring and reduce on the overall agricultural costs.

5.3.2 Health

The following gaps exist in the health sector in Uganda:

- The need to fully mainstream CC in the health sector polices, plans, programmes and activities

- Limited capacity of key sectors including the health sector to quickly adapt to CC and its negative impacts in the delivery of services
- Inadequate understanding and appreciation of climate change and its impacts thus creating a barrier to resource allocation
- Inadequate health sector, financial and technical capacity (human resources, health infrastructure, medical equipment and supplies)
- Weak institutional and coordinating mechanisms (inter and intra ministerial, public private partnership)
- Poor information access and flow to enable effective operation of early warning systems.
- Inadequate Information database on linkages between health and CC,
- Limited information exchange and capacity building
- Limited linkage between CC and variability forecasting with health emergency preparedness and response
- Insufficient community mobilisation, response and adapting to new innovations.

Support is therefore required to:

- Conduct health awareness campaigns that focus on treatment and prevention of diseases through CC actions. Sensitising the public about the relationship between CC and the climate sensitive diseases will enhance mitigation and adaptation, which will lead to reductions in the occurrence of the diseases, thus a reduction in government and individual spending on medications.
- Mainstream CC in health–related programmes and projects highlighted in the NAPA Report, namely: environmental health, water and sanitation provision, control of disease vectors and pests, and control of communicable diseases
- Implement the 61st and 62nd World Health Assembly (WHA, 2008, 2009) Resolutions
- Coordinate climate change response interventions in the health sector with relevant ministries and agencies.

5.3.3 Water Resources

Uganda needs to address the challenges in water resources arising from increasingly unreliable rainfall patterns. Specific attention is required in the most hit areas of the cattle corridor axis (which runs from the Karamoja region in the North East to Ankole in the South West) where a Mean Annual Rainfall of 400-1000mm is received. In addition, a large proportion of Uganda relies on groundwater sources. However, there is very minimal data on ground water resources and even the little that is available shows declining trends (for the groundwater monitoring wells in Pallisa, Soroti, Rakai and Mbarara districts). This decline is attributed to land use change, climate variability, land degradation, upstream deforestation and poor watershed management.

The major needs are therefore:

- To sensitise the population on proper land use because the biggest contributing factor to reduced rainfall is attributed to human settlement and activity.
- To undertake a thorough ground water resources investigation/study in order to explore the option of exploiting ground water when the open water resources are not reliable, most especially in the dry seasons of the year

5.3.4 Biodiversity, Forestry and Wetland Resources

Uganda's biodiversity needs to be sustainably managed. This can be achieved through:

- Enforcement of regulations, with tough penalties for people who are involved in activities that affect biodiversity
- Improvement on the provision of biodiversity information through increased sensitisation of communities on the dangers relating to poor land-use, including sensitisation on LULUCF.
- Lobbying of development partners to increase on the support, most especially financial, which is required for the implementation of CC projects related to biodiversity
- Ensuring that thorough environmental impact assessments are conducted when planning for and introducing an activity that may affect the biodiversity. Such activities include the development of the oil and gas industry.

5.4 Mitigation assessment capacity needs

While mitigation is not a priority for Uganda (given the very low levels of emissions globally in Africa), the commitment to participate in the global efforts is paramount. The main constraints and gaps are lack of capacity to undertake the necessary analysis such as least-cost analysis taking into account the environmental costs and benefits as well as inadequate institutional, scientific and technological capacity to plan, design, implement and MRV the various actions that Uganda has or needs to undertake. Other key areas are to do with continuous evaluation of the emission factors being used, regular update of activity data to ensure that nationally appropriate mitigation actions are developed.

Training in systems analysis and computer simulation modeling is therefore needed to enhance the current work. In addition, Uganda is in the process of setting up the necessary mechanism for data collection, analysis, storage and dissemination; this needs support to take it from the nascent stage until it is institutionalized and operational. Support in this area is needed through provision of adequate financial resources for research and training to build institutional and administrative capacity at all levels though supportive partnerships and cooperation, including technical and legislation and other mechanisms for information collection, monitoring and sharing.

5.5 Needs in Research and Systematic Observations

Uganda needs to develop a framework for research and development, as well as observation systems to support the climate change agenda. There is need to review and identify synergies in relation to the implementation of the NCCP and related sectorial policies. In this regard, there are several challenges that the metrological services are facing and these include:

- Poor climate database development and management. This includes the lack of structured transparent systems and guidelines to ensure that the appropriate data dissemination from the meteorology department to the relevant climate change mitigation and adaptation players take place.
- Lack of an operational Legal and Institutional Framework.
- Persistent under funding for modern equipment.
- Limited financial and human resources for capacity building to increase the base of local expertise.
- Decline in observation network coverage.
- Lack of ISO 9000 Certification.
- Lack of Standard Equipment and operations.

The following interventions have been identified:

- To upgrade and substitute conventional equipment with digital ones to minimize the impact of observer/instrument technician failings and also provide continuous recording of selected atmospheric, terrestrial and oceanographic state variables.
- To rehabilitate and expand existing monitoring networks for more representative monitoring of atmospheric and terrestrial state variables.
- To upgrade information technologies installed in key institutions and installation of appropriate productivity software.
- To strengthen human resources capacities in traditional and new areas of knowledge.

With respect to meteorological services, Uganda has recently carried out reforms that need support for the following activities:

- Operationalization of Uganda National Meteorological Authority.
- Upgrade of Class IV Meteorologists to Class III.
- Certification of QMS ISO 9001:2008 in Aeronautical Meteorological Services
- Development of an early warning system.
- Improving the Data Processing and Archiving Capability.
- Continuous participation in community weather, climate and climate change awareness programmes.

- Improvement on information dissemination and public image of the services.

5.6 Needs in education, training and public awareness

The major, cross-cutting capacity building challenges include limited awareness on climate change issues at various levels due to limited climate change expertise. These are outlined below:

- Lack of appropriate skills and expertise frustrate effective institutional participation in the assessment of mitigation and adaptation options;
- limited knowledge-sharing within the country and at various levels of negotiations in the UNFCCC and other concerned global institutions;
- Limited financial and technical support still remains a constraint to climate change education, training and public awareness for sustainable development (for instance training of approximately 80,000 thousand in-service primary teachers requires colossal amount of money and many trainers);
- Lack of fellowships and scholarships for formal specialized training at scientific and technical levels.

5.7 Community Sensitization and Awareness Creation

Community awareness is a crucial factor in addressing climate change where it hurts most; targeting the actual people who are directly affected by the impacts of CC. The major method used in Uganda is through awareness creation materials like the media, drama shows, localized meetings and site demonstrations. Several constraints have been encountered; namely:

- Limited coverage of community sensitization.
- High costs of sensitization in order to reach all communities in affected areas (which are basically the whole country).
- Using poor methods. The traditional/cultural set-up is often ignored, leading to the target audiences acting indifferent. For example, it becomes useless to train women to undertake CC activities without first sensitizing the communities about gender mainstreaming and the myths of the traditionally defined roles of a woman in a household.

To overcome these shortcomings, it is necessary to:

- Improve on the mode of delivery of the awareness creation campaigns through incorporating crucial aspects like gender mainstreaming
- Package the trainings in an easy to understand way, so that the community members do not find difficulties in understanding what they are supposed to do.

- Increase on the frequency of trainings and include monitoring and evaluation in the
- Review the sensitization projects so that relevant campaigns are undertaken in the right communities
- Implement the Public Awareness, Training and Capacity Building Strategy as stipulated in the Uganda National Climate Change Policy.
- Develop the capacity for inclusion of gender mainstreaming considerations in all climate response activities and training of all gender focal point persons in ministries, local governments on mainstreaming gender in CC responses.

5.8 Co-ordination, Data and Information Sharing

There is weak inter-institutional collaboration among climate change actors. The government, academics, private sector and the Civil Society lack an institutionalized coordination mechanism. There are several uncoordinated activities that address climate change in the various ministries and government agencies.

A critical element is data and information sharing. Several institutions have developed databases but these are not shared for better planning. For example, there is a database at the Directorate of Environmental Affairs at the Ministry of Water and Environment, a database at the Uganda Bureau of Statistics and one at the Uganda Red Cross that has got critical information, but accessing information from these databases is complex.

