THE REPUBLIC OF UGANDA

NATIONAL STATE OF THE ENVIRONMENT REPORT 2024

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

NEMA
National Environment Management Authority
ENSURING SUSTAINABLE DEVELOPMENT

30 YEARS
1995 - 2025

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THE REPUBLIC OF UGANDA

NATIONAL STATE OF THE ENVIRONMENT REPORT 2024

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

The National State of the Environment Report 2024

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ACRONYMS

BMCA	Bwindi Mgahinga Conservation Area
CNOOC	China National Offshore Oil Corporation
CO	Carbon monoxide
CD	Cooperation and Development
DPSIR	Drivers, Pressures, State, Impact, and Response model of intervention
DRR	Disaster Risk Reduction
DWRM	Directorate of Water Resources Management
ENR	Environment and Natural Resources
ESIA	Environment and Social Impact Assessment
FAO	Food and Agricultural Organization
FMD	Foot and Mouth Disease
FY	Financial Year
GDP	Gross Domestic Product
GEO	Global Environment Outlook
GHG	Green House Gas
GOU	Government of Uganda
GW	Giga Watt
GWH	Giga Watt Hour
HP	Hydropower
IGC	International Growth Centre
KVNP	Kidepo Valley National Park
LMCA	Lake Mburo Conservation Area
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MDA	Ministries, Departments and Agencies
MEMD	Ministry of Energy and Mineral Development
MENP	Mount Elgon National Park
MFCA	Murchison Falls Conservation Area
MFNP	Murchison Falls National Park
MTWA	Ministry of Tourism, Wildlife and Antiquities
MWE	Ministry of Water and Environment
MW	Megawatt
NAP	National Action Plan/National Agricultural Policy
NASA	National Aeronautics Space Administration
NDPII	National Development Plan 2
NDP	National Development Plan
NEMA	National Environment Management Authority
NFA	National Forestry Authority
NGO	Non-Governmental Organization
NPA	National Planning Authority
NSOER	National State of the Environment Report
OECD	Organization for Economic Cooperation and Developemnt
OPM	Office of the Prime Minister
PM	Particulate Matter
QECA	Queen Elizabeth Conservation Area
QENP	Queen Elizabeth National Park
REDD	Reducing Emissions from Deforestation and Forest Degradation
SDGS	Sustainable Development Goals
SDG	Sustainable Development Goal
THF	Tropical High Forest
UBOS	Uganda Bureau of Statistics
UGX	Uganda Shilling
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNMA	Uganda National Meteorological Authority
UNRA	Uganda National Roads Authority
UPDF	Uganda People's Defence Forces
USAID	United Stat es Agency for International Development
USDA	United States Department of Agriculture
UWA	Uganda Wildlife Authority
WCS	Wildlife Conservation Society
WHO	World Health Organisation
WWF	Worldwide Fund for Nature

STATEMENT FROM THE MINISTER OF WATER AND ENVIRONMENT

The National State of Environment Report 2024 is a cornerstone document for guiding Uganda's environmental stewardship and sustainable development. This report presents an in-depth analysis of the country's current state of the environment and provides strategic insights into the challenges and opportunities that lie ahead.

As Uganda pursues Vision 2040 and strives to meet the Sustainable Development Goals (SDGs), the country's environment remains the foundation of socio-economic growth and transformation. However, a number of drivers including rapid urbanization, industrial growth, deforestation, and climate change and climate variability present significant challenges to the environment and hampers achievement of socio-economic transformation as a key outcome of the national development aspiration. This National State of the Environment Report (NSOER) examines these drivers of environmental and socio-economic change and offers evidence-based solutions to them.

In view of the above, there is an urgent need to continually safeguard the country's environment and natural resources viz air, water, soil, and biodiversity while balancing environmental sustainability with national development and socio-economic transformation. Furthermore, the report highlights the need for innovative policies and practices in key sectors such as agriculture, tourism, transport and communication, infrastructure and urban development in order to achieve environmental sustainability with maximum benefits.

Moreover, the report evaluates the effectiveness of existing environmental policies and governance structures and illuminates gaps that need to be filled. In addition, it outlines the vision for a sustainable future, proposes actionable pathways to build climate resilience and attainment of green growth in tandem with the national, regional and global development trends.

This report is an invaluable resource for policymakers, development partners, civil society organizations, academia and other stakeholders committed to the attainment of environmental sustainability. I urge everyone to use the insights and recommendations in this report to catalyze impactful actions that will ensure the protection and preservation of Uganda's natural heritage for the benefit of the present and future generations.

Hon. Sam Cheptoris Mangusho, MP
MINISTER OF WATER AND ENVIRONMENT

STATEMENT FROM CHAIRPERSON NEMA BOARD

It is my honor to present the National State of Environment Report 2024 that gives a comprehensive account of Uganda's environmental status and a call to action for sustainable management.

Uganda is undergoing profound environmental changes, driven by a multitude of factors including urbanization, industrialization, and climate variability. These challenges demand coordinated efforts to protect our environment and natural resources, which are critical for national development and the livelihoods of our people.

This report provides a detailed examination of the state of Uganda's environment and highlights key areas such as air quality, water resources, biodiversity, and land management. It identifies the challenges faced and opportunities available for leveraging green growth and enhancing environmental resilience in the country.

A cornerstone of this report is its emphasis on actionable pathways informed by a robust theory of change. These pathways prioritize collaboration across government Ministries, Departments and Agencies (MDAs), private sector, and civil society organizations to address gaps in governance and resource mobilization.

As the Board of Directors of NEMA, we remain steadfast in our commitment to providing oversight and strategic direction to advance the priorities identified in this report in sync with the National Development Plan IV. Together, through shared responsibility and innovative application of solutions, we can ensure that Uganda's environment and natural resources support sustainable development for generations to come.

I extend my heartfelt gratitude to the NEMA team and partners for their dedication in producing this essential document. Let us now take the bold steps required to translate its vision into reality.

Prof. James Okot-Okumu
CHAIRMAN BOARD OF DIRECTORS
NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

FOREWORD

As we unveil the National State of Environment Report 2024, we reaffirm our collective commitment to sustainable environmental stewardship. This report is more than an assessment; it is a strategic tool to align environmental management with Uganda's national development goals as well as regional, international and global conventions.

The report underscores the statutory imperatives driving our mandate and highlights the role of environmental governance in achieving sustainable development. It identifies and analyzes key drivers of environmental change, including rapid urbanization, industrialization, climate variability, biodiversity loss, and unsustainable agricultural practices.

This document provides an in-depth analysis of critical environmental components such as air quality, water resources, land, biodiversity, and urban development, offering a comprehensive picture of our ecosystem's health. In addition, it evaluates the effectiveness of existing policies, laws, and regulatory frameworks and provides valuable insights into areas that require enhancement.

Looking ahead, the report charts a vision for long-term sustainability. It outlines actionable pathways for climate resilience, resource optimization, and community engagement, serving as a guide for decision-makers and stakeholders. More importantly, it emphasizes the resource needs to achieve our environmental goals, including data collection and analysis, technology application, and development of skilled human capital.

Anchored in a robust theory of change, the report integrates scientific rigor with a participatory approach, delivering a document that is informative, actionable and forward looking. As we navigate the challenges of environmental degradation in the country, let this report serve as a clarion call for urgent action, fostering a harmonious balance between development and conservation.

NEMA expresses gratitude to the Government of Uganda, through the Ministry of Water and Environment, for the support in producing this report. Significant contributions of information from various Ministries, Departments, and Agencies have played a pivotal role in the preparation of this National State of Environment Report, 2024. We acknowledge the contribution from United Nations Development Programme (UNDP) towards supporting the dissemination of this report.

Barirega Akankwasah, PhD
EXECUTIVE DIRECTOR
NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

EXECUTIVE SUMMARY

The National State of the Environment Report 2024 (NSOER) offers a comprehensive assessment of Uganda's environmental governance, aligning national policies with global commitments such as the Sustainable Development Goals (SDGs), Uganda's Vision 2040 and the National Development Plan IV. It highlights the roles of key institutions, including the Ministry of Water and Environment (MWE), the National Environment Management Authority (NEMA), Uganda Wildlife Authority (UWA), and the National Forestry Authority (NFA), in tackling environmental challenges through collaboration with local governments, civil society non governmental organisation and international partners.

The report identifies key drivers of environmental change, including rapid population growth, urbanization, economic development, and climate change. These factors exacerbate deforestation, habitat loss, and resource depletion, while contributing to poverty and inequality among the citizens. Climate change impacts, such as rising temperatures, floods, and droughts, further disrupt ecosystems health and agriculture. In addition, air pollution, water contamination, land degradation, and biodiversity loss are major concerns that need to be tackled.

Despite these challenges, Government of Uganda has implemented policies to mitigate environmental damage, including enforcement of air quality standards, water resource management, and natural resources conservation. The country's biodiversity remains globally significant, with unique ecosystems such as wetlands, forests, and savannas that are continuously threatened by human activities. Efforts to restore forest cover and protect endangered species, including mountain gorillas, are underway, with goals to increase forest cover from 12% in 2021 to 21% by 2030.

Urbanization, waste management, and agricultural practices continue to pose challenges, but initiatives like climate-smart agriculture, waste recycling, and sustainable tourism are being promoted. The energy sector, through the green growth strategy, is transitioning to renewable energy sources, including hydropower, solar, and geothermal energy to reduce dependence on biomass as a major source of energy.

Looking forward, Uganda aims to achieve environmental resilience by 2040 through strategies focused on renewable energy, sustainable agriculture, and green infrastructure. Key actions include strengthening regulations, promoting green technologies and enhancing community involvement to ensure sustainable and impactful development for the present and future generations.

CHAPTER 1 Introduction

1.1. Overview of the report

In this edition of the National State of the Environment Report (NSOER), a detailed assessment of the Environmental landscape for the period 2022 to 2024 is made. The report systematically analyses the current state of air, water, land, biodiversity, and other critical environmental components. The report underscores the urgency of addressing pressing environmental challenges amidst rapid socio-economic development and increasing human population. It reflects Uganda's commitment to achieving sustainable development in sync with the aspirations of the United Nations by aligning environmental management practices with national development goals and international and multi-lateral environmental agreements.

This report is organized into sections, each designed to provide a thorough and coherent flow of information. Chapter One introduces the statutory requirements, environmental governance, and contextualizes environmental management within national development goals and targets. It is followed by Chapter Two which covers the drivers of environmental change. Chapter Three describes the state of the environment across various dimensions such as the atmosphere, water resources, land and soil, biodiversity, urban development, agriculture, tourism, culture, and heritage. Chapter Four demonstrates the linkages of relevant environmental policies, examining their efficacy within the broader framework of environmental laws and regulations. Chapter Five provides the outlook and potential pathways for achieving sustainable environmental management, articulating a long-term vision and delineating plausible trajectories. Lastly, Chapter Six explores the resource needs encompassing data acquisition and knowledge, funding, human resources research technologies that are essential for effective environmental management.

1.2. Statutory requirements for reporting on the National State of the Environment

Section 46 of the National Environment Act, Cap. 181, requires the National Environment Management Authority (NEMA) to produce National State of Environment report biennially (i.e., every two years). In addition, the National Development Plans III & IV integrate environmental sustainability as a key pillar, thus necessitating periodic environmental assessments, reporting, and the fulfilment of objectives set out in Uganda Vision 2040, which emphasizes sustainable environmental management.

The primary objectives of the National State of the Environment Report are to: (1) identify trends in key environmental indicators, (2) inform policymakers and stakeholders about the state of the environment (3) enhance public awareness and education on environmental issues, and (4) support sustainable development by integrating environmental considerations into national planning and development frameworks. The intended outcomes of the report include, improved environmental policies and legislation based on current data and trends, enhanced capacity for environmental monitoring, management and reporting, greater public and stakeholder awareness and engagement in environmental conservation practices, strategic planning for informed decision-making to achieve sustainable development, as well as provide information to support regional and international environmental reporting obligations to treaties, protocols and conventions to which Uganda is a party such as the East African Vision 2050 (EAC, 2050), the African Union (AU) Agenda 2063, the African Water Vision 2025, the United Nations Framework Convention on Climate Change (UNFCCC), the

Convention on Biological Diversity (CBD) and the United Nations Sustainable Development Goals (SDGs).

1.3. Environmental governance in Uganda

National Environment Management Authority (NEMA) is the principal agency responsible for coordinating, monitoring, regulating and supervising all activities relating to the environment. The National Environment Act, Cap. 181 empowers NEMA to coordinate lead agencies to develop capacity in their preparedness and response to environmental emergencies or disasters. NEMA also ensures that in case of an environmental emergency such as a disaster of any magnitude, the lead agencies promptly notify other relevant agencies and departments so as to guarantee the availability of support. The Ministry of Water and Environment (MWE) has the overall responsibility of the development, managing, and regulating water and environment resources in Uganda.

1.4 Environmental management in the context of national development goals and targets

The alignment of environmental management practices with national development goals is a cornerstone of Uganda's strategic development planning, as articulated in NDP III and Uganda's Vision 2040. In the effort to increase household income and improve quality of life of Ugandans, Chapter Nine of NDP III stipulates the need to reduce environmental degradation and adverse effects of climate change. In addition, it elaborates how to improve utilization of natural resources for sustainable economic growth and livelihood security. Chapter Five sub-section 8 in Uganda Vision 2040, outlines the aims to attain a green and clean environment with zero water and air pollution while conserving the flora and fauna and restoring and adding value to the ecosystems in order to sustain the flow of ecosystem services.

It is envisaged that economic growth will be bolstered through the promotion of green industries and eco-tourism in order to create employment opportunities, generate revenue and minimize environmental impacts. This symbiotic relationship between economic development and environmental conservation is essential for fostering long-term prosperity and ensuring ecological health. Uganda strives to balance economic advancement with environmental protection to achieve sustainable development. Coordinating environmental management across different sectors in Uganda involves a multi-pronged approach facilitated by various mechanisms. At the heart of this coordination function is the National Environment Management Authority (NEMA), which collaborates closely with lead agencies and stakeholders to ensure the country attains sustainable development.

To monitor progress towards achieving national development and environmental targets in NDP III and Vision 2040, there are indicators that provide a comprehensive overview of the country's performance across various domains. These indicators encompass economic metrics such as GDP growth rate, poverty headcount ratio, population growth rate and employment status alongside environmental parameters like the proportion of forest cover, biodiversity indices, water quality indicators, greenhouse gas emissions, and status of other pollutants.

1.5 Development approach, theory of change and structure

The preparation of Uganda's National State of Environment Report, 2024 applied a robust methodological approach that ensured precision, comprehensiveness, and relevance. Beginning with a scoping phase, the process entailed identification of key environmental issues and objectives that are pivotal to the report. The report relied mainly on existing data from government institutions, civil society organisation and non governmental organisation. Additional data were collected from field observations. This approach

formed the cornerstone of the report that encompasses secondary and primary data. Primary data were obtained from field surveys, environmental monitoring, and direct observations, while secondary data were derived from existing reports, databases, and scientific studies. Stakeholders including government agencies, academic and research institutions, civil society organizations, and local communities contributed invaluable data and insights presented in this report.

The Driver-Pressure-State-Impact-Response (DPSIR) framework guided the structure and content of the report. DPSIR is a widely embraced approach in environmental reporting. The framework facilitated the comprehension of intricate interactions between human activities and the environment, delineated into drivers, pressures, state, impact, and response.

The Theory of Change for the NSOER 2024 outlines the systematic process through which the report aims to effect positive environmental change and contribute to impactful development in the country.

CHAPTER 2 Drivers of Environmental Change

2.1 Drivers of Environmental Change

The environment and natural resources in the country face immense threats mainly from anthropogenic processes and natural factors. The drivers include rapid human population growth, poverty, unplanned urbanization, industrialization, climate change, land use changes, drought and floods.

2.1.1 Population demographics

Uganda's population has grown steadily over the years from 2.5 million in 1911 to 45.9 million people in 2024 (UBOS, 2024) (**Figure 1**). This is attributed to the high growth rate of 3.32% per annum and the influx of refugees that has made Uganda a major refugee hosting country in the world with about 1,500,000 refugees recorded in the 2023. Increased human population drives environmental change through escalated resource including energy consumption, land use and cover changes, waste generation, biodiversity loss, and climate change.

Rapid population growth and urbanization are key contributors to environmental degradation exacerbated by increasing rural-urban migration leading to generation of large volumes of municipal solid waste.This problem is compounded by poor waste management in cities and urban areas. United Nations Population Division estimates the population of Uganda to reach 75 million by 2040 (**Figure 2**). This means that the environment and natural resources will experience enormous degradation that calls for implementation of stringent environment protection measures supported by enforcement of policies, laws and regulations.