5.9 Gender Mainstreaming

Gender mainstreaming is the process of assessing and incorporating the impacts of any planned actions on men, women and children. Gender mainstreaming has been identified by the NCCP as a cross cutting issue without identifying a way forward on incorporating it in the adaptation and mitigation programmes. There is therefore need to ensure that gender is incorporated in all climate change activities since women (and children) have been the most affected by climate change, and yet society tends to limit them from participating in the adaptation and mitigation process.

The development of a Gender and Climate Change Training Course, by Uganda's Climate Change Unit, is supposed to promote gender mainstreaming in climate change projects in communities, thus yielding better results against the negative impacts of a changing climate. This should be popularized and scaled up.

5.10 Financing of Climate Change Activities

Financing is the most important factor in the implementation of climate change adaptation and mitigation programmes. Without financing, neither is the setting up of required infrastructure nor

mobilization of community members possible. Currently, climate change activities in Uganda are being supported through the dedicated climate change funds from bilateral and multilateral sources, national budget, private sector finance and Foreign Direct Investments (FDI), Carbon Markets and the East African Community /COMESA climate change fund**s.**

However, there is lack of information on the potential cost of planned adaptation responses to CC, especially in relation to uncertainties about the potential wide range of needs for infrastructure upgrade and new infrastructure development.

With most of the available funds directed to mitigation (approximately 80% of the entire climate finance), adaptation remains severely underfunded and yet it is Uganda's priority. In addition, given that only a small percentage (2%) of the CDM projects implemented globally are located in Africa, it is explainable for Uganda to have difficulty in accessing climate finance. The most pronounced financial challenges related to climate change in Uganda include:-

- Mobilization of adequate, reliable and sustainable funding;
- Capital requirements to meet the necessary investment capital;
- Limited incentives for private investment;
- Time wasting bureaucracies for accessing funds from funding agencies;
- Failure to identify sources of funding for priority and immediate needs;
- Failure of existing financing models to adequately match the climate change priority needs of Uganda;
- The prevailing global financial crisis that limits spending;
- Limited national budgetary allocations to climate change issues;

The major reforms that are required to address the above-mentioned challenges include:

- Developing an effective financial delivery system with view of making climate financing more affordable and more effective for Uganda;
- Promoting sectoral co-ordination mainly focusing on information sharing and coordinated action taking, translating into coordinated funding and cost cutting;
- The promotion of inter-agency information sharing;
- Ensuring that financial support solicitation processes meet set timelines;
- Ensuring that government creates appropriate budgetary allocations for handling CC issues;
- Setting up of Public Private Partnerships (PPPs) that incentivize private investment.

5.10.1 On-going financial support for climate change activities

Climate change activities in Uganda are currently being supported through state contributions, development partners and the emerging EAC Partnership Fund. There are dedicated funds from

bilateral and multilateral sources. The multilateral institutions through which funds are channelled include the following:

- The Global Environment Facility (GEF)
- Climate Change Investment Funds (CIF) of the World Bank
- Carbon Funds of the World Bank
- The UN-REDD funds of FAO, UNDP and UNEP
- Least Developed Countries Fund (LDCF) of UNFCCC
- Adaptation Fund (AF) of the Kyoto Protocol
- Green Climate Fund (proposed) under UNFCCC
- Development Bank of South Africa (DBSA)
- COMESA Carbon Fund

The major bilateral sources include:

- European Investment Bank (EIB),
- German Development Bank (KfW)
- Japan International Cooperation Agency (JICA).
- French Development Agency/Agence Française de Développement (AFD)
- Nordic Environment Finance Corporation (NEFCO)

The National Budget supports the climate-based activities that are mainstreamed in several ministries. Some investments are funded by the private sector as well as through Public-Private Partnerships (PPP). This is common in the energy/ renewable energy and forestry activities.

Market-based mechanisms such as CDM and voluntary market schemes have provided funds for mitigation actions in Uganda The East African Community has started a new initiative with a main aim of enhancing the region‘s capacity to mobilise existing, new and additional climate change funds from both international and domestic sources.

Table 5-1 shows the different actors, agencies and international institutions who have partnered with the government of Uganda to fund Adaptation projects in the country. Table 5-2 shows those projects implemented by international institutions in Uganda.

Table 5-1: Actors Funding Adaptation Projects in Uganda

Development Partner	Project	Duration	Budget USD eqv.
World Bank	Second Environmental Management and Capacity Building Project	2001-2012	24.10M
Embassy of Ireland	Environmental Accountability in Uganda Initiative	2010 - 2012	310,000
Embassy of France	Strengthening Environmental Governance at Village level in Kampala City	2011-2013	38,500
	Making Energy Efficiency Affordable through Carbon Credits	2011-2013	17900
European Union	Increased access to energy efficient stoves among rural households in Northern Uganda and enhance local reforestation efforts.	Nov 2011 to 2015	1,268,000
	Global Climate Change Alliance: Adaptation to climate change in Uganda	2012-2016	13,425,628
FAO	Trans-boundary Agro Ecosystem management project in the Kagera Basin: Rwanda, Burundi, Uganda and Tanzania	2010-2014	1.05M
UNDP	Territorial Approach to Climate change project (TACC) for Mbale region project	2010-2013	300,000
	Ecosystem Based Adaptation Programme for Mountain Ecosystems	2011-2014	1,731,733
	Strengthening Sustainable Environment and Natural Resource Management, Climate Change Adaptation and Mitigation in Uganda project	2011-2014	4,695,000
	Improving Policies and Strategies for Sustainable Environment, Natural Resources and Climate Risk Management Project	2011-2014	1,450,000
UNDP through WWF	Strengthening Sustainable Environment and Natural Resource Management, Climate Change Adaptation and Mitigation in Uganda	Annual agreement until 2014	140,221
DFID	Territorial Approach to Climate change project (TACC) for Mbale region project	2010-2013	450,000
DANIDA	Territorial Approach to Climate change project (TACC) for Mbale region project	2010-2013	250,000

German Embassy through GIZ	Reform of the Urban Water and Sanitation Sector in Uganda	2011-2014	6,000,000
German BMU	Ecosystems based Adaptation in Mountain ecosystems (EBA)	2011-2014	600,000
Austria Development Agency	Building drought resilience through land and water management (2)	2012-2014	577,044
ECHO	Building resilience to drought in the Karamoja Region through sustainable Natural Resources Mgt-NRM in catchment areas	2012-2013	201,069
ILO and International Institute for Environment and Development (IIED)	African Green Enterprises Development Project	2012-2013	200,000
Artists Project Earth (APE)	Promoting Awareness, Mitigation and Adaptation performance of a Waste-to-Energy Program	2012-2013	21,000
Macarthur Foundation, The David & Lucile Packard Foundation, USAID Global	HOPE Lake Victoria Basin	2011-2014	-
OXFAM GBU/UKAID	Climate Change Advocacy	2012-2013	77,000
CORDAID Netherlands	Integrated Community Managed DRR, CCA And EMR (ICMDCE) Project	2011-2015	266000
SIDA/WWF Sweden	Forests For People – Participatory Environmental Management, Uganda	3 years	1,644,106

Source: Muyambi (2013)

Table 5-2 :Adaptation Projects Implemented by International Institutions

Implementing agency	Project	Budget USD eqv
Lutheran World Federation-Uganda	Increased access to energy efficient stoves among rural households in Northern Uganda and enhance local reforestation efforts.	1,268,000
Food and Agricultural Organization (FAO)	Global Climate Change Alliance: Adaptation to climate change in Uganda	13,425,628
	Trans-boundary Agro Ecosystem management project in the Kagera Basin: Rwanda, Burundi, Uganda and Tanzania	1.05M

UNDP	Territorial Approach to Climate change project (TACC) for Mbale region project	300,000
World Wildlife Fund (WWF)	Strengthening Sustainable Environment and Natural Resource Management, Climate Change Adaptation and Mitigation in Uganda project	4,695,000
	Forests For People – Participatory Environmental Management, Uganda	1,644,106
IUCN	Strengthening Sustainable Environment and Natural Resource Management, Climate Change Adaptation and Mitigation in Uganda	140,221
UNDP	Territorial Approach to Climate change project (TACC) for Mbale region project	450,000
	Territorial Approach to Climate change project (TACC) for Mbale region project	250,000
IUCN	Ecosystems based Adaptation in Mountain ecosystems	600,000
	Building drought resilience through land and water management (2)	577,044
	Building resilience to drought in the Karamoja Region through sustainable natural resources management (NRM) in catchment areas	201,069
Ecological Christian Organization	HOPE Lake Victoria Basin	-
	Climate Change Advocacy	77,000
	Integrated Community Managed DRR, CCA And EMR (ICMDCE) Project	266000

Source: Muyambi (2013)

5.10.2 Financial Support by the Global Environment Facility (GEF)

Since joining the GEF, Uganda has received GEF grants totalling USD 81.6 Million that leveraged USD 623.8 Million in co-financing resources for 27 national projects. These include 11 projects in biodiversity, nine in climate change, three in land degradation, two in persistent organic pollutants, and two in multi-focal areas.

Similarly, Uganda has participated in 38 regional and global projects financed by the GEF totalling USD 298.7 Million that leveraged USD 698.5 Million in co-financing resources. These

include 14 projects in biodiversity, six in climate change, five in multi- focal areas, five in persistent organic pollutants, four in land degradation, and four in international waters.

Additionally, the GEF Small Grants Programme (GEF SGP) which started in Uganda in 1996, has received financial support totalling USD 4.8 Million leveraging USD 4.4 Million in co-financing resources for 166 projects executed by civil society and community-based organizations.

According to the GEF-Uganda Factsheet, Uganda has received an indicative allocation to formulate and execute projects for USD 3.8 Million in biodiversity, USD 4.6 Million in climate change, and USD 2.2 Million in land degradation during the current GEF-5 replenishment period (July 2010 – June 2014). Table 5-3 outlines the funding that the GEF has/is dedicating to improving on the environment in Uganda and tackling CC related issues.

Table 5-3: Allocation & utilization of resources in Uganda in GEF-5(All amounts in USD)**

Focal Area	STAR GEF-5 Indicative allocation	Allocation utilized	Projects awaiting Council approval	Allocations yet to be programmed
Biodiversity	3,830,000	3,830,000	0	0
Climate Change	4,640,000	3,821,000	0	819,000
Land Degradation	2,220,000	1,210,000	0	1,010,000
Total	10,690,000	8,861,000	0	1,829,000

**As of 16th April 2013 Source: GEF, 2013

Table 5-4: Total of LDCF and SCCF financing in Uganda (All amounts in USD)

	Number of Projects	Total LDCF/SCCF financing	Total Co-financing
LDCF	3	12,569,790	61,664,000
SCCF	0	0	0
Total	3	12,569,790	61,664,000

Source: GEF, 2013

5.11 Proposed Projects for Financing

In the near term Uganda proposes to undertake the projects in the outlined areas below.

5.11.1 Projects on National Reporting Systems under UNFCCC:

Uganda needs additional financial resources to support its national reporting systems under the UNFCCC, especially, in the run up to the 2015 and the post 2020 climate change process. These will require that resources are made available to develop and mainstream robust GHG, NAMAs and MRV systems that are able to address national decision making in planning and interventions as well international reporting.

Specifically, Uganda will be needing funds for the following activities:

- Preparation of National Adaptation plans
- Development the Technology Action Plan
- Establishment of technology development and innovation centre
- REDD Plus project implementation
- Preparation of the Third National Communication
- Preparation of the First Biannual Update Report
- Preparation of the Intended National Determined Contributions

5.11.2 Programmes on Implementation of National Climate Change Strategy

Uganda needs additional support to implement programmes arising from her national climate change strategy that has been developed as follow up of the National Climate Change Policy. The need will be to focus on activities that have a wider impact on vulnerable communities and the systems that support them. Funding could be deployed in the following areas among many others:

- Develop robust Climate Scenarios for Uganda at the right scale
- Enhanced support to farming communities to develop climate change resilience and adaptation capacity
- Support to Cities and municipalities in integrating climate change into their planning, infrastructure development and management to mitigate climate change and adapt to extreme weather events like floods
- Scale-up development and deployment of renewable energy access mechanisms
- Further energy efficiency programmes to minimize the need for fossil fuel generated energy
- Strengthen continuous climate observations and early warning system throughout the country.

Chapter 6: OTHER RELEVANT INFORMATION FOR REACHING CONVENTION OBJECTIVES

This chapter provides other information considered relevant to the achievement of the objectives of the UNFCCC. It includes: Uganda climate change legal framework, the steps taken to integrate climate change into policies programmes and development planning, research and systematic observation, education, training and public awareness.. The chapter also highlights the public private partnerships, international cooperation and networking as well as the monitoring and evaluation framework for climate change activities.

6.1 Uganda climate change legal framework

At the national level, the Constitution of Uganda provides an overall regulatory framework for the implementation of the Uganda's National Climate Change Policy. The Uganda Constitution of Uganda (1995), as amended in 2005, states that "Every Ugandan has a right to a clean and healthy environment." Objective X111 of the Uganda Constitution advocates for the management of the environment for sustainable development. *Vision 2040* and the *Uganda National Development Plan* (NDP) 2010/11-2014/15 specifically mainstream climate change into development plans, policies and budgets of all sectors. The focal climate change institutional home is the Ministry of Water and Environment (MWE). *The National Climate Change Policy Committee* (NCCPC) coordinates policy implementation and ensures information flow on resource allocation for the implementation of the policy. The Committee is chaired by the Prime Minister and brings together ministers from the various departments at the national level. A National Climate Change Advisory Committee ensures working level coordination and provides technical input to the NCCPC. This committee is chaired by the Minister of Water and Environment and brings together technical representatives from the various government sectors at the national level, along with representatives from private-sector associations, civil society, academia and district authorities.

The Parliament of Uganda, which is the legislature, exercises overall oversight of national policies, programmes and actions; including the important roles of budgetary appropriation and ensuring accountability. Details of climate change matters are discussed under the Parliament's Standing Committee on Natural Resources. *The Parliamentary Forum on Climate Change* promotes awareness and climate change actions within the Parliament of Uganda.

The Climate Change Department is the UNFCCC focal point and a secretariat to the Designated National Authority (DNA) for Clean Development Mechanism (CDM) projects. Its main functions include:-

- Acting as an information clearing house on climate change concerns
- Providing policy and strategic advice on climate change
- Supporting communication and outreach on climate change
- Ensuring the integration of climate change concerns into overall national planning through coordination with the relevant ministries, departments and governmental agencies
- Providing secretarial services to the National Climate Change Policy Committee, the National Climate Change Advisory Committee and the CDM-Designated National Authority
- Monitoring the implementation of the Climate Change Policy and its Implementation Strategy
- Serving as the National Focal Point for the United Nations Framework Convention on Climate Change (UNFCCC)

The other three national ministries or authorities that have a specific role to play in national coordination to ensure policy implementation are: The Ministry of Finance, Planning and Economic Development (MoFPED); the National Planning Authority and the Ministry of Local Government. Other Ministries, Departments and Agencies designate a departmental focal point and are accountable for coordinating the implementation of the prescribed policy responses to climate change that concern their Department Agencies/Authorities.

6.2 Integration of climate change into policies, programs and development planning

Different Sectors in Uganda have formulated National Policies to guide their operations in accordance with the national development objectives. Ensuring resilience to Climate Change (CC), through the implementation of Mitigation and Adaptation measures, being a key aspect of the development of the country has led to the incorporation of CC related issues in many of these policies. Also in light of Uganda's commitments under the United Nations Framework Convention on Climate Change (UNFCCC), Uganda has made endeavours to ensure that policies appropriately tackle climate change.

6.2.1 The Uganda national climate change policy (2012)

The main policy instrument that Uganda has enacted is the Uganda National Climate Change Policy. The policy provides direction for the key sectors being affected by the impacts of climate change. It provides a framework for ensuring coordinated action; with adequate attention paid to

capacity requirements and the development of the financial mechanisms and tools required to respond to the CC challenge.

The goal of the policy is to ensure a harmonized and coordinated approach towards a climate resilient and low-carbon development path for sustainable development in Uganda. The overreaching 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.