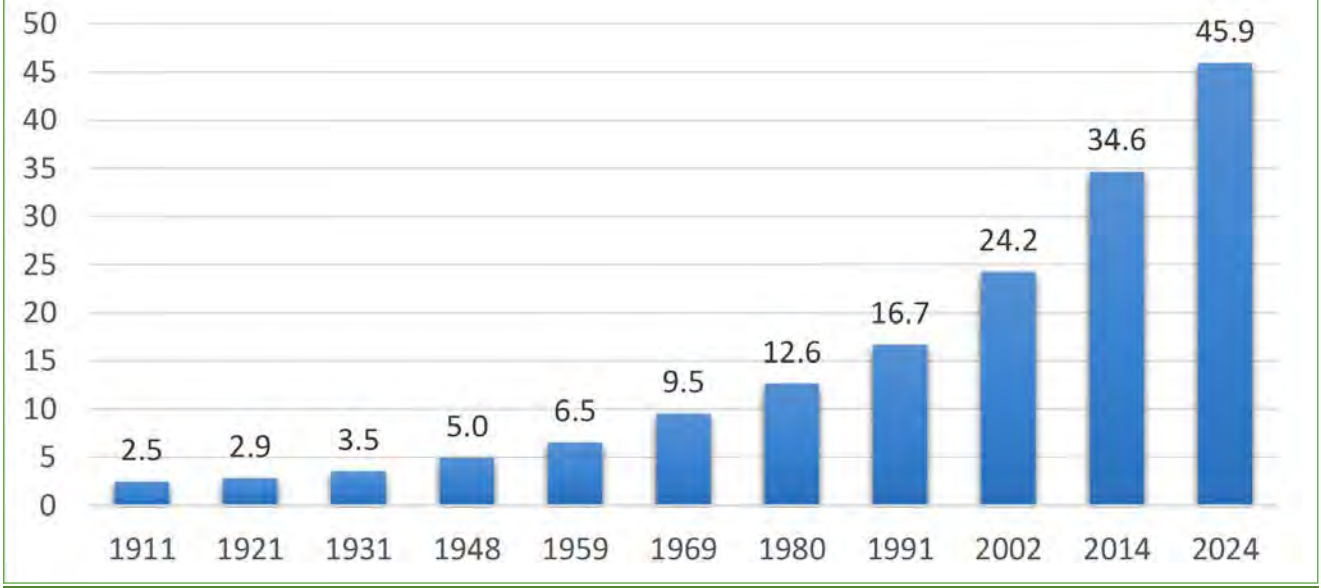

Figure 1*: Uganda's population growth trend from 1911 to 2024. (***Source***: UBOS, 2024).*

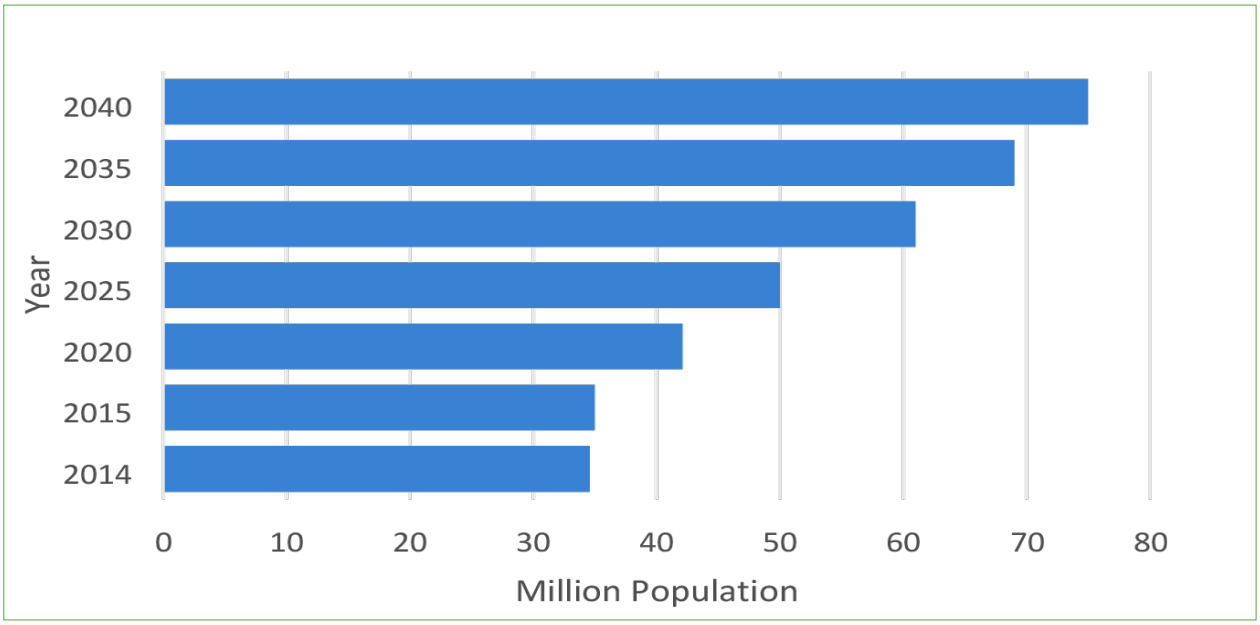

Figure 2*: Population projections for Uganda from 2014 -2040.* Source*: UNPF, (2017).*

2.1.2 Waste production and management

Waste generation in Uganda is driven by several socio-economic, demographic, and environmental factors. Economic growth amplifies waste generation as rising incomes and consumerism promote higher consumption of goods, particularly packaged and disposable items. Medical wastes, and beauty products have become major sources of water pollution and increased antimicrobial resistance. Weak recycling infrastructure and insufficient waste collection systems in rural and urban areas worsen the problem leading to illegal dumping and open burning of wastes across the country. The urban poor have limited access to waste management services and this results in further pollution and environmental degradation. Technological advancements and global trade in low quality products have also escalated the generation of waste in Uganda. The country grapples with a continuously growing e-waste due to importation of electronic products and yet there is no extended producer responsibilty in place to handle the waste that originates from these electronics.

2.1.3. Illegal wildlife trade

Poaching for bush meat is a common practice and together with illegal trade in wildlife products, have led to drastic decline in flagship species such as elephants, rhinos, and birds (Snyman et al., 2021). Uganda's wildlife continues to face severe threat from illegal wildlife trade, primarily driven by the demand for wildlife products from Asia particularly China. The country's iconic species, such as pangolins and African grey parrots, are on the brink of extinction due to illegal wildlife trade (Marcet, 2021).

2.1.4 Poverty

Limited economic opportunities compel impoverished populations to exploit their environment unsustainably, leading to remarkable ecological changes. This dynamic is evident in rural and urban communities where livelihoods depend heavily on natural resources thus exacerbating environmental pressures that result in land degradation, increased soil erosion, and pollution of water resources (UBOS 2023). In many rural areas in Uganda, subsistence farming, charcoal production and brick baking are the primary income sources. Rural and urban poor households rely on biomass fuels such as firewood and charcoal for cooking and large quantities of fire wood are used for baking bricks. These activities contribute to deforestation and air pollution. Moreover, the rural poor also practice unsustainable agricultural practices that result in soil fertility decline and land degradation.

Agriculture is the main source of food in the country and over 70% of the population is employed in the

sector. Most deforestation, wetland degradation, and destruction of river banks is attributed to agricultural activities. Furthermore, agricultural activities generate waste, particularly through the use of non-biodegradable inputs like plastics. Pesticides and fertilizers used in agriculture contaminate water bodies and affect aquatic life.

2.1.5 Economic development: demand, markets and trade

Uganda made important strides in 2023 geared towards achieving economic stability and registered 5.3% growth in Gross Domestic Product (GDP), up from 4.7% in the Financial Year (FY) 2022/23 compared to growth rate of 3.5% in FY 2020/21 and 3.0 % in FY 2019/20 (**Figure 3**) (UBOS, 2023).

Uganda's GDP is projected to more than double, to USD 158 billion in 2030, in exchange rate terms and USD 296.9 billion, in Purchasing Power Parity terms.

which adversely affect biodiversity and ecosystem services.

2.1.6 Urbanization and infrastructure development

Uganda's urban population is estimated to grow from 11 million in 2022 to 20 million by 2035 with a corresponding housing demand for additional 1.4 million units. The high urbanization rates, thus strain urban infrastructure and services. Currently, over 4.2 million people live in the cities (**Figure 4**) (UBOS, 2024). Kampala is Uganda's largest and oldest city and comprises about 25% of the country's total urban population. About 60% of the urban population lives in slums and informal settlements

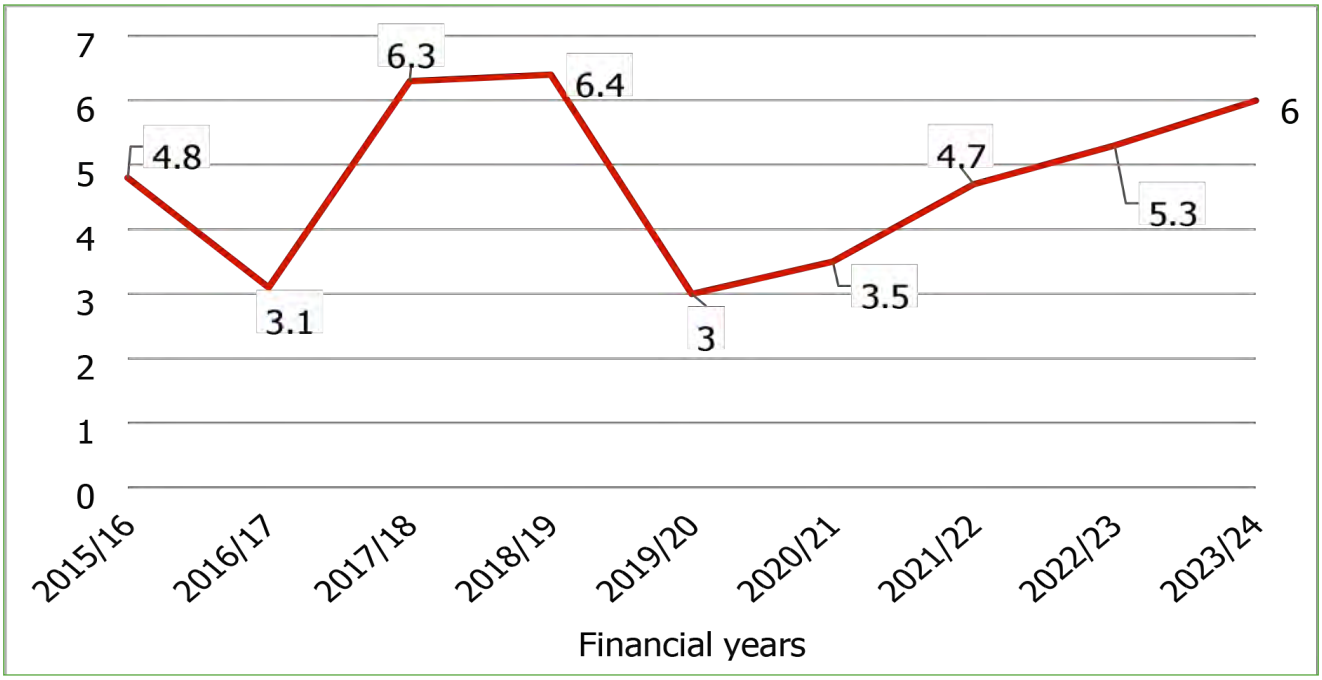

Figure 3*: Uganda's GDP growth rate (%) from 2015 to 2023.* **Source***: UBOS (2023).*

Economic development in Uganda has both positive and negative impacts on the environment. Uganda is rich in natural resources such as timber, minerals, and oil. Economic development often drives the extraction of these resources to support industries and generate revenue. However, the processes lead to deforestation, habitat destruction, land degradation and pollution all of

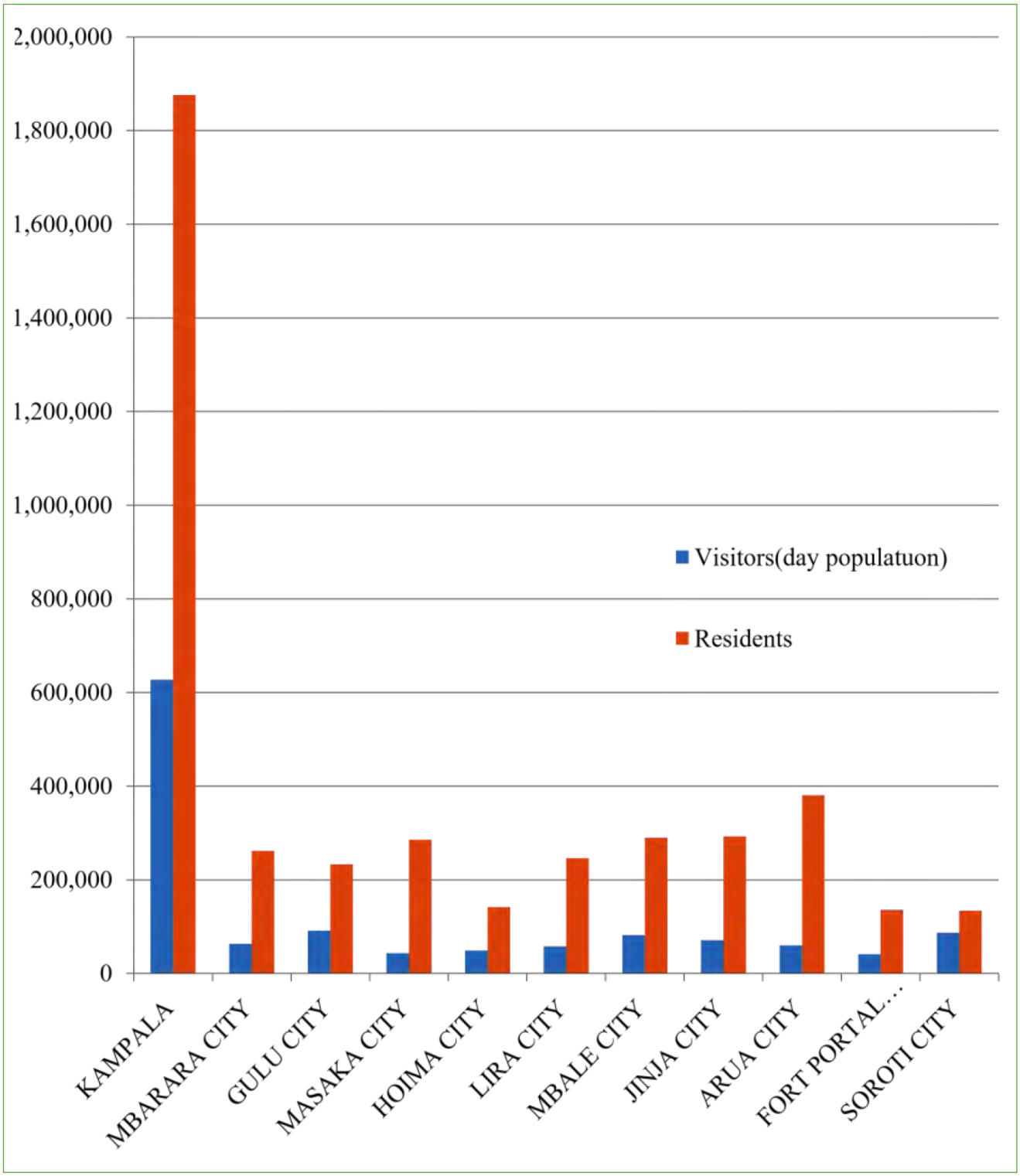

Figure 4*: Population status in cities in 2024.* Source*: UBOS (2024).*

Such rapid and often unplanned urbanization results in conversion of natural habitats such as forests, wetlands, and agricultural land to built-up areas. This has led to habitat fragmentation, loss of biodiversity and disruption of ecosystem services. Loss of natural habitats threatens the existence of plant and animal species. With growing urbanization, there are significant quantities of solid waste generated, including household wastes, industrial wastes, and construction debris. Without adequate waste management infrastructure and services, much of the waste is improperly disposed in open dumps or water bodies, leading to environmental pollution and posing a serious public health hazard.

2.1.7 Climate change and climate variability

Climate change and climate variability have significant impacts on Uganda's environment. The characteristics of climate change include changes in weather patterns, alteration of ecosystem services, declining water resources, hard-to-plan agricultural activities, and deterioration of human health. Climate variability results in irregular weather patterns, including fluctuations in temperature and precipitation. This variability can lead to more frequent and intense extreme weather events such as droughts, floods, and storms. This exacerbates pollution and degradation of water resources affecting nutrient transport and concentrations for agricultural production. These events also have profound negative effects on the environment including loss of biodiversity.

Shifts in temperature and rainfall patterns alter habitats and ecological niches hereby affecting the distribution and abundance of plant and animal species. Ecosystems such as forests, wetlands, and grasslands face increased stress, leading to fragmentation, degradation, and loss of biodiversity. Changes in precipitation patterns impact surface water and groundwater levels, leading to water scarcity or excess water in some parts of the country. This affects availability for domestic and industrial use, agricultural production and hydropower generation, with implications for ecosystem health and human livelihoods.

Erratic rainfall patterns, prolonged droughts, and increased temperatures as a result of climate change affect crop yields, livestock productivity, and food security. Increasing temperatures and dry periods exacerbate incidences of bush burning, hence increasing emissions of carbon dioxide to the atmosphere and causing property damage. In addition, climate change leads to increased incidences of diseases such as malaria in the population.

2.1.8 Industrialization

Industrialization has both positive and negative impacts on the environment. For instance, whereas the use of fossil fuels has accelerated economic development and lifted the standard of living of people, it has also contributed to environmental change. Increased energy consumption by the growing population leads to increased release of greenhouse gases into the atmosphere.

Activities such as manufacturing, transportation, and energy production release pollutants into the environment thus resulting in water and air pollution among others and greatly affecting ecosystems. Atmospheric pollution includes release of particulate matter, sulfur dioxide, and nitrogen oxides into the atmosphere which adversely affects human health and the environment. Improper disposal of industrial waste, including chemicals and untreated effluents leads to water pollution. Uganda's growing industrial sector, particularly manufacturing and food processing, has contributed to pollution of air, rivers, and lakes.

2.1.9 Land use and land cover changes

As Uganda's human population continues to grow, more land is needed for settlement, agriculture, urban growth and infrastructure development all of which contribute to environmental degradation. Land use and land cover change is also an indicator of vegetation degradation due to human activities such as large-scale plantation establishments, establishment of ranches, brick making and others. Uganda has experienced extensive deforestation due to urbanization, agricultural expansion, logging, and fuelwood harvesting. When forests are cleared for agriculture or timber extraction, it leads to loss of wildlife habitat, loss of biodiversity, disruption of water cycles, soil erosion, and reduced carbon sequestration. Thus, the role of forests in climate change mitigation and cleansing of the atmosphere is curtailed.

At the same time, rapid urbanization in Uganda has led to conversion of natural habitats into urban areas thus resulting in habitat fragmentation, loss of biodiversity and loss of ecosystem services.
Land fragmentation, land renting, traditional tillage practices, and introduction of options for nutrient enrichment, burning of plant materials

during land preparation for agriculture and use of agrochemicals have increased greenhouse emissions into the atmosphere. Bush burning is a common traditional practice in rural areas that has contributed to biodiversity loss mainly in grasslands and other terrestrial ecosystems.

2.1.10 Land tenure and governance

Land tenure systems also drive deforestation and environmental degradation in Uganda. The land tenure systems and weak land governance regime contribute to land degradation and biodiversity loss. Poorly defined land ownership and user rights lead to overuse and mismanagement of environment and natural resources.

Deforestation is more likely to occur under the Mailo and Customary tenure systems than the private land tenure system.

2.1.11 Weak enforcement of laws

Uganda has a good legal and policy framework for the regulation and protection of environment and natural resources, including water. However, the enforcement of laws and regulation are ineffective due to inadequate financial and human resources capacity of the relevant institutions and agencies whose mandates relate to environment and natural resources. There are weaknesses in some legal frameworks that need to be addressed. For example, the Water Act, Chap 152, and the National Environment Regulations rely on only organic matter-dependent Biological Oxygen Demand (BOD), as a sole parameter for noncompliant industries and municipal plants to pay for environmental damage. Furthermore, some polluting sectors do not account for their activities that pollute the environment. Worse still, the fines for pollution are not punitive enough to deter polluters from degrading the environment. As a result, there are entities that can pollute the environment and pay the fines.

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CHAPTER 3 State of the Environment

3.1 ATMOSPHERE

3.1.1 AIR QUALITY

Air quality is the condition of air in the environment. Good air quality means that the air is free of harmful substances (pollutants) and poor air quality contains substances which are harmful to humans and the environment. Air pollution, primarily particulate matter ($PM_{2.5}$) is one of the most serious contemporary health threats globally. It causes over 7 million premature deaths annually, and African cities are disproportionately affected by air pollution, resulting in over 1.2 million deaths annually (Gilderbloom et al., 2020). Worth still, many the cities lack capacity and resources to establish effective air quality management programmes, which hampers health and economic outcomes.

Uganda has one of the highest urbanization rates in the world estimated at over 5.2% annually (Tumwesigye et al., 2023). Rapid transformation of rural landscapes into urban markets and production centres has resulted in dense agglomeration of air pollution-generating activities in the emerging cities and major towns in the country e.g., Kira, Jinja, Gulu, Fort Portal, Mbale, Hoima, Mbarara, and others. Inevitably, ambient air quality in most of Uganda's urban areas has changed over time (Okure et al., 2022; Clarke et al., 2022; Okello et al., 2024) and can be linked to thousands of deaths per year as well as substantial economic losses. For example, in Kampala, mortality attributed to air pollution over a four-year period 2018 and 2021 is estimated to be 7,257 deaths (Atuyambe et al., 2024).

Whereas tackling air pollution is resource intensive, stakeholder-driven participatory engagements, coupled with advances in new technologies such as Artificial Intelligence (AI) and remote sensing technologies offer opportunities for enhancing capacity for air quality management through: 1) development of cost-effective approaches for air quality monitoring and modelling to quantify the scale of pollution and impacts; 2) application of novel digital solutions for health early warning and as decision-support systems to facilitate integration of air quality into health management, and targeted policy development (3) enabling cross-sectoral coordination, and (4) increasing awareness and public participation advocacy

a) Pressure on air quality

The drivers of air pollution in Uganda's urban areas are diverse and interconnected, arising from a wide range of diffuse sources and activities. Key sectors that contribute to pollution include transport, energy, waste management, and industry. The pressures arising from the major drivers include the following:

i) Domestic energy

Heavy reliance on solid biomass for cooking by more than 80% of the households, open burning of agricultural residues and tree felling compounds air pollution. Traditional cooking methods that use firewood and charcoal, emit high levels of indoor pollutants and account for the devastating effects of indoor air pollution (Kansiime et al., 2022). The country's fast-growing population has added to the problem and undermines efforts to increase access to cleaner energy. To date, more than 50% of the households have access to the national electricity grid but cannot use it for cooking due to the high tariffs.

Households' use of fire wood and charcoal for cooking accounted for around 87% of the national total energy (16.8 Mtoe) consumption in 2021. Furthermore, dependence on biomass fuels contributes to deforestation and environmental degradation through increased emission of pollutants from burning. Around 11% of energy consumption was in the form of oil products,

mostly petrol and diesel for transportation while 2% was in the form of electricity, mostly from hydropower. Households accounted for 61% of the total energy consumption, industry 22%, transportation 7%, and commercial and public services together consumed around 9% (International Energy Agency, 2023). Reliance on biomass and solid fuels release pollutants such as carbon monoxide (CO) and fine particulate matter (PM2.5) that increases the amount of carbon in the atmosphere and results in global warming.

ii) Transport

The growth of urban populations and rising incomes have increased the number of vehicles in the country. In 2022, Uganda adopted EURO 4/ IV vehicle emissions standards of the East Africa Community (EAC), and prior to that, a ban on imports of vehicles that are more than 15 years old had come into force. While this has led to a sharp reduction in the average age of newly registered vehicles, operational factors such as vehicle maintenance, poor road conditions, and driving practices coupled with a lack of reliable mass transit alternatives and fuel quality continue to undermine the gains from improved fleet age. During COVID-19 mobility restrictions, air quality improved by up to 50% in greater Kampala (Green *et al 2022*), which underscores transportation an important sectoral driver for air pollution, which according to a recent study (Okure *et al., 2025*), transport could be responsible for more than 24% of air pollution in Kampala.

iii) Industrial Emissions

Rapid industrialization in Uganda has increased emissions from factories and other manufacturing plants and reduced air quality. The capacity of industries to self-regulate and adopt emissions reduction technologies, including monitoring systems is limited. Uganda's industrial sector, which now accounts for over 20% of the country's GDP, is concentrated in Greater Kampala (Kampala, Wakiso and Mukono districts) that accounts for over 32% of manufacturing activities. This concentration of manufacturing plants emits pollutants into the atmosphere and reduce air quality. Industrial operations, including cement production, steel manufacturing, and brick-baking kilns, are sources of air pollutants such as sulfur dioxide (SO_2), volatile organic compounds (VOCs), and particulate emissions. Many industries lack efficient emission control technologies and operate without waste filters thereby releasing of large amounts of pollutants into the atmosphere.

iv) Poor waste management

Poor waste management practices, including open dumping, burning of waste, and inefficient landfill management, directly contribute to air pollution and emission of greenhouse gases into the atmosphere. Millions of residents in Uganda turn to informal, open-air burning as a way to dispose of household waste, which exposes them to polluted air (Buntaine et al., 2024). Waste and residential combustion is responsible for about 30% of air pollution in greater Kampala.

v) Infrastructure development

Infrastructure development associated with increased construction activities releases dust and other particulate matter into the atmosphere. Construction machinery and equipment also emit pollutants such as carbon monoxide, nitrogen oxides and particulate matter into the atmosphere (**Figure 5**).

Figure 5: ***Air pollution due to road construction. (*****Photo Credit*****: *NEMA (2024).***

vi) Bush-burning

This is a common practice that negatively affects air quality. Farmers often burn grass in the dry season to regenerate pastures, destroy pests and trap animals while hunting them for bush meat. In addition, farmers burn crop residues to clear land before the planting season. These practices release gaseous and particulate matter into the atmosphere, including carbon dioxide (CO_2)

b) State of air quality

Current air quality monitoring initiatives in the country (***Table 1***) involve continuous tracking in selected cities with the aid of low-cost sensors (LCS) and advanced artificial intelligence technologies. These efforts align with the UNEA-6/10 resolution that emphasizes the importance of digital solutions and LCS, particularly in low and middle-income countries (LMICs) and data-deficient regions (United Nations Environment Programme, 2024). Collective efforts by stakeholders including Makerere University AirQo-, NEMA, Kampala Capital City Authority (KCCA), United Nations Environment Programme (UNEP) and US Mission have improved air quality monitoring that involves over 170 networks of LCS in Uganda. The sensors are deployed in conjunction with key stakeholders including education institutions, regulated facilities, local city authorities and community-based organizations. This comprehensive approach supports robust data collection and fosters a participatory network design, engaging local communities in monitoring efforts and facilitating targeted interventions to combat air pollution effectively.

Table 1: ***Cities and Municipalities with air quality monitoring sites 2024.***

Region	Cities and municipalities with air quality monitoring sites	Number of Sites
Central Region	Kampala, Kira, Masaka, Makindye Ssabagabo, Entebbe, Mubende, Mukono, Luwero, Mityana.	107
Northern Region	Gulu, Lira.	11
Eastern Region	Jinja, Soroti (Two pilot deployments).	25
Western Region	Mbarara, Kabale, Fort Portal.	28

The average concentrations of particulate matter in Uganda are just like many African Cities, above the World Health Organization (WHO) PM recommended levels. WHO recommends that the annual mean concentration of particulate matter, $PM_{2.5}$, and PM_{10} should not exceed 35µg/m^3 and 70 µg/m^3 respectively as interm first target. The second, third and fourth interim targets for $PM_{2.5}$, are 25, 15 and 10. The final target is 5 µg/m^3 For the case of annual average PM_{10} the, WHO interim recommended targets 1,2,3 and 4 are 70µg/m^3, 50µg/m^3, 30µg/m^3 and 20µg/m^3. The ultimate target is 15µg/m^3,TAs of present, no country in the World has met the ultimate targets for WHO. All countries are still in the interim targets 1 to 4.

For the case of Uganda, according to AQI estimates, the average annual $PM_{2.5}$ .based on the average air quality level across Uganda is 13µg/m³, which is considered safe for every citizen (AQI, 2025). However, certain areas may subject to local conditions experience higher particulate matter concentrations.

The current PM_{10} level based on the average air quality level across Uganda is 32 µg/m³, which is considered safe for every citizen. Specific locations may have higher concentrations based on local conditions.

NEMA is working with KCCA and Makerere University Airqo to establish a network of sensors in various to get more accurate records for the whole country. The current network does not cover the whole country as indicated in **Table 1** above.

c) Impacts of air pollution

The impacts of air pollution on the environment, human health and social wellbeing are elaborated below.

(i) Human health is adversely affected by air pollution as it causes respiratory diseases such as asthma, bronchitis, and lung cancer. Exposure to fine particulate matter ($PM_{2.5}$) and indoor air pollution is estimated to cause over 13,000 premature deaths annually in Uganda. Vulnerable populations, including children, the elderly, and those with pre-existing health conditions, face heightened risks, leading to increased morbidity and mortality rates. The burden of these illnesses puts immense strain on the healthcare system and families, often leading to emotional and financial distress.

(ii) Air pollutants adversely impact biodiversity, reduce agricultural productivity, and accelerate soil degradation. Pollutants bio-accumulate in crops and contaminate water bodies, affecting plant growth and the quality of aquatic ecosystems.

(iii) Greenhouse gases such as Carbon dioxide and methane accumulate in the atmosphere and cause global warming and climate change. This exacerbates existing climate-related effects that lead to frequent and severe weather events such as droughts and floods that negatively affect agriculture and livelihoods.

(iv) Air quality degradation leads to economic burdens, including increased healthcare expenditures and loss of labor productivity due to illness. Poor air quality can also affect tourism as visitors seek destinations with clean environments. These economic ramifications highlight the need for policies and interventions to improve air quality and protect human health, the environment and the economy.

d) Responses

i) Government of Uganda has implemented interventions to reduce air pollution guided by international frameworks and national commitments. For instance, the UNEA-6/10 Resolution promotes regional cooperation to tackle air pollution, while Uganda aligns its priorities with the Sustainable Development Goals (SDGs), 3, 7, 11, and 13, as outlined in Vision 2040. The United Nations World Health Organization (WHO) has established air quality guidelines that Uganda strives to meet. Furthermore, as a party to the United Nations Framework Convention on Climate Change (UNFCCC), Uganda has submitted its Nationally Determined Contributions (NDC) in which it commits to enhance institutional capacity to combat air pollution during the NDC implementation process. National Development Plan (NDP) III prioritized measures to curb air pollution. The National Environment (Air Quality Standards) Regulations 2024 are now fully operational, and the East Africa Community (EAC) has adopted EURO 4/IV vehicle emissions standards aimed at reducing air pollution. The National Energy Policy 2023 aims to expand electricity transmission and distribution networks, promote alternative energy sources, and strengthen the legal and institutional frameworks for the energy sector. Transport sector interventions, including progressive policies for Non-Motorized Transport (NMT) and the National Road Safety Action Plan 2021/22-2025/26 further support efforts to ensure air quality. Initiatives within the transport sector, such as the inaugural Car Free Day and vehicle inspection facilities, are aimed at improving air quality. Gradual improvements in road infrastructure, including NMT, and energy pricing initiatives are additional efforts for promoting cleaner energy access by households in the country.

Figure 6: Electric buses and motorcycles aimed at reducing air pollution

ii) Air quality monitoring and assessment

Efforts to monitor air quality have led to the establishment of over 150 low-cost monitoring stations by AirQo in the urban areas, including high-resolution systems that have been deployed in Kampala, Jinja, Fort Portal, Kira, and Kabale.

iii) Education and awareness

Institutionalized air quality awareness campaigns take place annually during the first week of May. This demonstrates effective collaboration between government, development partners, academia, and the public in the efforts to achieve air quality in the country.

3.1.2 CLIMATE

Climate is the average weather conditions of a place over an extended period of time normally taken for a period not less than thirty years (30 years). Climate is driven by an interplay of many systems that result in temporal and spatial natural variability. It is subject to natural or anthropogenic external forces (Salinger et al., 2005). Climate variability and climate Change over Uganda have major impacts on the environment.