The Policy's specific objectives are:-

2. To identify the top-priority adaptation and mitigation issues for Uganda
3. To support appropriate awareness raising, information exchange, capacity building and technology transfer in addressing climate change
4. To support the integration of climate change issues into planning, decision making and investments in all sectors and trans-sectoral themes
5. To support research and the dissemination of scientific information and innovations on climate change
6. To develop and implement appropriate climate change adaptation strategies
7. To develop and implement appropriate climate change mitigation strategies
8. To facilitate the mobilisation of financial resources to address climate change in Uganda

6.2.2 Sectoral policies

A number of sectoral policies pay particular attention to climate change issues (mitigation or adaptation; or both) as outlined next.

The National Forestry Policy (2001) emphasizes Government commitment to the conservation of Uganda's rich forest biodiversity to meet the needs and aspirations of present and future generations. The National Forestry and Tree Planting Act (2003) executes the policy and commits government to protect and sustainably manage the Permanent Forest Estate(PFE), which is set aside permanently for conservation of biodiversity and environmental services and sustainable production of forest products. Institutions such as the Directorate of Environmental Affairs (DEA), Forestry Sector Support Department (FSSD), National Forestry Authority (NFA) and Programs like REDD+ and the National Forestry Resources Research Institute (NaFIRRI) address climate change mitigation and adaptation issues in the sector.

The National Environment Management Policy (NEMP) of 1994 arising from the *Uganda National Environment Action Plan (NEAP*) provides a framework for addressing gaps in environmental management as well as a strategy for integrating environment into the national socio-economic development process. The National Environment Act (1995) and the National Environment Management Authority (NEMA) as the principal government agency for the

management of the environment are major instruments of the policy. NEMA is mandated to coordinate, monitor and supervise all activities in the field of the environment.

The Water Policy (1999) aims at managing and developing water resources of Uganda in an integrated and sustainable manner so as to secure and provide water of adequate quantity and quality for all social and economic needs of the present and future generations. It establishes responses to emergencies such as droughts and floods therefore integrating adaptation to climate change in the policy. The Water Act, the Water Action Plan (1995) and the Water Statute (1995) form the framework for development, management and wise use of water resources and sustainable provision of clean and safe water to the population.

The National Disaster Preparedness and Management Policy 2005 has an overall goal to establish institutions and mechanisms to reduce Uganda's vulnerability to disasters. Its guiding principles recognize climate change as real and highlights that the effects of global warming are already evident and suggests that proactive actions should be undertaken to reduce the causes and the negative impacts of climate change. The proposed Disaster Preparedness and Management Act and the Policy Implementation Strategy are positioned to concretely highlight and mainstream the climate change adaptation actions with respect to climate change related disasters.

*The Energy Policy (2000) s*ets out to manage energy related environmental impacts by promoting the use of alternative sources of energy and technologies which are environmentally friendly and by establishing and ensuring the acceptance of broad targets for the reduction of energy related emissions that are harmful to the environment. The policy recognizes the need to mitigate both the physical and social environmental impacts. One of its key objectives is to manage energy related environmental impacts. The Energy Act and the Atomic Energy Act emphasize environmental conservation and human protection though they do not highlight the linkages to climate change.

The Renewable Energy Policy (2007) promotes the utilization of the country's abundant clean energy resources; contributing to mitigation of climate change. The policy vision is to make modern renewable energy a substantial part of the national energy consumption. The overall policy goal is to increase the use of modern renewable energy from the current 4% to 61% of the total energy consumption by year 2017. One of its key objectives is to promote sustainable production and utilization of bio-fuels.

The Meteorology Policy's mandate is to promote the monitoring of weather and climate, maintain a climate database, provide regular advice on the state of weather and climate and provide accurate and timely climate and weather information to various stakeholders. One of its strategic objectives is to improve the accuracy and reliability of weather forecasts and advisory services to customers through the development of climate predictions and short-term weather

forecasting capacities. The Uganda National Meteorological Authority has been established to improve service delivery through mitigation of social and economic impacts of natural disasters, promotion of the use of meteorological data and information for social and economic activities, promote and enhance quality of the environment, and monitor and provide warnings about adverse weather conditions.

The National Health Policy 2010/11-2019/20 recognizes the negative health consequences of the changing climate as a guiding principle, as reflected by the Health Sector Strategic Plan (HSSP) of 2010. In the HSSP, under Section 2.3.6, on the changing lifestyles and climate change, there are highlights of the negative consequences of climate change, the effects on the sector and suggestion of adaptation and mitigation as the strategies to combat climate change and its impacts. One of the plan's strategies is to mainstream climate change and improve adaptation within the health sector through:

- Development of guidelines on mainstreaming CC in the health sector to improve adaptation to CC impacts.
- Sensitizing staff at the MoH and local governments on climate change and adaptation.
- Development of early warning systems and disseminate weather forecasts to health managers to improve preparedness and response. This includes strengthening functional linkages and information sharing with the Meteorological Department, Ministry of Water & Environment.
- Coordinate CC response interventions in the health sector and collaborate with relevant line ministries and agencies. A draft adaptation to climate change in Africa plan of action for health sector 2012 – 2016 is also in place.

The National Policy for the Conservation and Management of Wetland Resources (1995): The overall aim of this policy is to promote the conservation of Uganda's wetlands in order to sustain their ecological and socio-economic functions for the present and future well being of the people. There are four goals of Uganda's National Wetland Policy that are in consonance with the climate change policy. These are:-

- To establish the principles by which wetland resources can be optimally used now and in the future.
- End practices which reduce wetland productivity.
- Maintain the biological diversity of natural or semi-natural wetlands.
- Maintain wetland functions and values.

The Oil and Gas Policy (2008) considers environmental protection from both physical and social aspects to mitigate environmental damages and hazards associated with oil and gas exploration development and production. It explicitly supports control measures against release of hazardous gases, chemical wastes and spills into the atmosphere. It sets out to reduce the green house effects by prohibiting the venting of gas and flaring of oil and gas except in emergency situations. It advocates for the use of natural gas to reduce the degradation of the environment that can arise through felling of trees. It supports control measures against the release of hazardous gas into the atmosphere and endorses the principal of "polluter pays" which shall mitigate the effects of oil and gas on the environment.

The Fisheries Policy (2004) has the goal of sustainable management and development of the fisheries sector. It specifies that fisheries will be managed and developed to promote socially, economically and environmentally sustainable use and development of the resources so as to meet the needs of present generations without compromising the ability for future generations. The adaptation issues are implied in the policy though it does not mention climate change as a principle to guide its planning.

The Draft National Agricultural Policy (2010) aims at enhancing agricultural production in an environmentally sustainable manner. The policy has put in place institutions that address climate change and they include; - the Plan for Modernization of Agriculture (PMA), the National Agricultural Advisory Services (NAADS) and NARO. The Ministry of Agriculture Animal Industry and Fisheries development strategic plan 2011/2012 - 2014/2015 addresses Climate Change issues through interventions identified in the sustainable land and water management, capacity building and research components. These interventions are yet to be implemented.

The revised Decentralization Policy (2003) gave rise to the Local Government Act, which transferred planning, financial, administrative, political, legislative and judicial powers from the Central Government to Local Governments. Natural resource management is one of the sectors that were decentralized. However, the act does not elaborate how Local Governments shall address climate change issues. At the moment there is no specific strategy put in place to mainstream climate change in local governments.

The Land Policy (2011): Though not yet implemented, the overall goal of the Uganda Land Policy is to ensure sufficient, equitable and sustainable utilization and management of Uganda's land and land based resources for poverty reduction, wealth creation and overall socio-economic development. Under the land use and land management framework, the issue of climate change is highlighted. The policy acknowledges that deforestation, wetland degradation, land degradation and poor settlements planning are issues of great concern. The strategies laid down by the policy to mitigate and adapt to climate change are; -

- To regulate anthropogenic activities which generate greenhouse gas emissions such as the burning of forests, destructive agricultural practices, and enhance participation in initiatives for mitigating greenhouse gas emissions worldwide;
- To mitigate the destruction of forests, water bodies, and other phenomena which act as sinks for greenhouse gasses;
- To strengthen the adaptive capacity to climate change and promote climate change adaptation mechanisms;
- To promote efficient use of new and renewable resources; especially the exploitation and regeneration of renewable sources of energy;
- To build capacity for rapid response to and management of extreme events arising from variability in climate parameters;
- To encourage and facilitate the operations of civil society networks concerned with ecosystem protection and preservation;
- To provide for re-settlement of environmental refugees and initiate co-operation with neighbouring countries on issues to do with Kyoto Protocol and related matters, including adaptation to climate change;
- To strengthen environmental governance and ensure sound management of natural resources.