Weather and climate are influenced by the physical properties of the source regions and the surrounding area. These source regions can be several hundreds to thousands of kilometers away covering large sections of the continents and they occur on a timescale of days, weeks, months, season, or centuries. The occurrence of natural variability in one location affects a distant place through the transportation of moist air mass. The moisture sources for weather and climate over Uganda are: the humid boundary layer of the Congo air mass, local influence from Lake Victoria, and the global oceans (Atlantic, Indian, and Pacific).

a) Pressures

i) **Deforestation** is one of the most pressing environmental challenges that result from overexploitation or destruction of forest resources to create room for agriculture, produce timber, poles, and fuel wood. As human population grows and the demand for land and forest products increases, vast tracts of forest cover are cleared to make way for agricultural expansion and urban development. Deforestation reduces the biodiversity that forests harbour and diminishes the capacity of forest ecosystems to sequester carbon dioxide thereby exacerbating climate change.

ii) **Land degradation** is primarily driven by unsustainable agricultural practices, such as subsistence farming, mono-cropping, and the excessive use of agrochemicals including fertilizers and pesticides. These unsustainable practices cause soil erosion, nutrient depletion, and a decline in soil fertility thus reducing agricultural productivity. Loss of arable land threatens food security and reduces the variety of crops that can be cultivated.

iii) **Pollution** of the environment is mainly caused by industrial activities, coupled with inadequate waste management systems. Industrial discharges contaminate water bodies, and adversely affect aquatic ecosystems and the health of communities that depend on them. Air pollution, driven by emissions from factories and vehicles is harmful to human and

animal health and causes respiratory diseases and other health complications. A polluted environment undermines human well-being, particularly for vulnerable populations who have limited access to clean air and safe drinking water.

iv) **Climate variability and climate change** exert additional pressures on Uganda's environment. Changes in temperature and precipitation patterns disrupt traditional weather cycles and kindle extreme weather events such as prolonged dry spells, droughts and floods. These changes hamper agricultural production due to unpredictable rainfall and temperature. Increased frequency and severity of weather events place immense strain on water resources, infrastructure, and livelihoods of communities.

b) State of climate over Uganda

i) Key highlights

The warmest climate in Uganda was recorded in 2023 since 1950 followed by; 2019, 2009, 2021, and 2020 respectively. The warm condition in 2023 was due to rise in temperature of about 0.52°C above the long-term mean for the base period of 1981 – 2010. Observed extreme weather and climate events in 2023 led to flooding that affected thousands of people across the country. The rate of temperature increases during the period 1950-2023 was about 0.44 °C per decade. In the last thirty-four years (1990-2023) temperature increased at a rate of ~0.46°C per decade.

There has been statistically significant increase in annual rainfall in the eastern sector of the country while there has been near normal to insignificant decrease in rainfall over the western sector for period 1981-2023. Eight people were reported to have died due to floods and landslides/mudslides in Buhirira and Murora sub-counties in Kasese and Kisoro districts and nearly 3000 persons were displaced in 2023.

ii) Regional temperature status

Temperature anomalies of varying warming levels were experienced over seven sub-regions in the country (**Figure 7**) namely West Nile, Northern, Karamoja, Eastern, Central, Western, and Southwestern regions.

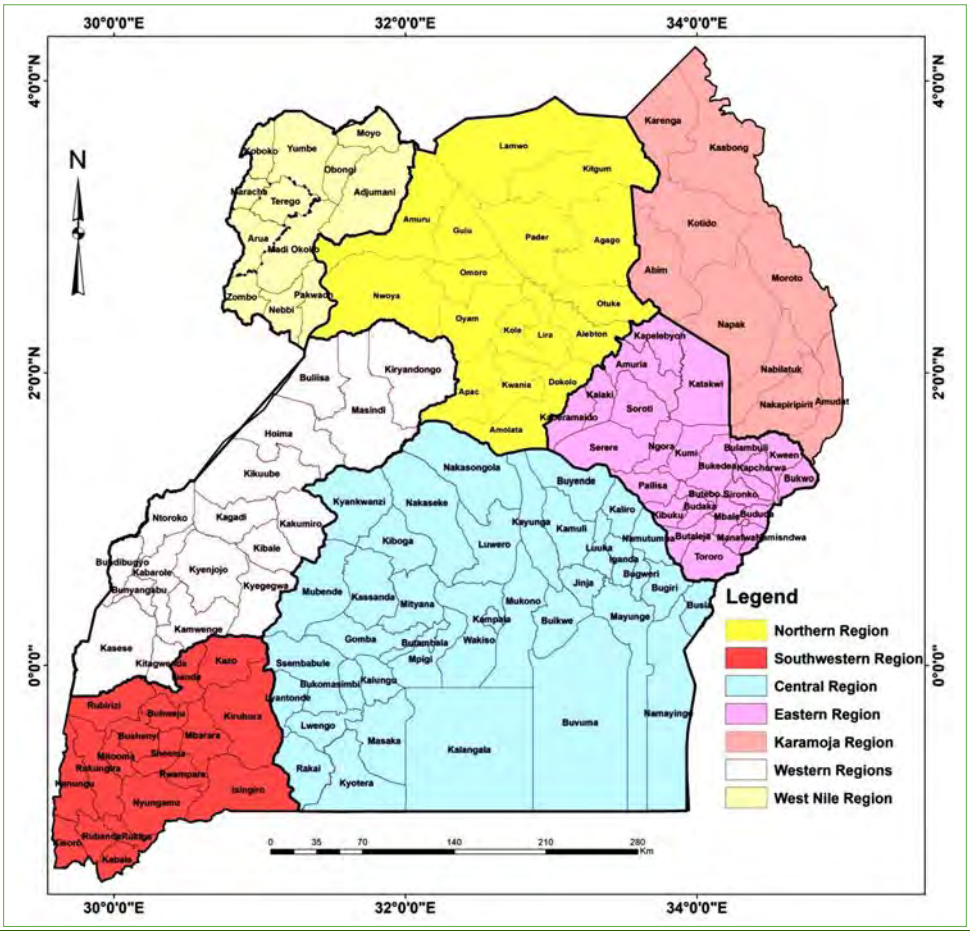


Figure 7: ***The sub-regions considered in the 2023 state of climate report.***

West Nile Region (2.5-3.8°N and 30.7- 32.0°E) experienced temperature increases of 0.68°C and 0.40°C per decade over the period 1950 to 2023 and 1990 to 2023 respectively (**Figure 8**). The ranking showed that 2023 was the second warmest year after 2019 in the region.

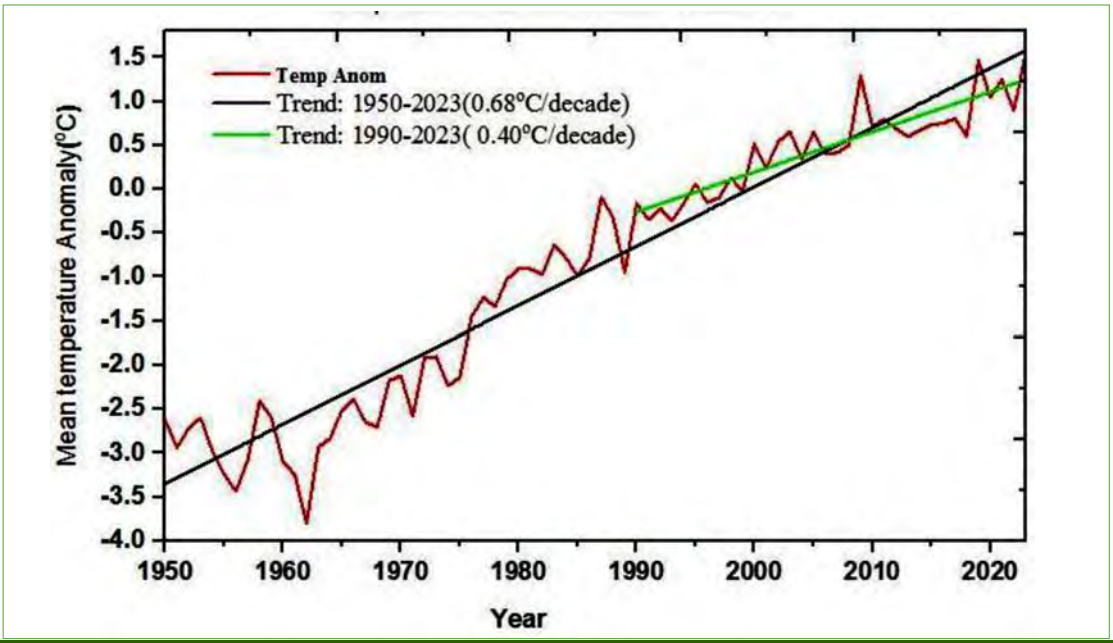


Figure 8*: Trends in the mean annual temperature anomalies (°C) over the West Nile Region for the period 1950-2023 for the 1981-2010 reference period. The red line represents temperature anomalies.*

Northern region (2.3ºN-3.8ºN and 32.3°E-33.5ºE) includes Gulu, Kitgum, Pader, Nwoya, Lamwo, Agago, Lira, Kole, Kwania, Nwoya, Oyam, Apac, and Dokolo districts. Temperature increased at a rate of 0.54 ºC and 0.46ºC per decade over the period 1950 to 2023 and 1990 to 2023 respectively (**Figure 9**). Ranking showed that 2023 was the warmest year in the region followed by 2019, 2021, 2009, 2020.

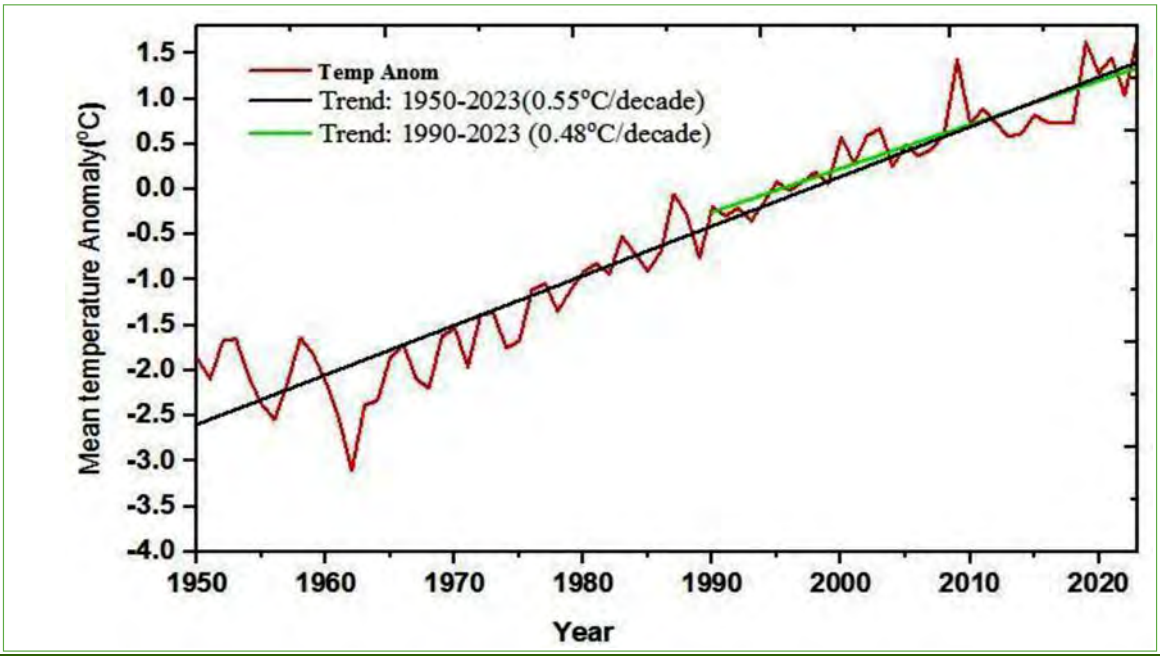


Figure 9*: Trends in the mean annual temperature anomalies over Northern region for the period: 1950-2023 with respect to 1981-2010 reference period. The red line represents temperature anomalies.*

Karamoja Region (2.5-4.2°N and 33.5-35°E) includes Karenga, Kaabong, Kotido, Moroto, Napak, Abim, Nakapiripirit, and Amudat districts. The temperature increased at a rate of 0.37°C and 0.36°C per decade over the period 1950 to 2023 and 1990 to 2023 respectively (**Figure 10**). Records show that 2023 was the second warmest year after 2009.

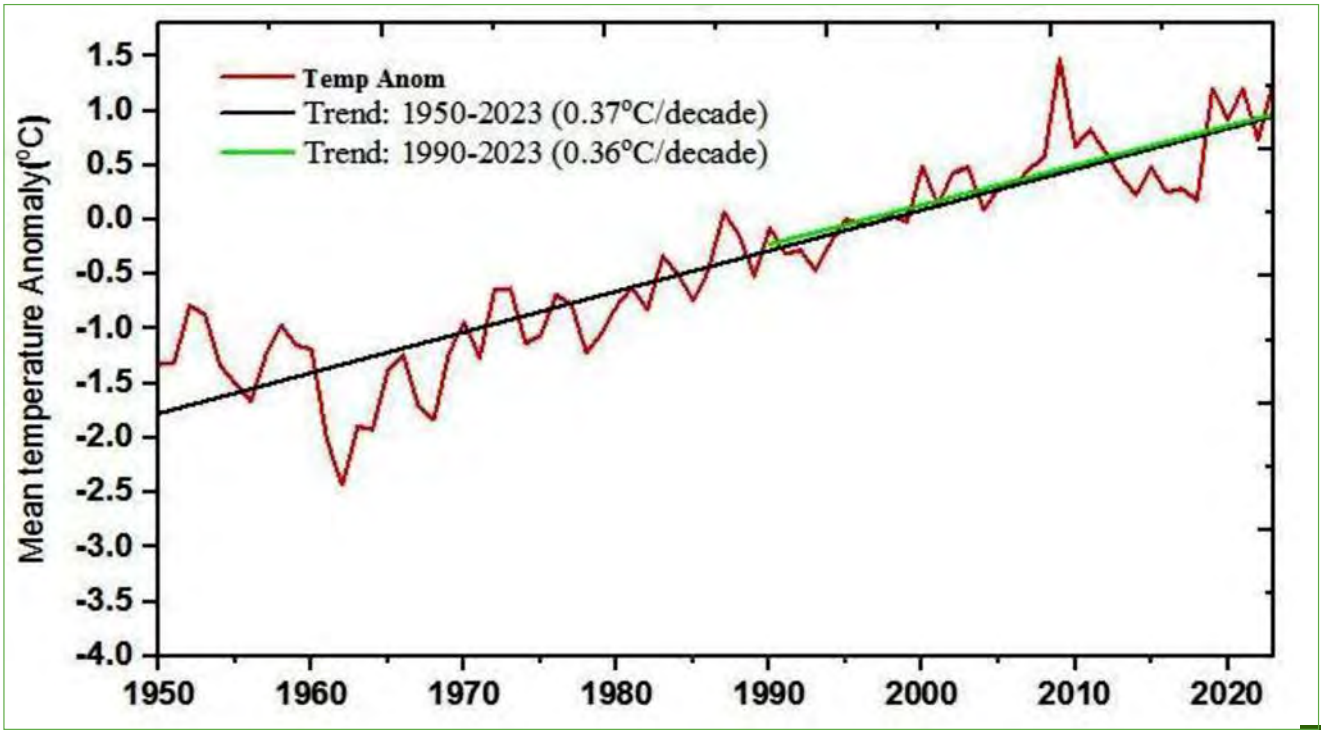


Figure 10: ***Trends in the mean annual temperature anomalies over Karamoja region for the period: 1950-2023 with respect to 1981-2010 reference period. The red line represents temperature anomalies***

Eastern Uganda (0.25-1.5°N and 32.5-34.5°E) covers Soroti, Serere, Kumi, Pallisa, Kalaki, Katakwi, Tororo, Sironko, Budaka, Bududa Kween, Bukwo, and Ngora districts. It is one of the most disaster-prone regions in Uganda with a number of incidences of landslides, floods and droughts recorded over the decade. Temperature has increased at a rate of 0.21°C and 0.46°C per decade over the period 1950 to 2023 and 1990 to 2023 respectively (**Figure 11**). Records show that 2023 was the warmest year followed by 2009, 2019, 2021, 2020 and 2011 respectively.

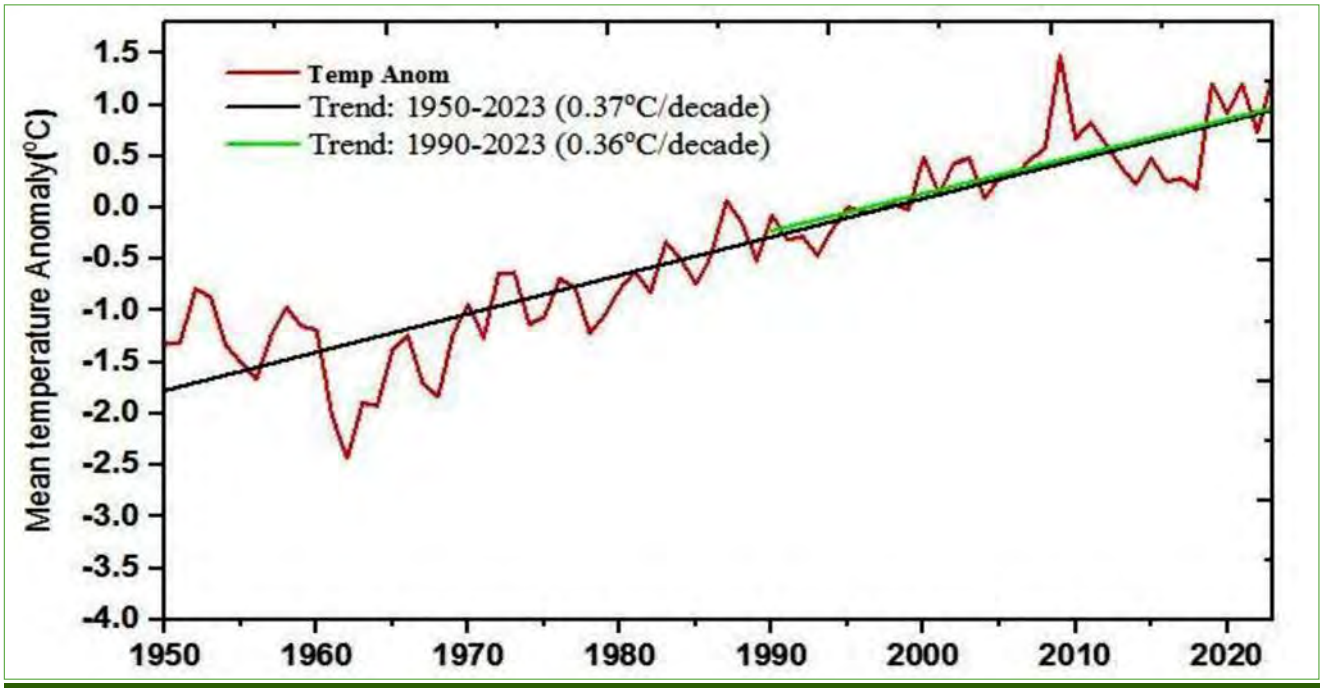


Figure 11: ***Trends in the mean annual temperature anomalies (°C) over Eastern region for the period: 1950-2023 with respect to 1981-2010 reference period. The red line represents temperature anomalies.***

Central Uganda (0-1°N and 31.0-33.0°E) covers Kampala, Mukono, Jinja, Gomba, Kaliro, Mayuge, and parts of Nakasongola and Nakaseke districts in the cattle corridor. Temperature has increased at a rate of

0.41°C and 0.55°C per decade over the period 1950 to 2023 and 1990 to 2023 respectively (**Figure 12**). The three warmest years over this region since 1950 were 2009, 2019, and 2021 respectively. Records indicate that 2023 was the warmest year followed by 2019, 2021, 2009, 2016 and 2020 respectively.

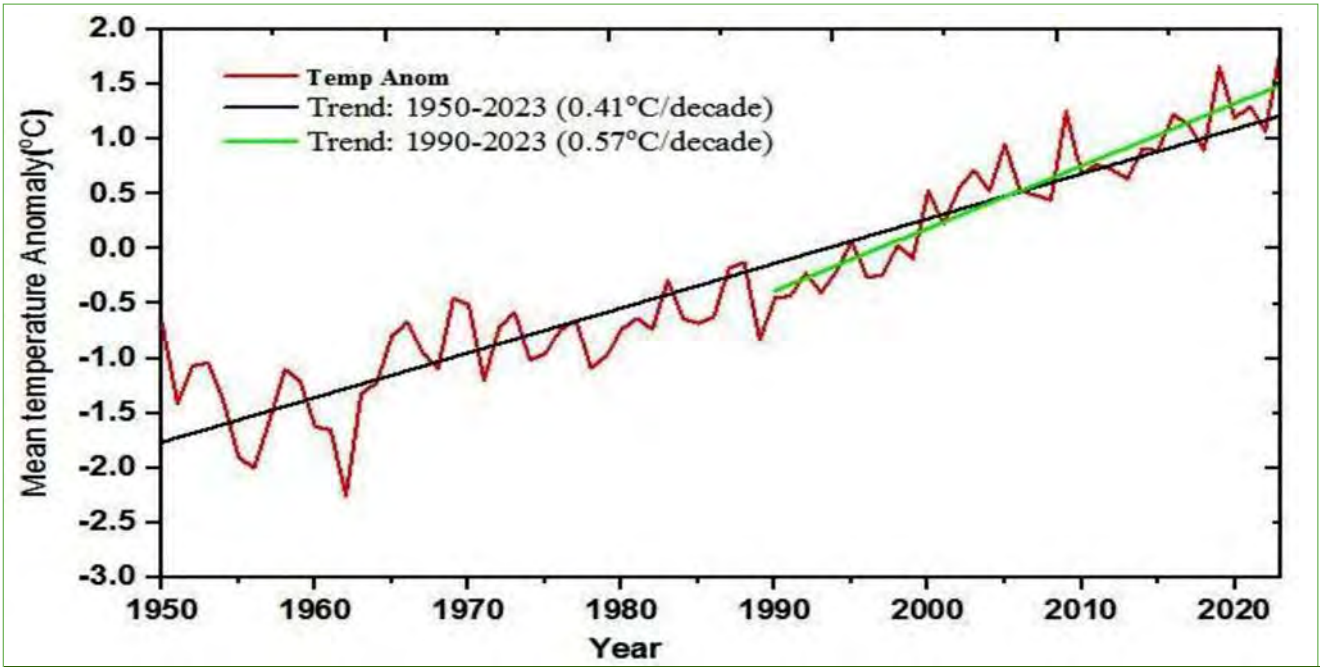


Figure 12*: Trends in the mean annual temperature anomalies over Central Uganda for the period: 1950-2023 with respect to 1981-2010 reference period. The red line represents temperature anomalies.*

Western Region (0oN-2oN and 29.8-31.0oE) stretches from Lake Albert to Rwenzori Mountains covering most of the oil rich districts of Bulisa, Hoima, Kikuube, Kakumiro, Ntoroko, Kyenjojo, Kyegegwa, Kabarole, Kasese, and Kamwenge. The average temperature anomaly was about 0.61°C warmer than the long-term mean value. Temperature increased at a rate of 0.60°C and 0.60°C per decade over the period 1950 to 2023 and 1990 to 2023 respectively (**Figure 13**). Over the last decade, the region experienced some of the most devastating floods caused by the overflow on River Nyamwamba triggered by heavy rainfall. Records indicate that 2023 was the second warmest year after 2019 followed by 2021, 2009, and 2020 respectively.

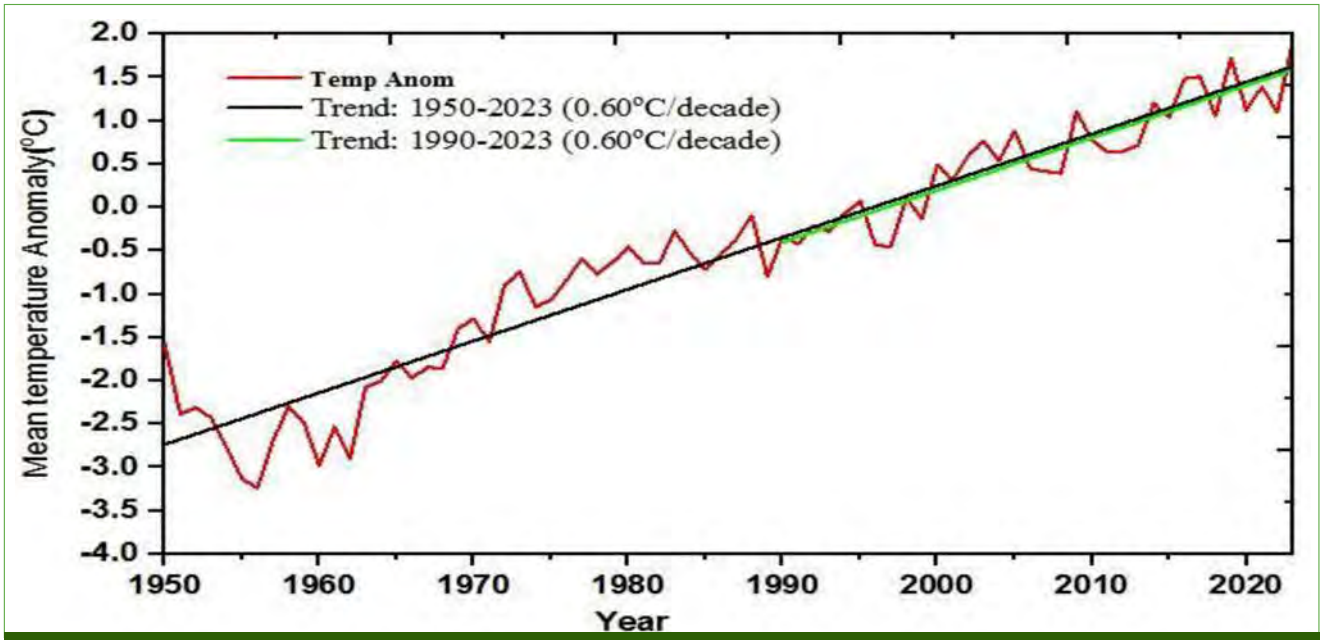


Figure 13: ***Trends in the mean annual temperature anomalies (°C) over western region for the period: 1950-2023 with respect to 1981-2010 reference period. The red line represents temperature anomalies.***

South Western Region (1°S-0°N and 29.7-31.5°E) has heterogeneous terrain and it is prone to natural disasters such as landslides. The region includes Kisoro, Kabale, Ntungamo, Rukungiri, Mitooma Bushenyi, Rubirizi, Rubanda, and Rukiga districts. Over this region the average temperature anomaly was about 0.59°C which was warmer than the long-term mean value. Temperature increased at a rate of 0.55°C and 0.56°C per decade over the period 1950 to 2023 and 1990 respectively (**Figure 14**). Records show that 2023 was the warmest year followed by 2019, 2017, 2016, and 2021 respectively.

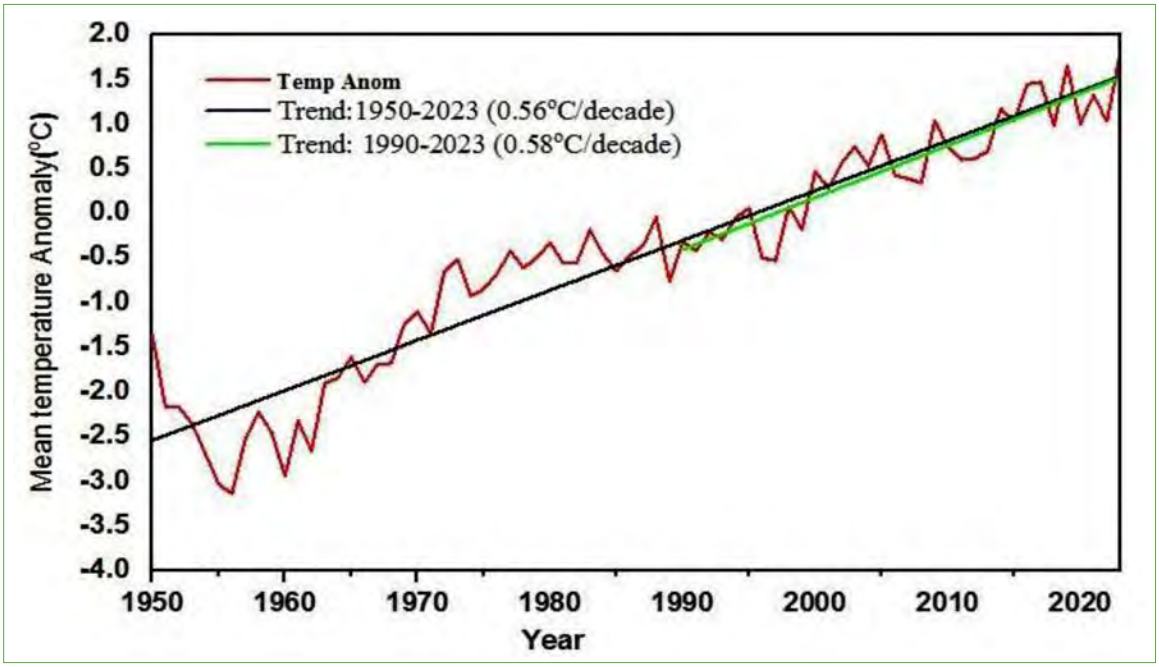


Figure 14: ***Trends in the mean annual temperature anomalies (°C) over Southwestern region for the period: 1950-2023 with respect to 1981-2010 reference period. The red line represents temperature anomalies.***

iii) National rainfall assessment

The annual rainfall shows that 2023 was one of the wettest years (**Figure 15**). The highest rainfall total of 2650.1 mm was recorded in the Lake Victoria crescent and Mount Elgon sub region, while the Karamoja sub-region received lowest amount of rainfall of 506.6 mm. Patches of central region around Nakasongola district, southern region covering Mbarara, Kyotera and Ssembabule districts and parts of the Albertine sub-region received between 850.6.0 to 1250.1 mm of rainfall.

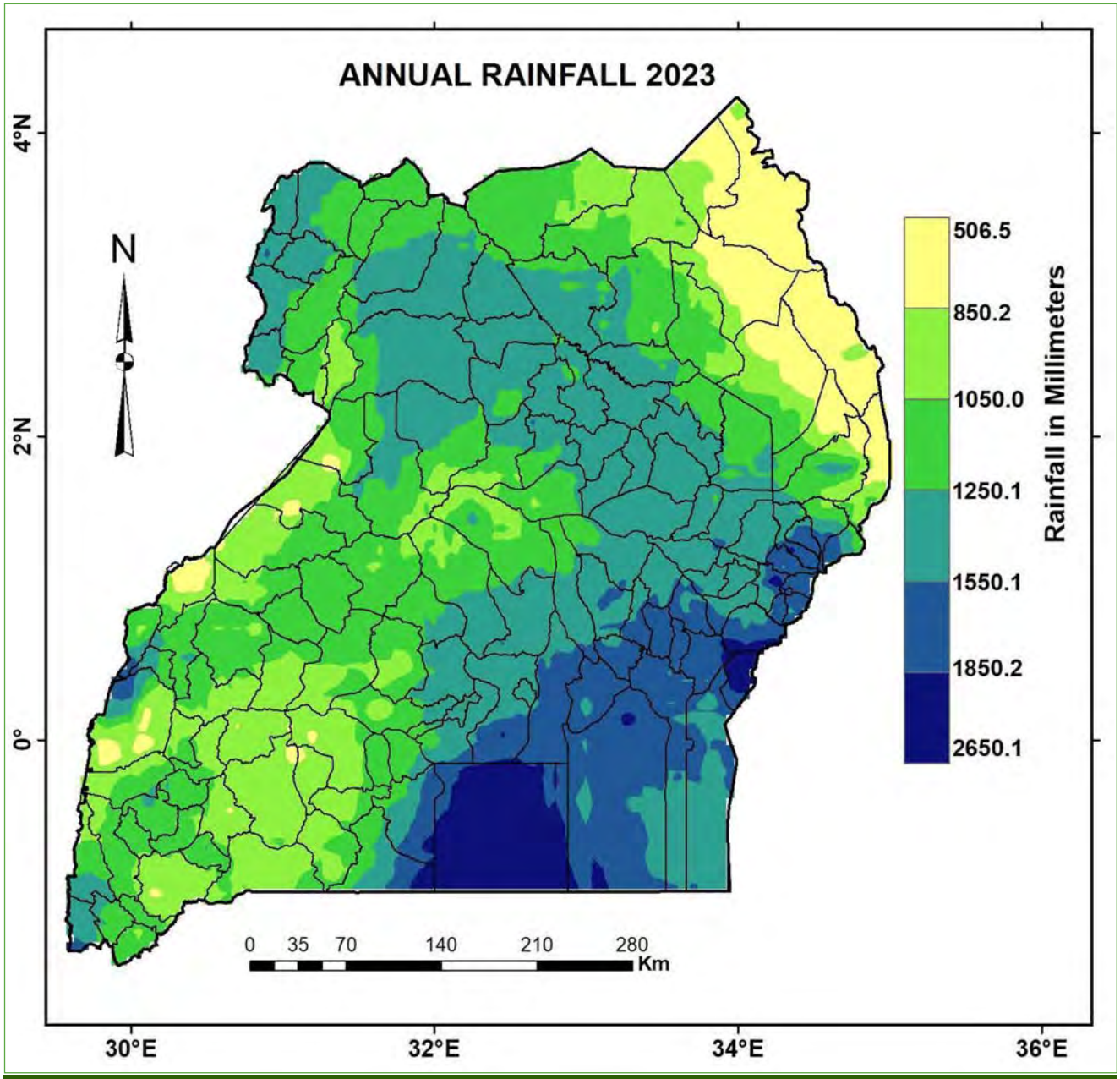


Figure 15*: Annual precipitation (mm) over Uganda in 2023.*

Seasonal rainfall performance in 2023

March – April - May (MAM) 2023 Rainfall Season: During this season, Lake Victoria sub-region and eastern region received the highest rainfall ranging from 521.7 to 965.0 mm. Most of the remaining areas including central, northern, West Nile, western region and parts of southwestern Uganda received between 294.4 and 434.6 mm of rainfall. The lowest rainfall amount of 180.0 to 346.3 mm was recorded in most parts of Karamoja sub-region, patches of southwestern and the Albertine sub-region (**Figure 16**).