The Education Policy states the laws and rules that govern the operations of the education systems. The Ministry of Education is integrating climate change into research and is developing a curriculum for Climate Change for primary and post- primary levels.

The Gender Policy (2007) emphasizes the reduction of gender inequalities to move out of poverty and achieve improved and sustainable livelihoods. The REDD+ gender strategy has been put in place.

The Climate Change Policy for the East African Community has been developed and the process of completing the climate change strategy 2011-2016 is underway, as well as the East Africa Community climate change master plan 2010 – 2031. These documents are set to guide the member states to develop comprehensive national policies to address climate change.

6.2.3 Other Relevant Institutions

The specific sectoral roles being played by related active institutions in the implementation of climate change activities in Uganda can be outlined as follows:

The Ministry of Works and Transport is developing a climate change strategy strategy in the transport sector and requires the Uganda National Roads Authority to ensure that road projects are climate proof through climate change adaptation and mitigation strategies. Indeed, most of the projects supported by the World Bank (WB), Japanese International Co-operation Agency (JICA) and African Development Bank (ADB) require that climate change issues are considered when carrying out environmental impact assessments. However, the level of awareness on climate change issues in the sector is very low. Only a few members of staff have been exposed to climate change issues.

The Uganda Investment Authority (UIA) is an institutional framework that is responsible for promoting investment in Uganda. Within its mandate, UIA should promote CDM projects in Uganda. The CCU with support from BTC has embarked on building capacity to prepare CDM projects. However, the UIA as an institution has inadequate capacity to raise awareness on climate change.

The Uganda Wildlife Authority is mandated with promoting sustainable alternative sources of livelihood from wildlife resources. There are no specific activities or references made to climate change. The integrated Tourism Development Master Plan (1992) does not make concrete references to CC concerns and the awareness on issues of climate change is still limited in the sector.

6.3 Research and systematic observations

Meteorological services play a strategic role in the social and economic development of Uganda. The data and information on weather and climate provide useful inputs for proper planning in sectors such as agriculture, livestock development and food security, road, air and maritime transport, health and public safety, building and construction industry, disaster management, as well as water resources management. The need for meteorological data, information and services to support these sectors is even more pressing due to the challenges of climate variability and climate change. The Meteorological services in Uganda are therefore currently faced with high demand for historic and real time quality data, information, services and products. However, the meteorological infrastructure is just recovering from some major draw backs that include:

- Sparse/inadequate observational/monitoring station network and equipment;
- Inadequate and obsolete, telecommunication networks and systems for data exchange;
- Inadequate data processing and forecasting systems;
- Inadequate information dissemination facilities;

- Limited IT capabilities among meteorologists;
- Inadequate Funding, and
- Weak Institutional Framework

6.3.1 The Hydro-Climatic Observation Network Development

Uganda's hydro-climatic observation network comprises of the following classes of stations.

Synoptic Stations: There are 12 synoptic stations currently in operation in Uganda. These observe a wide range of meteorological parameters; mainly rainfall, temperature, wind speed and direction, cloud cover, atmospheric pressure, saturation vapour pressure, hours of sunshine and solar radiation. The meteorological parameters are observed on an hourly basis for either 12 or 24 hours a day and submitted to the Department of Meteorology (now the Uganda Meteorology Authority) on a daily basis.

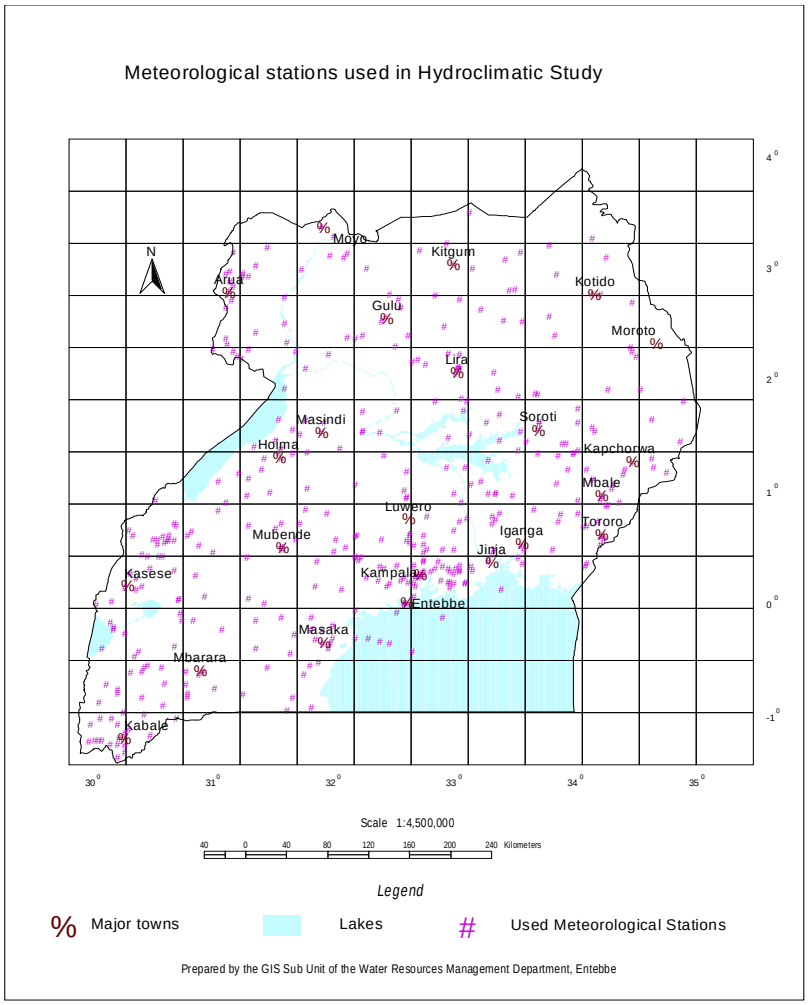
Climatological Stations: Uganda has 17 operational climatological stations. These stations record observations of rainfall, temperature, atmospheric, pressure and sunshine hours. Observations are recorded twice daily and submitted to the Department of Meteorology in Kampala at the end of every month.

Agro-meteorological Stations: There are 14 such operational stations in Uganda. These stations essentially record additional phenological parameters of soil temperature and crop development stage. The stations are operated mainly by district farm institutes and agricultural research institutes. Observations for climatological parameters are recorded daily and phenological parameters are recorded on a weekly basis. Data from these agro-meteorological stations, together with that from the synoptic and climatological stations, is reported every 10 days and then used in the 10 day agro-meteorological bulletins.

Rainfall Stations: There are about 130 operational rainfall stations. However, during the era of the East-African Community (prior to 1977), that also included stations in Kenya and Tanzania as one regional network, there were over 1000 rainfall stations in Uganda that recorded data on a daily basis. The breakup of the East African community in 1977 and the political upheavals that followed in Uganda destroyed a significant part of that network and by 1986 about 100 stations were operational. The Government has been rehabilitating and installing new stations to the network. Details of about 600 rain gauge network stations that operated were compiled from the Department of Meteorology and shown in Map 6-1.

More specialized observation network: There is one upper-air station that has been rehabilitated with support from Vaisala and is operational. The Government of Uganda has also funded the establishment of a new wind-shear system and weather radar.

Map 6-1: The past hydro-climatic network



6.3.2 Appraisal of the available data for analysis/research

An appraisal of the available data for purposes of analysis and research has recently been done. The findings showed that data available was of daily records from 597 stations, comprised of a total of 16363 station-years of records of which 11636 were complete. The records date back to the beginning of the 20th century, and include all available data up to 1999. Other than the more populated areas around the north shore of Lake Victoria that were over-represented, the records were reasonably well distributed across the country. However, the distribution of records across time was not smooth because of establishment of stations at different times and disruptions of others for several years.

Figure 6-1 shows the number of records, both complete and incomplete in each year. This is a peculiar time-series that reflects the complicated history of the records themselves and the civil history of the country in recent decades.

From 1943 to the late 1970's, the records were more prolific, though the tendency of completeness did decline slowly. From about 1977, there was a rapid decline in the number of operating stations; also less than 50% of the annual records were complete. Improvement in the network evident in the 1990s was not comparable to that of the data-rich decades. UMD aims at rebuilding a network of 300 stations, and by 2001 over 100 stations were operating.