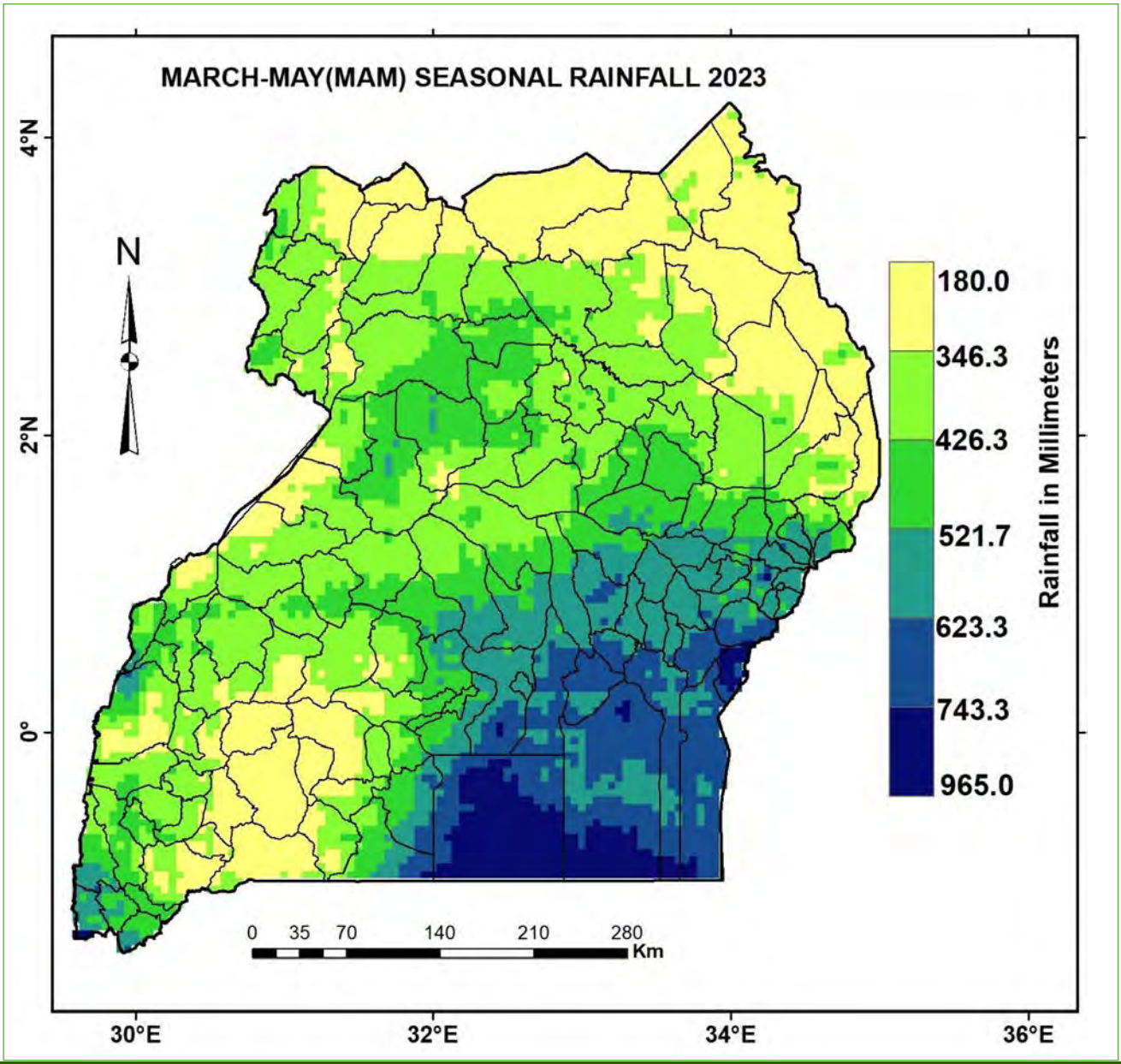


Figure 16: ***Performance of March – April -May (MAM) seasonal rainfall (mm) over Uganda in 2023.***

June-July-August (JJA) 2023 Rainfall Season: **Figure 17** shows the performance of the second rainfall season of the year (JJA). The highest rainfall amount of 350.1 to 550.1mm was recorded over a narrow stretch from the lower Mt Elgon region covering Bududa, Butaleja and Mbale districts to the upper Mt Elgon region covering Sironko, Kween and Kapchorwa districts and the adjacent Katakwi, Kapelebyong, Otuke, Agago and Kitgum districts in the northern region. The same amounts of rainfall also experienced in the areas covering Teso and mid-northern sub-region that covers Amuru, Adjumani and Moyo districts. The lower West Nile region, western and southwestern Uganda as well as Lake Victoria Basin received the lowest rainfall amount of 140.0 to 350.1 mm. This amount is consistent with the climatology of rainfall reported during this season.

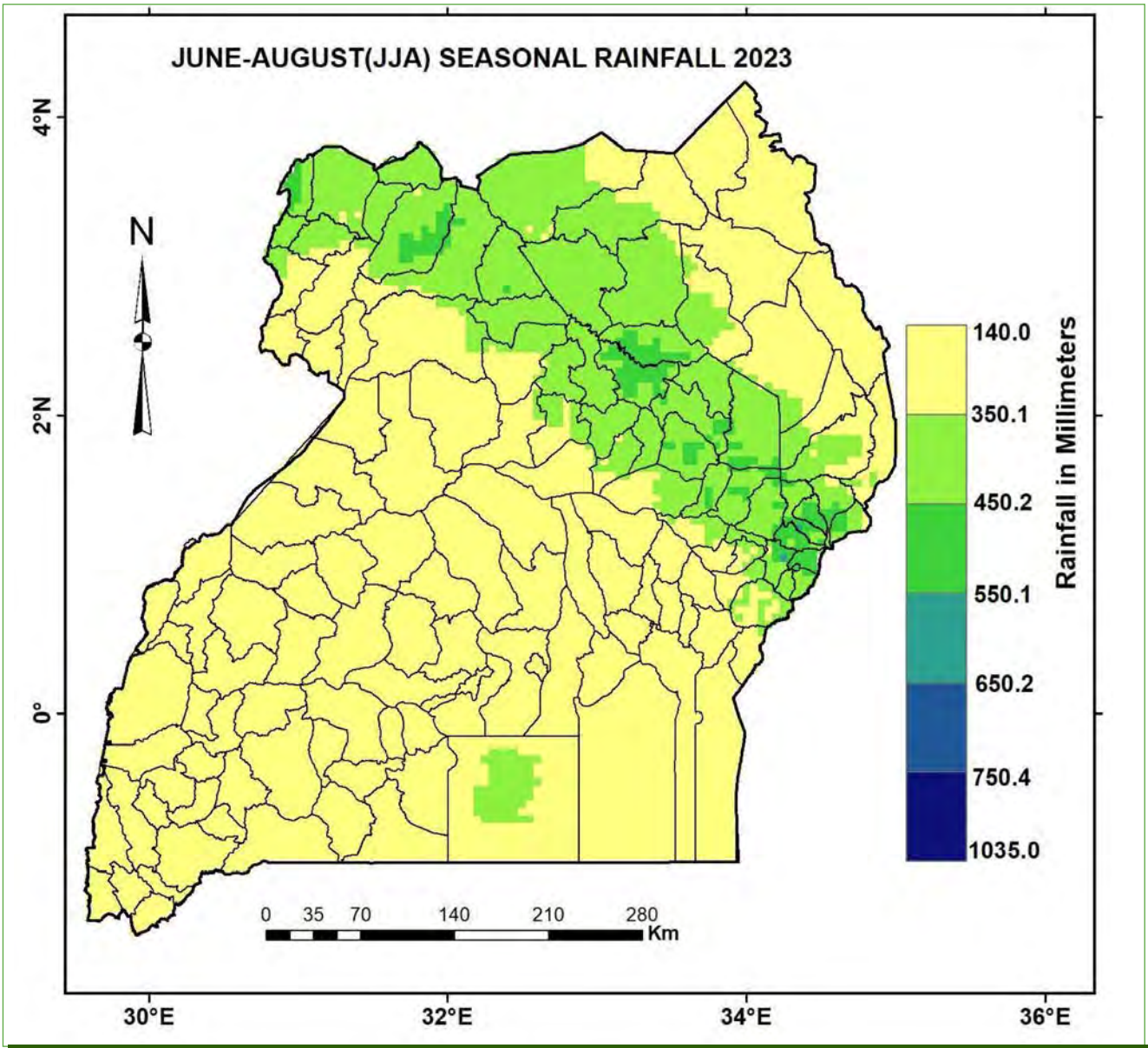


Figure 17: ***Performance of June-August (JJA) seasonal rainfall (mm) over Uganda during the year 2023.***

September-October-November-December season (SOND) 2023: **Figure 18** shows an enhanced rainfall performance during the September-October-November-December season. A bigger part of the western sector, Lake Victoria basin, and top of Mount Elgon received between 550 and 1035 mm. Most parts of the country; including central, Mid-Northern, Mid-Western regions and parts of West Nile received between 350.1 and 550.1 mm of rain. Karamoja and Southern region received the lowest rainfall amount of 140.0. to 350.1 mm. The persistent dry conditions in the Karamoja, and Southern regions during September –October-November and December (SOND) season adversely affected crop and livestock production resulting into severe food insecurity, as well as livestock and human death (Nkuba *et al.*, 2019).

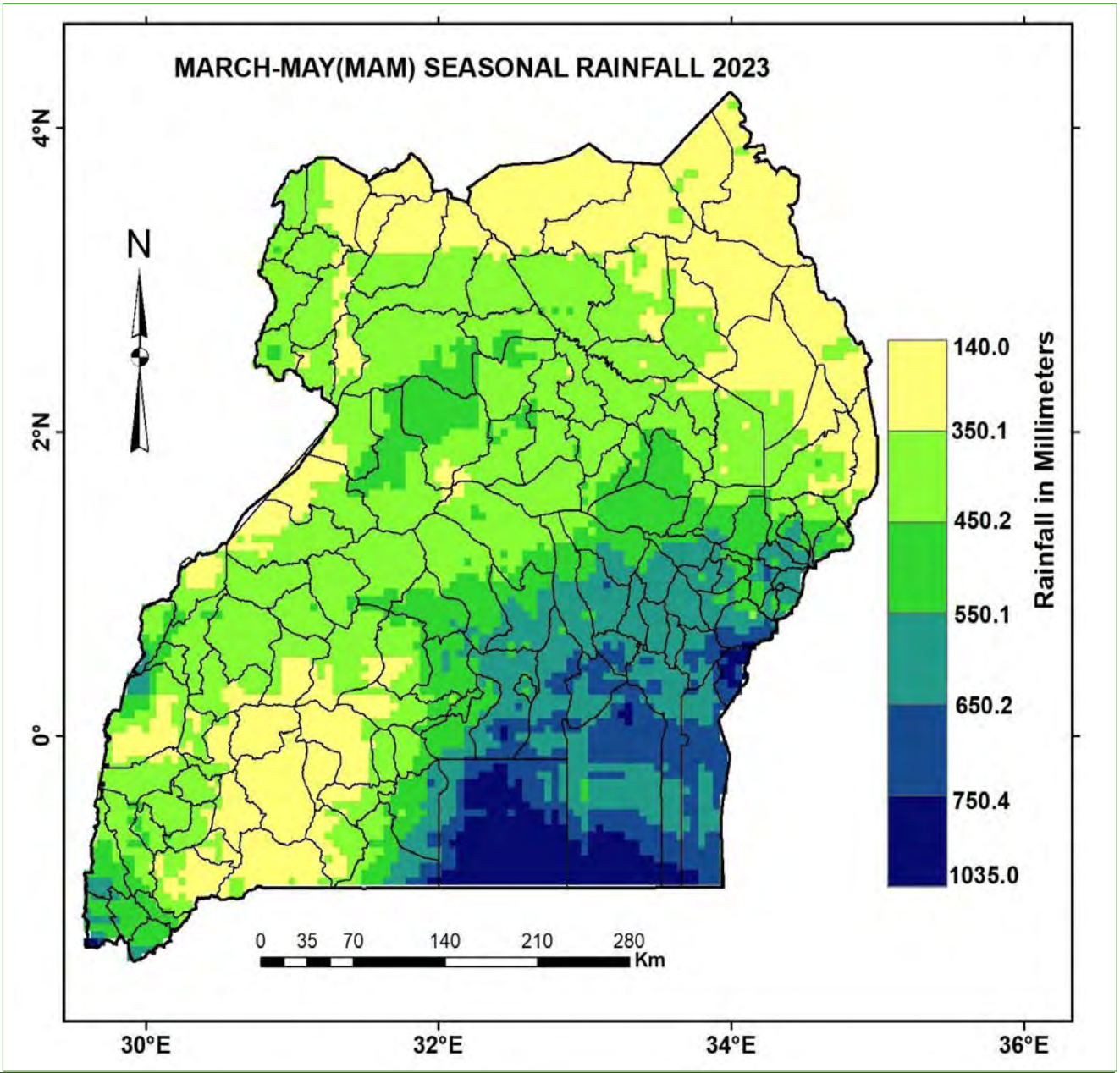


Figure 18: ***Performance of September-October-November-December (SOND) seasonal rainfall (mm) in 2023.***

c) Impacts

i) In 2023, a number of districts including Nwoya, Gulu, Oyam, Apac, Kiryandongo, Masindi, Hoima, Fort Portal, Ntoroko, Kasese, Mbarara, Pakwach, Arua, Zombo and Obongi experienced unpredictable rains and hailstorms (**Figure 19**), long dry spells, droughts, water scarcity and low crop production. The environment extremities continue to cause disasters such as mudslides in Bulambuli district and floods in Kasese district **(Figure 20**).

Figure 19: ***Hailstones destroyed Maize crops in Nwoya district during the second SOND, (Photo credit: District Entomologist, Nwoya, 2023).***

Flooding along river Namatale on Tirinyi-Mbale road.

Flooding in lower Bulambuli district.

Figure 20: ***Flooding in Eastern Uganda in 2024 (source NEMA)***

d) Responses

i) Implementation of the National Framework for Climate Services (NFCS)

Uganda National Meteorological Authority (UNMA) is in the process of developing a National Framework for Climate Services (NFCS). This is an institutional mechanism for coordinating, facilitating, and strengthening collaboration among national institutions. The aim of NFCS is to improve co-production, tailor delivery and use of science-based climate predictions and services from national to sub-national level. It focuses on the five pillars of the Global Framework of Climate Services (GFCS) namely, reducing the vulnerability of society to climate-related hazards through provision of climate information and services; advancing the key national development goals through provision of climate information

and services; mainstreaming the use of climate information and services in decision-making; strengthening the engagement of providers and users of climate services; maximizing the utility of existing climate service infrastructure. NFCS ensures representative atmospheric observations and research. In addition, it guides countries to prepare, maintain and communicate their Nationally Determined Contributions (NDCs). Furthermore, it complements National Adaptation Plans (NAPs) by assessing climate vulnerabilities, identifying adaptation options, and enhancing planning and implementation capacity in climate-sensitive sectors.

ii) Early Warning Information (EWI) Generation and Sharing Framework

The Early Warning Information (EWI) was first generated at regional level and thereafter cascaded to national level in conjunction with national level experts who participated in the co-production processes. Thereafter, the information is communicated through different channels to the end users. The national products are again downscaled to a sub-national level with inputs from sub national experts for coproduction processes and thereafter the information is communicated through different channels to the target audiences (**Figure 21**).

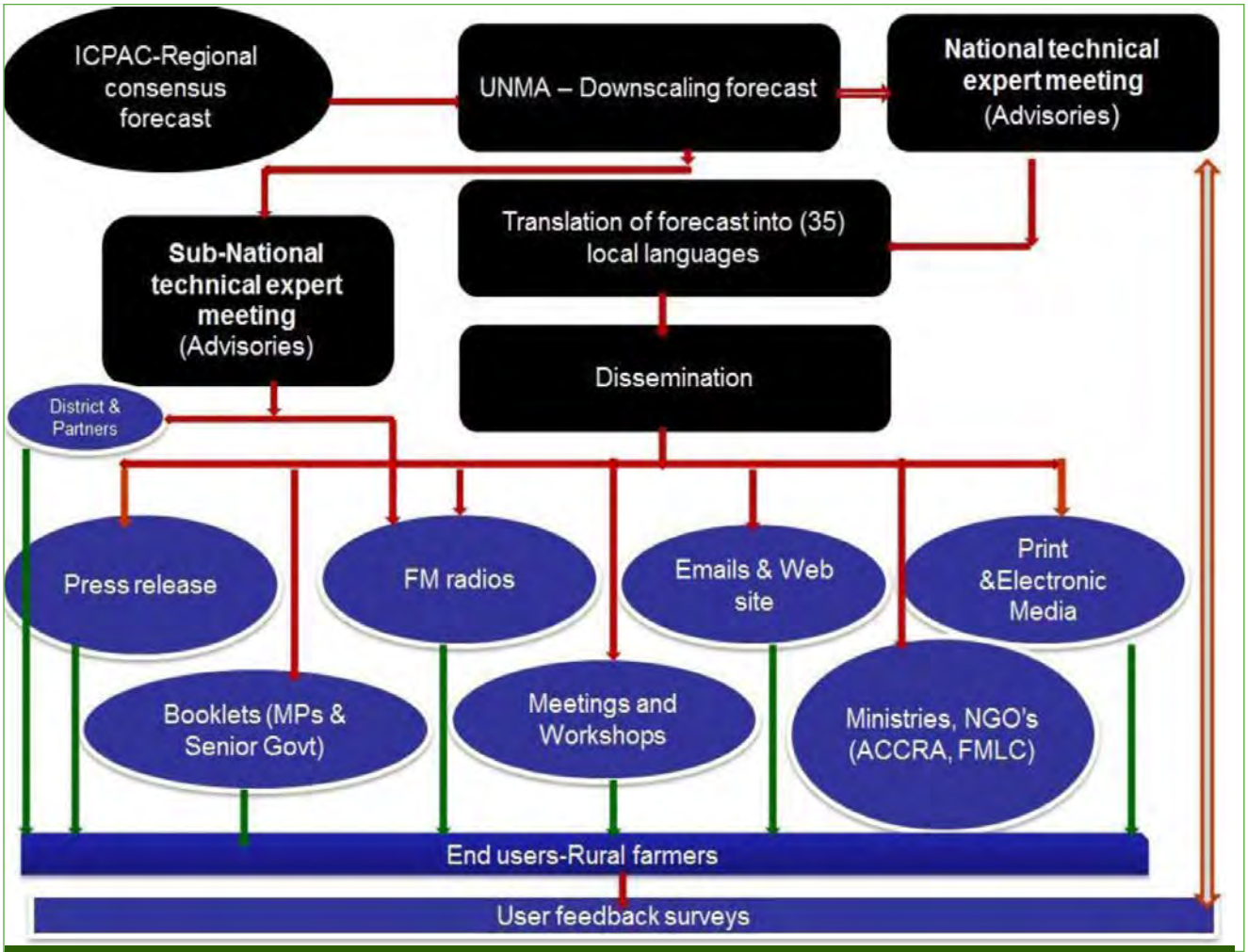


Figure 21*: Early Warning Information (EWI) Generation and Sharing Framework for Uganda.*

iii) Early Warning Information Sharing Framework at Sub-national level

To reach the target audiences within the stipulated time frame, UNMA in collaboration with the district local governments developed an information sharing framework (**Figure 22**).

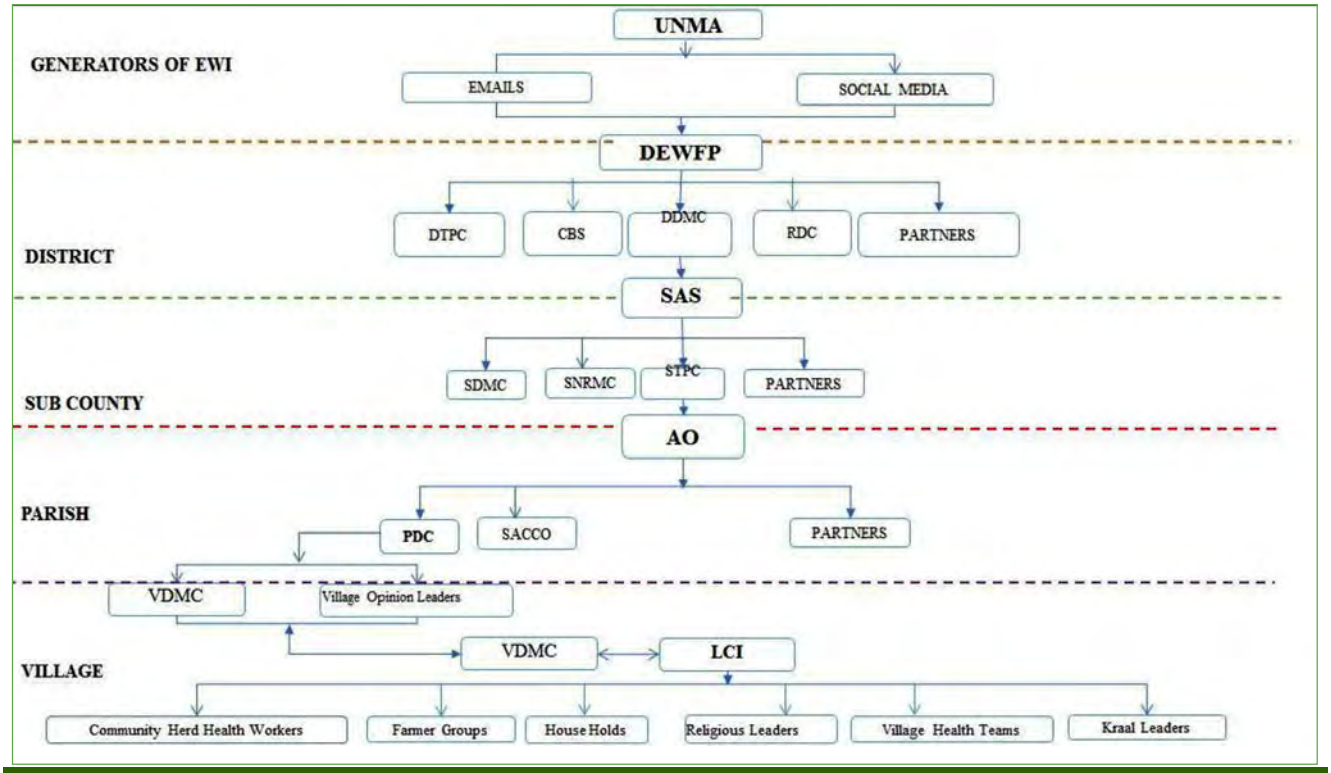


Figure 22*: Early Warning Information Sharing Framework.*

Agricultural Officers (AO), Community Based Services (CBS), District Disaster Management Committee (DDMC), Sub County Disaster Management Committee SDMC), Sub County Natural Resources Management Committee (SNRMC), District Early Warning Focal Point Person(DEWFP), District Technical Planning Committee (DTPC), Sub County Technical Person Committee(STPC) and Village Disaster Management Committee (VDMC).

iv) Building capacity of extension staff and farmers on interpretation and use of weather information for decision making

Uganda National Meteorological Authority (UNMA) engages various stakeholders on matters related to weather and climate through knowledge sharing and training of local communities at different levels as specified in the framework.

v) Promoting dissemination of weather and climate information using Apps

UNMA in partnership with Makerere University has developed an app to promote the dissemination and farmers use of weather and climate information in rural areas. This system is known as Weather Information Dissemination System (WIDS) and the weather information can be accessed by dialing *201# on the mobile phone.

vi) International Commitments

Uganda is committed to various international and multilateral environmental agreements, including the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement that align with SDG 7 and SDG 13. For instance, SDG 7 aims to ensure access to affordable, reliable, sustainable, and modern energy for all while SDG 13, calls for urgent action to combat climate change and its impacts.

3.1.3 NOISE

Noise pollution is a growing environmental concern globally and it is a menace in Uganda. It is characterized by generation of unwanted or disturbing sound that can adversely affect human health, wildlife, and the broader environment. Noise pollution emanates from various sources, including industrial activities, transportation, entertainment, and natural events. It can be harmful due to it's intensity, frequency, and duration. Understanding the dynamics of noise pollution

and it's impacts is crucial for implementation of responses aimed at mitigating the effects and promoting a healthier environment.

The primary drivers of noise pollution in Uganda are rapid urbanization, industrialization, population growth and the fast-growing entertainment sector that includes music and performing arts. As urban centers expand, the number of vehicles increases, leading to higher levels of traffic noise. At the same time, the rise in construction activities using heavy and noisy machinery, industrial processes and entertainment sector in cities and towns compounds noise pollution. Cultural and social gatherings, such as traditional ceremonies and festivals, also contribute to elevated and uncomfortable noise levels, especially in the densely populated areas that irritate residents. These activities and generation of the associated noises are partly driven by economic development, social interactions, and cultural practices in the country.

a) Pressures

Uganda faces several noise pollutions pressures as a result of the aforementioned activities. Noise pollution is mitigated by the National Environment (Noise Control and Standards) Regulations 2003. However, noise continues to be generated by:

i. Increase in the number of vehicles, particularly in urban centers that generate a lot of noise. Public transportation, including buses and motorcycles are also major sources of noise.
ii. Use of heavy machinery in construction and demolition and drilling activities particularly in rapidly developing urban areas.
iii. Use of machinery and heavy-duty equipment in manufacturing, mining, and energy production
iv. High sound musical systems used in bars, night clubs, events, religious gatherings and promotional activities.

b) State of noise pollution

The current state of noise pollution in Uganda is characterized by elevated noise levels, particularly in urban areas. The continuous rise in noise levels is evident in cities and towns, where background noise from traffic, construction, industrial activities, and entertainment venues is pervasive. This high level of noise pollution can cause health related problems, particularly in densely populated rural and urban areas where people are constantly exposed to immense noise from high-tech music systems.

c) Impacts of noise pollution

The impacts of noise pollution in Uganda are far-reaching and affect both human health and the environment:

i. Noise-Induced Hearing Loss (NIHL): Noise pollution is a major cause of Noise-Induced Hearing Loss (NIHL) and can lead to high blood pressure, heart disease, sleep disturbances and stress. Children, particularly those living near noisy environments such as airports or busy streets, are especially vulnerable and may experience limited sleep, stress, memory impairments, and learning difficulties.

ii. Disruption of natural behavior of wild animals: Noise pollution adversely affects wildlife by disrupting their natural behaviors of navigation, communication, feeding, grooming and mating. Studies have shown that loud noises can cause physiological stress in insects and reduce reproductive success in birds. Although it is not applicable to Uganda, marine animals, particularly those that rely on echolocation, such as whales and dolphins, are severely impacted by underwater noise pollution from sonar devices and seismic surveys.

iii. Degradation of quality of life: Noise pollution degrades the quality of life in urban and rural areas thereby affecting the tranquility and natural ambiance of the environments. This negative effect can cause biodiversity loss as animals are forced to migrate or adapt to the noisy environment.

d) Responses to noise pollution

Mitigation measures for noise pollution include the following:

i. The National Environment Act Cap 181 assigns the responsibility of noise regulation to local governments while NEMA plays a coordination and supervisory role. Local governments are encouraged to develop and enforce ordinances or bylaws to manage and control noise within their jurisdictions. However, these regulations are not effectively implemented due to weak enforcement and absence of specific regulations in some areas.
ii. Educating the public about the negative impacts of noise pollution and promoting actions to reduce noise. Awareness campaigns can encourage individuals and businesses to adopt quieter technologies and practices.
iii. Incorporating noise mitigation measures into urban planning, such as the use of sound barriers and noise-reducing materials in buildings. This can minimize noise exposure in sensitive places such as hospitals, schools, and residential areas.
iv. Implementing noise-reducing technologies, such as mufflers, silencers, and use of soundproofing material. These can reduce noise levels, particularly in industrial areas and construction sites.
v. Establishing noise-free zones or quiet hours in urban centres, particularly around hospitals, schools, and residential areas.
vi. Continuously monitoring and mapping noise levels in order to inform policy and support mitigation efforts. Research into the impacts of noise pollution informs development of long-term noise management measures.
vii. Engaging communities, businesses, and government agencies in the development and implementation of noise reduction strategies. There is need to introduce economic incentives for adopting noise-reduction measures which can also encourage compliance and innovation.

3.2 WATER RESOURCES

Uganda is endowed with water resources which include lakes, satellite lakes, rivers, streams, wetlands, and groundwater. However, there are variations in spatial and temporal distribution as well as quality of water. Some areas experience water scarcity, for example, Karamoja region and the cattle corridor districts. Exceptions include mountainous regions such as the Rwenzori and Elgon as well as basins of Lake Victoria, Lake Kyoga and Lake Albert that have adequate surface and underground water resources some of which are transboundary.

Uganda's water resources are vital for sustaining life, promoting socio-economic development, and maintaining the environment. Fresh water is a strategic resource in Uganda's economic growth and fundamental in the health sector, industrial processing and tourism and hospitality industry. The attainment of Uganda's Vision 2040 and meeting of targets in NPD IV requires sustainable supply of water for domestic, agricultural, transport and industrial use.

Sufficient water of good quality is essential for production and contributes directly to poverty reduction and socio-economic development, rich biodiversity, ambient environment, and healthy ecosystems. Water resources, however, are under continuous threat from natural and anthropogenic processes including pollution by hotels, industries and processing plants that should be mitigated. This report elaborates the drivers, pressures, impacts, states, and responses to the challenges faced in the water sector.

a) Pressures on water resources

i) Pollution

To meet their socio-economic needs, humans resort to activities (Figure 29) including industrial development, where water is abstracted, and used, and wastewater (solid and liquid effluents) is discharged into the environment and ultimately ends up in water and other terrestrial ecosystems. The 5-top point pollution sources in Uganda include (1) meat and meat products processing (2) textile processing, (3) sugar processing, (4) milk and milk products processing, and (5) municipal wastewater (APPR, 2023). Others are artisanal mining, where toxic metals like Lead and Mercury are released into water resources, oil and gas exploration, production, and poor solid waste management.

Figure 23*: Anthropogenic activities that lead to water pollution: Motorcycle washing at the shores of Lake Victoria in Jinja City (A), Solid waste disposal at Kitezi landfill site in Kampala (B), and Effluent discharge in Mbarara city (C). (***Photo Credit***: NEMA 2024).*

ii) Industrialization and use of agrochemicals

Uganda Investment Authority (UIA) oversees the activities in eight government funded industrial parks and three private industrial parks in the country. Kampala district is the most industrialized and it is the epicenter of economic activities in the cuntry. A multitude of agrochemicals pollute the environment and they include fertilizers, (NPK, Organic manure, Urea, DAP, CAN, TAP, Allwin gold super, Vegimax, Evergreen, and Aminocop), pesticides (Super grow, Dudu cipher, Rocket, Stricker, Tafgor/dimethoate, Ambush, Dudu maki, and Golden drop), and Herbicides/Fungicides (Roundup, weed master, (2-4-D) Diamine, force up and Ametrine.

iii) Urbanization and settlements

The Greater Kampala Metropolitan Area (Kampala City, Mpigi, Wakiso, and Mukono) are the main urban areas. Whereas this urbanization rate is regarded as low (18%), its growth rate of 5.2% per annum is high. Hoima, Mukono and Mbarara city are undergoing rapid urbanization (SSUDU 2016/2021). Report of the 2014 National Housing and Population census revealed that the urbanization rate in the country is 21% and 6.4 million people were urban dwellers. This number is projected to reach 30 million in 2030 (UBOS, 2024).

A combination of socio-economic activities causes discharge of excessive nutrients like nitrogen and phosphorus, toxic heavy metals, pharmaceuticals, endocrine disruptors, emerging contaminants, electronic waste (e-waste) and total suspended solids (TSS) into the environment. These waste materials degrade land and the associated terrestrial ecosystems such as wetlands and water sources. The deterioration of water quality in Lake Kyoga over time has been partly due to activities that caused land use land cover (LULC) change coupled with climate change effects. Agriculture has been reported as the main source of nitrates in the water of Lake Kyoga.

Ministry of Water and Environment (MWE) monitors compliance of industries and municipal waste plants with the National Environment (Standards for Discharge of Effluent into Water or Land) Regulations, 2020. There has been a decline on compliance with effluent quality in the last three years with some parameters dropping below 50% compliance level. For example, in 2022/23 effluent quality was 47% taking into account the amounts of total nitrogen (TN), total phosphorus (TP), chemical oxygen demand (COD), total suspended solids (TSS), and electrical conductivity (EC) (**Figure 24**). Compliance improved by over 33.4% in the FY 2021/22 (**Figure 25**).