The record length at an individual station is important in hydro-meteorological and general statistical terms. Many stations had records that were discontinuous with broken gaps of one or more years.

Figure 6-2 shows the histogram of record length for all 597 stations, counting both nominal and complete years. The upper histogram shows that most stations had a record length of 15 to 40 years with the median length of 26 years. The lower histogram that includes only complete years of record, showed a more realistic appraisal of a record length of 10 to 30 years for most stations with a median of 18 years. The incompleteness of data complicates its analysis as well as quality control; making most text book procedures neither relevant nor easy to apply.

6.3.3 Planned Optimum Climate Observation Network (OCMN)

It should be noted that several operating stations were still making irregular returns. Based on this handicap among other factors, a study was undertaken during 2007/08 to determine an Optimum Climate Observation Network that would cover all the regions adequately. In this, the Department of Meteorology committed itself to regular supervision and monitoring of these stations to ensure accurate and regular reporting.

Figure 6-1: **The number of records on the database for each year**

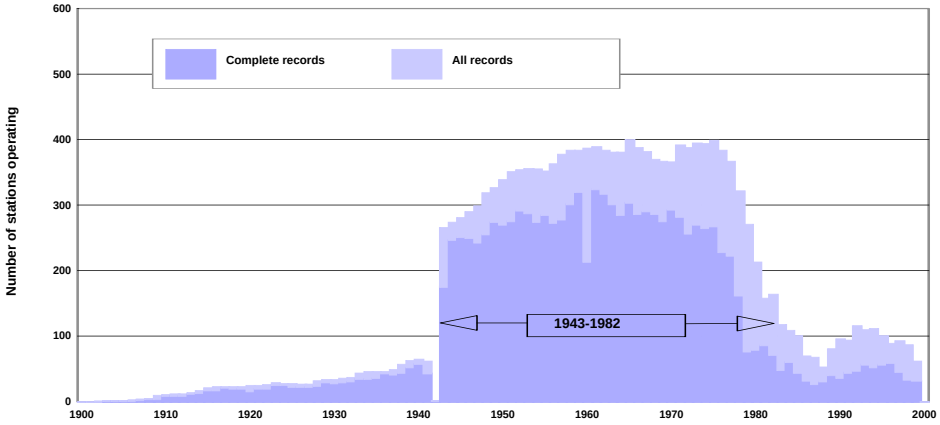
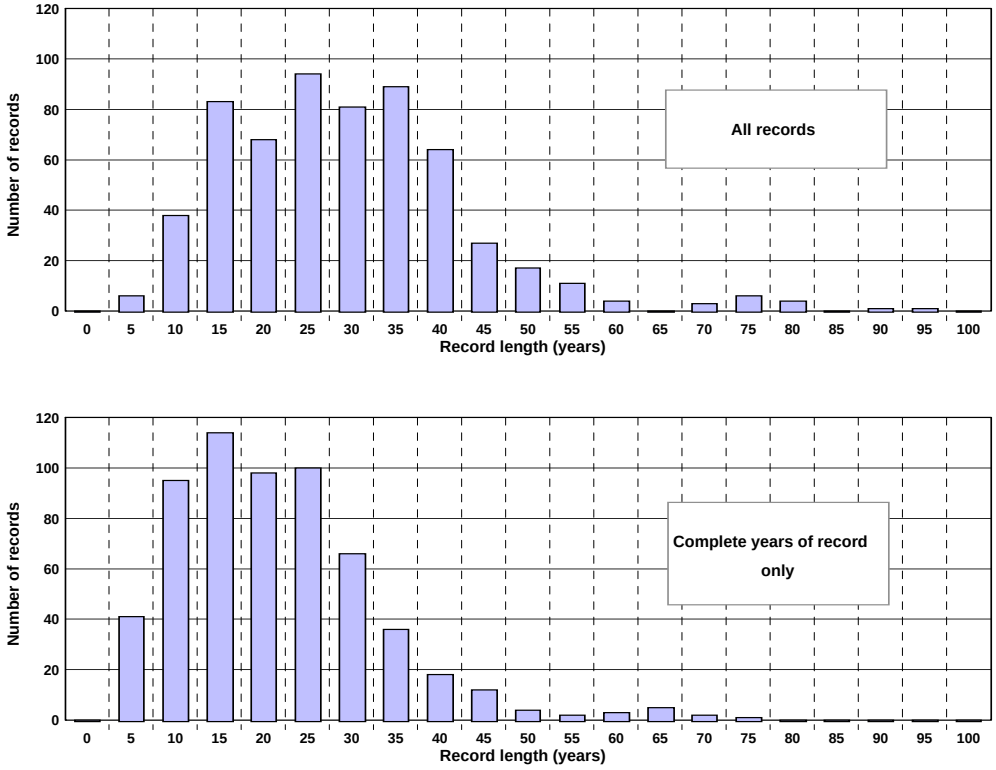


Figure 6-2: Histograms of record length

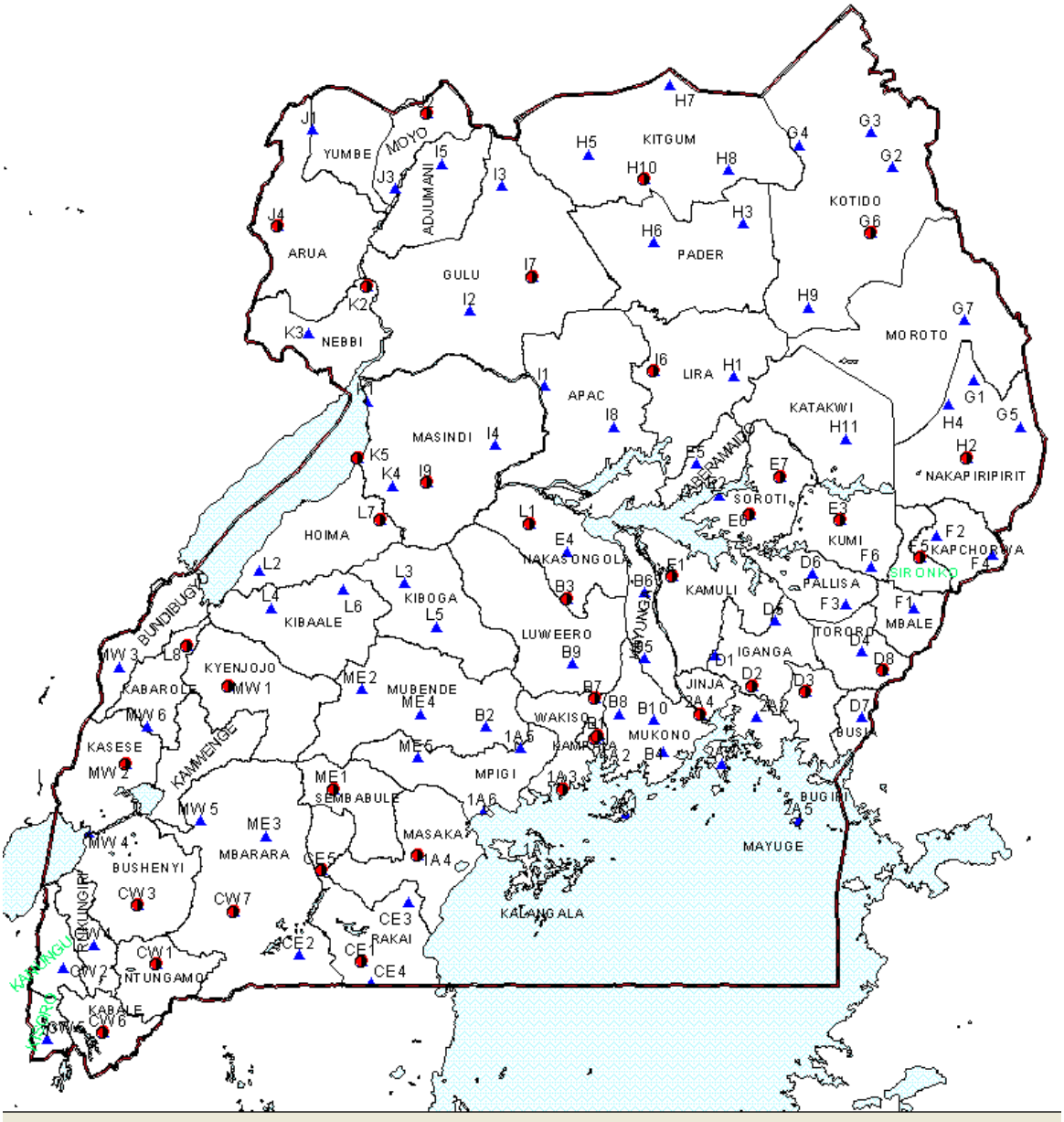


By definition, an OCMN design principle constitutes the least number of climatological stations (in particular rain gauges) that must be operated in order to obtain optimum weather (in particular rainfall) information for the various weather (in particular water) use and or other sensitive activities over the desired region, in this case Uganda**.** Thus the developed Optimum Climate-Monitoring Network is constituted of a minimum number of climatological (in particular rainfall) stations that should operate to obtain optimum weather (in particular rainfall) information for the various weather (in particular water) use and other sensitive activities in

Uganda. The climatological station network for OCMN would be sparsely but well distributed in all regions to capture even the data on minor but important weather elements like temperature.

The Optimum Climate Monitoring Network was determined as an extension of the comprehensive scientific principles employed by Basalirwa (1991) in the development of the Minimum Raingauge Network (refer to climatological section-Map 6-2.)

Map 6-2 Proposed Optimum Climate Monitoring Network for Uganda



Notes: A combination of the operating (Circular dots) and those to be rehabilitated and or opened up (triangular)

6.3.4 Other fields/activities relevant to systematic observations

Uganda's Department of Meteorology accesses telecommunication/climate databases through the linkage with the Global Telecommunications System (GTS) through the Regional Telecommunications Hub (RTH) in Nairobi, Kenya. Nationally the data is exchanged either by General Packet Radio Service (GPRS) or High Frequency Single Side Band (HF-SSB) Radio Telephones and/or Fiber Optic Cable System.

With respect to forecasting, the necessary capability is being developed. The department currently relies on the PUMA satellite system for SYNERGIE satellite data reception and analysis of forecast data and the Numeric Weather Prediction Model forecast products from various International Meteorological centers (UK, South Africa, Kenya, and ECMWF) to build its ensembles.

6.3.5 Weather and Climate Products and Services

Uganda's Department of Meteorology provides number of services related to research/systematic observation; including:

Mobile Weather Alert (MWA) Service For Fishermen Over Lake Victoria: This service was developed as a pilot scheme under the WMO Severe Weather Forecast Demonstration Project (SWFDP) as a way of bridging the huge technological gap in severe weather forecasting that existed between developed and developing countries. The MWA service was designed to utilize mobile phone technology to develop a sustainable weather warning service to reduce the vulnerability of fishing communities on Lake Victoria to weather hazards by sending daily weather forecasts/alerts directly to fishermen in the Kalangala Island District via SMS text messages.

Stakeholder needs and tailor-made weather and climate products: The meteorological department piloted the provision of weather and climate information and products to rural farmers in Kasese District beginning early 2012. This was in partnership with Grameen Foundation Uganda that had technologies to transmit data and products collected from rain-gauges in the field at every sub county. The products transmitted include, seasonal forecasts, monthly forecast reviews and updates, ten-day weather forecasts and daily weather forecasts. Two versions are usually relayed; one in English and the other in the local language. The information is sent to all farmers on the system and agricultural extension workers at sub-county level. Upon successful completion of the pilot phase, the project would be scaled up to more districts and finally the whole country.

Dissemination of Meteorological Products: Dissemination of meteorological products in Uganda is done through the media (by Press release on TV, FM Radios and print media), Emails

and Website. Forecast bulletins are also given to Government Primary Schools in the Eastern region of the country at the beginning of every rainy season. Also as a pilot project, DoM interprets seasonal forecasts into major local languages in the country, transmits it as text messages or audio tapes.

6.3.6 Quality Management System (QMS)

Uganda's Department of Meteorology has appointed a QMS Manager. Quality management manuals have been developed and are being implemented. The QMS system was internally audited and the external audit was done in December 2012 and non-conformities were identified. DOM is currently working on the non-conformities in preparation for ISO certification.

6.4 Education, training, public awareness and institutional strengthening

Uganda has, since 2002, been undertaking a number of activities related to Climate Change (CC) education, training and public awareness in order to promote CC adaptation and mitigation actions, at national and sub-national levels. This has been through both formal and informal channels. Formal avenues comprise of education at primary, secondary and higher (tertiary and university) levels of learning while informal channels mainly comprise of public/community mobilization, awareness and sensitisation campaigns. This has been undertaken by both government and non-governmental institutions as elaborated upon below.

6.4.1 Formal Education

The ultimate objective of Uganda is to integrate CC into the national education curricula at all levels. Some progress has been achieved at the primary and secondary levels of education. Through a Memorandum of Understanding (MoU) signed between the Ministry of Water and Environment and the National Curriculum Development Centre (NCDC), the national organization responsible for curriculum development, key activities have been undertaken. These have included training of a curriculum specialist and selected teachers in the climate change, compilation, preparation and writing up of the education, information and communication materials, and development of supplementary education materials in key subjects; namely: English, social studies, drama, geography, history, economics, sociology and political education. It is expected that the NCDC will continue with the reform of the secondary school curriculum that started in 2011. Climate change learning is to be incorporated in a phased manner from lower Secondary (classes of Senior 1 to 4) to upper Secondary (classes of Senior 5 to 6).

At the tertiary and higher institutions of learning, however, limited progress has been recorded due mainly to limited capacity. Only, the National Meteorological Training School offers formal training in meteorology at certificate and diploma levels which encompasses basic climate change issues including the science of climate change.

Universities have put substantial efforts into capacity building on climate change. This has been in form of embedding climate change issues into existing training programmes. The Meteorology Unit of the College of Agricultural and Environmental Sciences at Makerere University, for example, offers degree and post-graduate diploma programmes in Meteorology entailing detection and attribution of climate change. Another very good example is the Makerere University Centre for Climate Change Research and Innovation (MUCCRI) that was established in 2012 as an umbrella organ to generate and disseminate quality climate change knowledge and innovations. The centre is envisaged to promote awareness of climate change; support and improve existing, or create and implement new curricula for programs at the diploma, undergraduate, graduate, and post-graduate level at Makerere University in relevant fields; including Meteorology, Climate Science, and Climate Change.

6.4.2 Education, Training and Public Awareness Activities of Government

In implementing activities concerned with climate change, its risks, impacts, adaptation and mitigation measures, Uganda has ensured that different ministries and departments are playing a role; most especially in promoting education in their respective areas of jurisdiction. As has already been elaborated elsewhere in this document, the key ministry is the Ministry of Water and Environment (MWE). The other key government institutions involved in climate change education, training and public awareness activities fall within the following ministries: Ministry of Finance, Planning and Economic Development, Ministry of Agriculture Animal Industry and Fisheries and Ministry of Relief and Disaster Preparedness.

The Ministry of Water and Environment (MWE) has been engaged in a number of programmes and activities to promote climate change education, training and public awareness and overall capacity building as well as implementation of climate change programmes. Notable ones include:

- National and sub-national/regional training of government officials at various levels
- Production and dissemination of documentaries such as the one on Gender and Climate Change and Lessons Learnt in Implementing Pilot National Adaptation Programmes of Action (NAPAs)
- Training of stakeholders in Clean Development Mechanisms, NAMAs and climate change negotiations.
- Production and dissemination of materials for national, sub-national and community levels such as posters, banners, t-shirts, policy briefs
- Establishment and operation of a website (www.ccu.co.ug) as a platform for information and knowledge sharing

- Development of a national climate change human resources and learning strategy through a consultative process involving stakeholders at various levels,

- Development of a Short Course Training Manual in Gender and Climate Change in collaboration with the Directorate of Gender, Makerere University; University of Iceland), the Icelandic Development Agency (ICEIDA) and the Norwegian Embassy in Uganda. This resulted in training of sector heads in 35 Districts in Eastern, Northern and Central regions.

- Undertaking research activities on gender and climate change to generate evidence-based information for public consumption. Other areas include use of ICT to enhance adaptive capacity of communities especially in the most unstable ecosystems in the cattle corridor. These reports are also shared with the public through the website and by distributing hard copies.

- Undertaking awareness and sensitisation campaigns through both electronic and print media for the general public, sector officials, parliamentarians and top government bureaucrats including permanent secretaries.

The Ministry of Finance, Planning and Economic Development (MoFPED), being the key financing channel of government, performs its role at a multi – sectoral level. It supports all other relevant ministries and institutions as the implementing agency. With respect to education, training and awareness creation, MoFPED has been mainly involved in the promotion of science education and research into adaptation and mitigation of climate change impacts and risks.

The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) has made significant progress in the establishment of climate change adaptation and mitigation strategies in the agriculture sector; targeting predominantly rural farmers at both large scale and subsistence levels. The Agricultural Sector Performance Report for the Financial Year 2011/2012, for example, presents the following as some of the accomplishments of MAAIF:-

- A Fully established weather and climate database system available at http://connectprofiles.com/climate/index.php.

- Conduct of participatory surveys to establish farmers' perceptions on climate change and their recommendations on the necessary course of action.

The Ministry of Relief and Disaster Preparedness has made effective use of media communication mechanisms as a key pillar to successful disaster preparedness and operations management. Other efforts of the ministry have included:

- Integration of Disaster Preparedness and Management in schools programs so as to increase awareness, appreciation and commitment to save human lives and livelihoods.

- Conduct of Human Resource Training and Development

Other government ministries that play a role in the promotion of climate change activities, especially through public awareness, mobilization and sensitisation campaigns, include Ministry of Health, the Ministry of Local Government, the Ministry of Energy and Mineral Development and the Office of the Prime Minister.

6.4.3 Education, Training and Public Awareness by Civil Society

Civil Society comprising of Non-Governmental Organisations (NGOs), Community Based Organisations (CBOs), and Faith Based Organisations (FBOs) play a major role in contributing to national objective of increasing resilience to climate change while promoting sustainable development as enshrined in the National Development Plan. Civil Society in Uganda is very actively engaged in promoting climate change education, training and public awareness at national, sub-national and community levels. Their major activities include: training seminars, radio talk shows, public dialogues and development of climate change awareness materials such as booklets, posters, stickers and essay competitions. Some of the major Civil Society Organisations include: the Climate Change Action Network Uganda (CAN-U), African Climate Change Resilience Alliance (ACCRA), Development Network of Indigenous Voluntary Associations (DENIVA), Advocates Coalition on Development and Environment (ACODE), Environment Alert (EA), OXFAM, Red Cross, Environment Alert, to name a few. While a few of these are local organisations, a number can be easily recognised from their international footprint.

6.4.4 Planned Activities for Climate Change Education, Training and Public Awareness

For climate change knowledge and capacities to be strengthened, mostly through education, training and public awareness, the following activities have been planned to enhance Uganda's efforts to address climate change.

6.4.4.1 Education and Training

- Building basic climate change knowledge and competencies of key actors including training of education legal officers, policy makers, other government officials and CC negotiators.

- Strengthening human resources and skills for climate change monitoring and evaluation of adaptation and mitigation strategies especially in the Department of Meteorology

which is responsible for climate systematic observations and detection and attribution (science) of climate change;

- Strengthening skills for mainstreaming climate change in key sectors such as agriculture, water energy and health and at National and District Local Government level;
- Supporting on-going efforts to integrate climate change learning in curricula from the primary to higher institutions of learning including supporting in-service teachers' and lecturers' training in climate change, in order to strengthen their capacity to transmit appropriate knowledge to the learners;
- Assessing the impacts of climate change learning in different sectors, and in the different levels of the institutions of learning;
- Harmonizing climate change learning among different institutions and levels;

6.4.4.2 Public awareness

- Developing Information, Education and Communication (IEC) materials for climate-resilience and sustainable development such as training manuals, teachers and students resource books, research publications, posters, calendars, policy briefs, CC tool kit;
- Establishment of national CC resource centres and a CC knowledge management information system, including for research and innovation;
- Enhancing information sharing and exchange through international cooperation most especially through increased participation in international forums;

6.5 Public private partnership

Uganda recognises the crucial role that private participants can play in the development process. According to Uganda Vision 2040, a quasi-market approach, that includes a mix of government investments in strategic areas and private sector market driven actions, will be pursued. The private sector will remain the engine of growth and development while government will facilitate this through the provision of conducive policy instruments, regulatory measures and institutional frameworks. The Government will also promote and encourage public-private partnerships in a rational manner. A clear illustration of this is in the area of sustainable development of Uganda's forest estate. The environment policy of Uganda: "*Efforts will be made to restore and add value to the ecosystems (wetlands, forests, range lands and catchments) by undertaking re-forestation and afforestation on public land, promoting participation of the population in tree planting on both private and public land and enhancing private investment in forestry through promotion of commercial tree planting on private land and adoption of green agriculture practices*."

6.6 International cooperation and networking

The global nature of climate change necessitates exchange and sharing of data, information and expertise at regional and international levels in order to enhance appropriate and effective responses. Uganda is committed to international cooperation and networking, and is actively involved in all the groupings in which Uganda is a party. A very good example of this a working group set up by Uganda's Ministry of Information and Communications Technology (ICT) for the purpose of developing a common methodology that ICT companies can use to measure their carbon footprints and to estimate the considerable savings through reduction of GHG emissions and energy that can be achieved in other sectors through the use of ICT.

Uganda would like to promote the sharing of such tools and information. A capacity building plan for implementing the methodology is being developed. However a number of challenges have been identified; including:-

- Lack of standardized accurate and complete data ideal for sharing
- Inadequate provision of ICT for researchers and managers in public and private institutions.
- Fragmented and unwillingness of some institutions to share information.
- Lack of environmental data and information cataloguing.
- Inadequate capacity to generate and update environmental data,
- Inadequate involvement of local governments to manage the generated information.
- Inadequate use and management of remotely sensed environmental data.

There is need to address these challenges through adequate funding and human resource development.

6.7 Monitoring and Evaluation (M&E)

As part of the Uganda Climate Change Policy and Implementation Strategy, a M&E framework for the policy is composed of the following two key components; monitoring and evaluation.

6.7.1 The monitoring function

Reporting on Monitoring shall be on an annual basis and will focus on issues of effectiveness and efficiency in the climate change strategy implementation against the approved outcomes and outputs under the detailed action programme for the strategy. The various ministries,

departments and agencies concerned with the indicative climate change programmes detailed in the strategy are expected to report on a quarterly and semi-annual basis on their progress in the implementation of their respective tasks and in the attainment of their expected results under the climate change strategy. This information will be reported to the Ministry of Finance, and copied to the National Planning Authority and the CCD. Specific roles of some of the actors are defined as follows:

- *The Climate Change Department (CCD) under the Ministry of Water and Environment (MWE):* The reporting from the various ministries, departments and agencies will be consolidated relevantly at the national level by the CCD. The CCD will be tasked with preparing a consolidated annual progress report on the overall implementation of the policy implementation strategy, for consideration by the Prime Minister's Office and Cabinet. The CCD may provide guidance to the various ministries, departments and agencies as they develop their PMFs and reporting formats, to ensure consistency and focus on result-based management in the implementation of the policy.

- *The Ministry of Local Government (MoLG)* will review relevant reports from the districts to ensure the quality of the reporting, and consolidate reporting on district-level actions towards the implementation of the policy on a semi-annual basis. This information will be reported to the Ministry of Finance, and copied to the National Planning Authority and the CCD.

- *The Ministry of Finance, Planning and Economic Development (MoFPED)* will review quarterly and semi-annual reports from the ministries, departments and agencies concerned, to ensure that resource use is in line with expected and actual progress in implementing the policy.

- *The National Planning Authority (NPA)* will review quarterly and semi-annual reports by the reporting institutions concerned.

- *Civil society and private sector organisations,* through their representation on the multi-stakeholder National Climate Change Advisory Committee, will also play a key role in the monitoring function.

6.7.2 The evaluation function:

An independent evaluation is planned after the first five years of implementation, which shall be commissioned by the National Climate Change Policy Committee (NCCPC). The recommendations will feed into the revision process for the policy. This shall be carried out basing on a thorough public consultation process and review of the prevailing results.

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