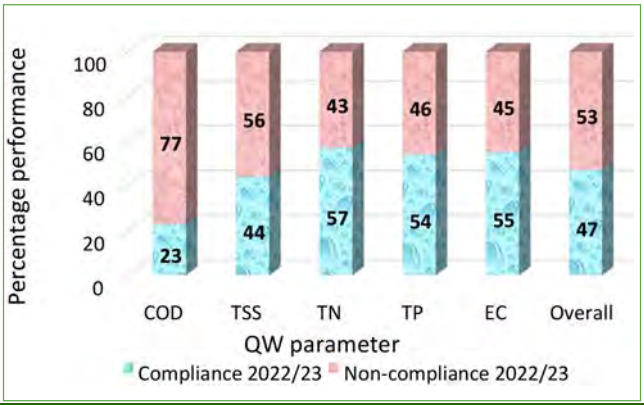


Figure 24: ***Compliance with nutrient contents of effluents (industrial and domestic) based on the National Standards.***

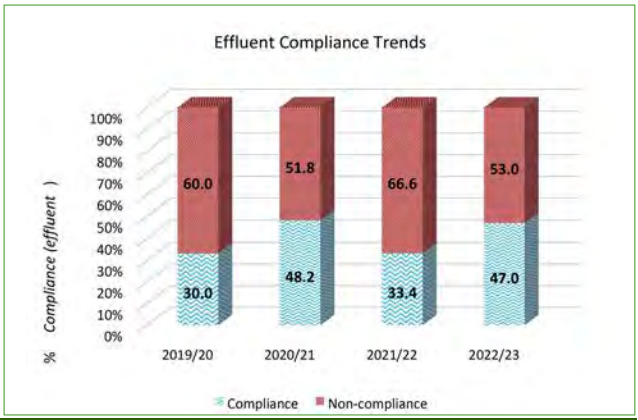


Figure 25*: Compliance with effluent discharge regulations from 2019/2 to 2022/23.*

b) State of water resources

i) Ambient water: Lake and River water quality and quantity

The state of water quality of Uganda's water resources is worrying, with a decreasing water quality trend observed in ground and surface waters (APPR, 2022; APPR,2023). Variation in sources of point and non-point pollutants is correlated to variation in water pollution across the country. Water bodies in and around the Greater Kampala Metropolitan Area are more contaminated by point and non-point sources of pollution than water bodies in other areas. Water resources in the Inner Murchison Bay, Nakiwogo, and Kitubulu Bays in Entebbe are the most polluted in the Lake Victoria basin. Generally, surface water bodies in the country receive large amounts of phosphorus and nitrogen that account for eutrophication, for instance, in Lakes Victoria, Kyoga, and George (Obubu et al., 2021, APPR, 2023).

Eutrophication has resulted in the proliferation of water hyacinth, and Kariba weed in water bodies. This problem has been reported in transboundary water bodies in East Africa, Africa, and other parts of the world; Andama *et al.,* 2017; Day *et al.*, 2020). Much of the water hyacinth observed in Lake Victoria comes from Rwanda and Burundi through River Kagera. The discharge of microbiological organisms such as E. coli, Klebsiella, and Enterococcus species into the environment has contaminated ground and surface water.

In 2015, about 13.9% of Uganda's land had experienced soil erosion and wetland degradation. But his dropped to 8.9% in 2023. Wetland degradation impairs the ability of wetlands to filter waste and storm-water before being discharged into the water bodies. This has resulted in increased sedimentation, reduction of depth, increased turbidity and proliferation of algal blooms in water bodies (APPR, 2023). Toxic heavy metals like Lead, pharmaceutical residues, e-waste and emerging pollutants also reduces water quality (UDHS, 2022; APPR, 2023). The parameters of water quality of five major lakes in Uganda are presented in **Tables 3** and **Figure 26**.

Table 2: *Water quality parameters of five major lakes in Uganda (***Data source:** *APPR 2023)*

Parameter	Units	L. Edward	L. George	L. Albert	L. Kyoga	L.Victoria Littoral	L.Victoria Pelagic
Euphotic depth	m	3	1.5	7	2.9	3.6	7.8
Phosphates as P	mg/L	0.24	0.32	0.08	0.09	0.09	0.04
Nitrates as N	mg/L	0.38	0.36	0.58	0.15	0.11	0.10
Chlorophyll – a	µg/L	5.84	13	_	5.15	8.53	1.03
Conductivity	µS/cm	777	261	538	179	95	85
Dissolved oxygen	mg/L	5.8	7.9	6.5	7.7	7.2	6.6

Table 3: *Heavy metal contamination of Lake Sediments (Mean Values) 2023.*

SN	Water Body	Source type	Mn (mg/Kg)	Cu (mg/Kg)	Pb (mg/Kg)
1	Lake Edward	Sediment	1272	33	15
2	Lake George	Sediment	756	31	16
3	Kazinga Channel	Sediment	1005	58	20

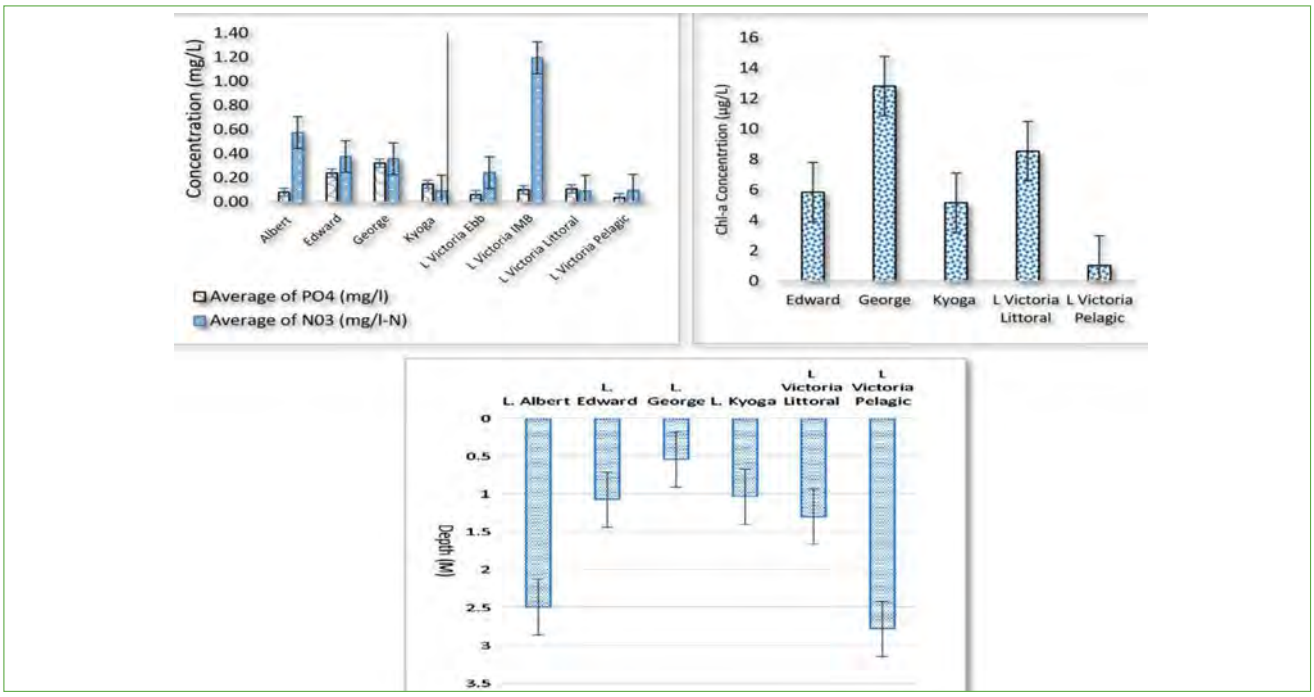


Figure 26: *Ambient water quality of five major lakes in Uganda.*

The results show two distinct qualities, with pelagic quality being better than littoral quality. This is evidence of the impact of pollution caused by human activities in the Greater Kampala Metropolitan Area (GKMA). Lake George was the most polluted mainly by hippo droppings/dung, as the lake is a habitat of a high number of hippos, and also receives effluents from Kasese town.

Water quality assessment of rivers and streams

Rivers are essential ecosystems to local communities and the biodiversity in their vicinity. They are sources of fresh water for domestic and industrial use, transport routes, and demarcate boundaries of administrative units. They are also modes of distribution of human-induced water polluters such as nutrients and organic matter from upstream to downstream ecosystems. Loads of nutrients and sediments from selected rivers are presented in **Table 4.**

Table 4: ***Ambient water quality of major rivers in 2023***

Rivers	TP Load (tons/yr.)	TN Load (tons/yr.)	TSS Load (tons/yr.)	TP Load (tons/yr.)	TN Load (tons/yr.)	TSS Load (tons/yr.)
	Dry season			Wet season		
River Aswa on Kitgum -Gulu road	74	136		78	144	
River Aswa at the Bridge	118	246		125	261	
River Kagera at Kasensero	6,030	16,292	578,086	5,781	15,616	554,127
River Kagera on Tanzania-Uganda boarder	594	11,627	1,806,519	570	11,146	1,731,648
River Nyarwodho at Alwi intake	14	76	8,325	17	92	10,131
River Nyarwodho at NWSC	16	95	13,205	20	116	16,070
River Nyarwodho	16	97	7,751	20	118	9,432
River Rwizi at Bishop Stuart University	303	1,356	29,761	840	3,764	82,604
River Rwizi at Katete	146	2,484	37,487	404	6,894	104,050
River Rwizi at NWSC	205	810	28,473	569	2,248	79,030

Lake water levels

The water level of Lake Victoria dropped by 0.61 meters, from 13.60 meters in June to 12.99 meters in October 2024. The water level also increased by 0.17 meters to 13.16 meters in November 2024. This water level was 0.34 meters below the historical level of 13.50 meters recorded in 2021. However, the highest water level recorded in Lake Victoria was 13.77 meters in May 2024. The water level of Lake Kyoga dropped by 0.03 meters from 13.09 meters in September to 13.06 meters in November 2024, and then rose by 0.10 meters in November to 13.16 meters. The water level of Lake Albert increased by 1.38 meters from 13.46 meters in April to 14.90 meters in November 2024 (**Figure 27**). The water level of 14.90 meters is the highest ever recorded in Lake Albert; it is higher than the historical level of 14.68 meters that was recorded in 2020. Ministry of Water and Environment regularly provides updates on water levels to the office of the Prime Minister so as to issue alerts for potential floods.

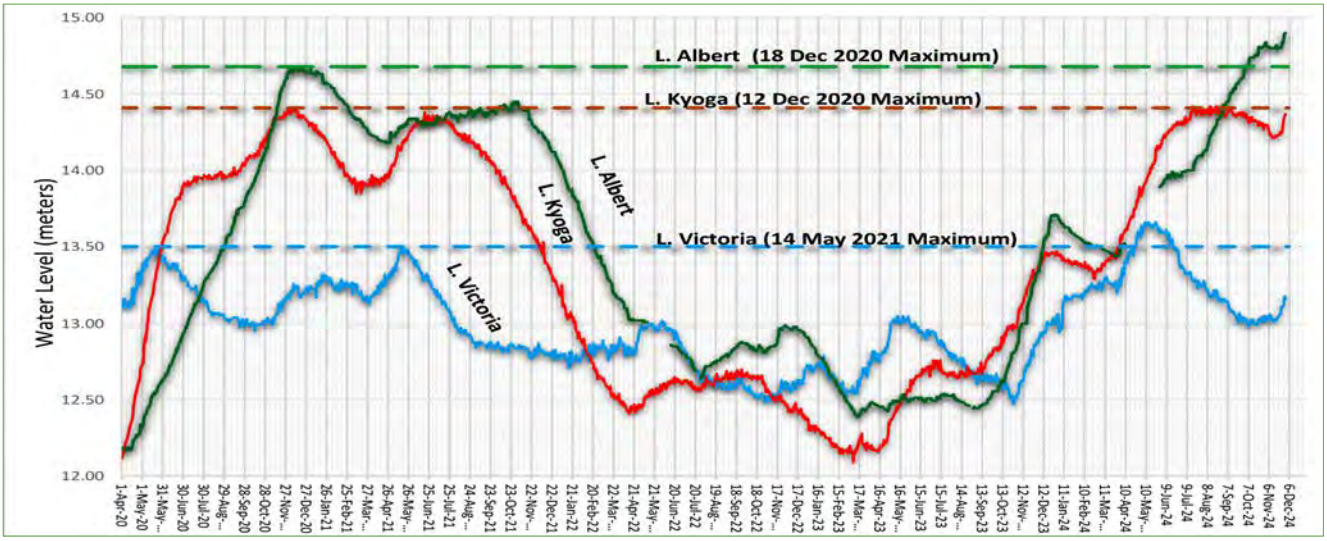


Figure 27: ***Water Levels status for major Lakes; Victoria, Kyoga, and Albert (April 2020 – 30th November 2024).***

ii) Quality of Drinking Water (rural and urban supplies)

Water that is meant for drinking should comply with all aspects of drinking water standards in terms of physical, chemical, and bacteriological components. Natural phenomena, like geological formations, influence the quality of drinking water, especially the mineral composition. However, materials generated by anthropogenic activities contaminate surface water that sips into the groundwater through recharge thereby reducing water quality. In the rural areas, groundwater aquifers and surface water are the main sources of drinking. Point and non-point source pollution contaminates these water sources. However, deep groundwater aquifer is less contaminated than shallow aquifers and surface water for two main reasons (APPR, 2023). Firstly, it is due to easy interaction of shallow groundwater aquifers with contaminated surface water. Secondly, soil and rocks filter water that enters into the aquifers. The suitability of drinking water is measured against the National Standards for Potable Water (EAS, 2018). The water samples collected from rural and urban drinking water sources should comply with the National Standards for Potable Water. In this case, the amount of Escherichia coli in the water sample is used as an indicator of microbiological/ bacteriological contamination (**Figures 28 and 29**). This parameter is important for gauging the quality of drinking water as it shows the presence of pathogens of water-borne and related diseases in water.

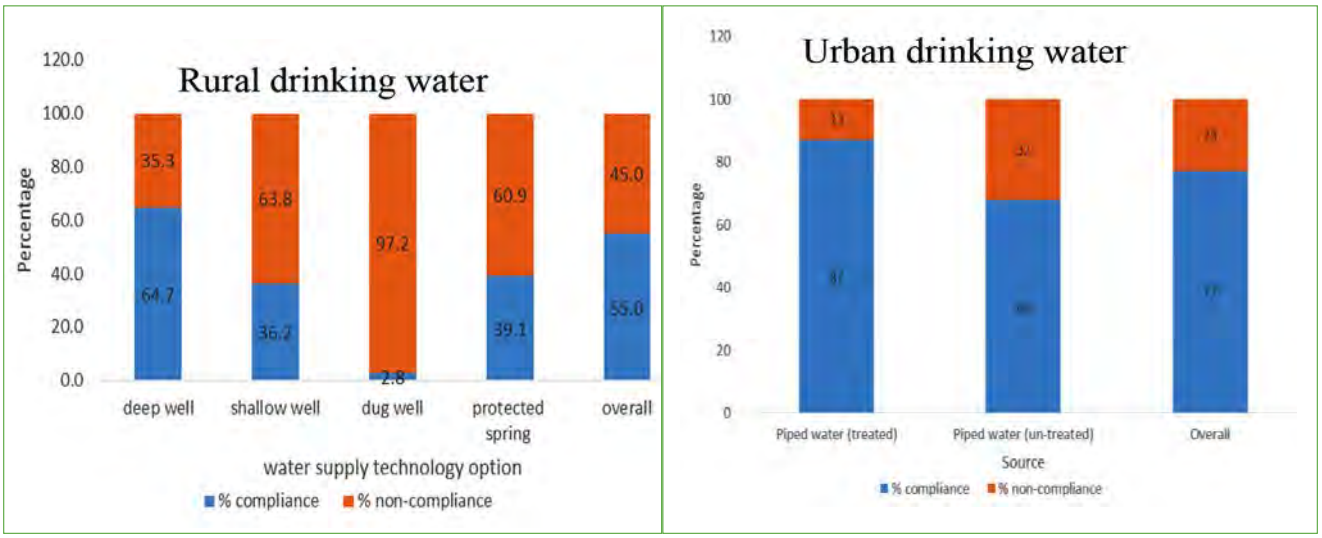


Figure 28*: Sources of rural and urban drinking water by type of technology.*

The results show that shallow water sources such as dug wells are the most contaminated, while deep boreholes are relatively less contaminated and as such the water quality is good.

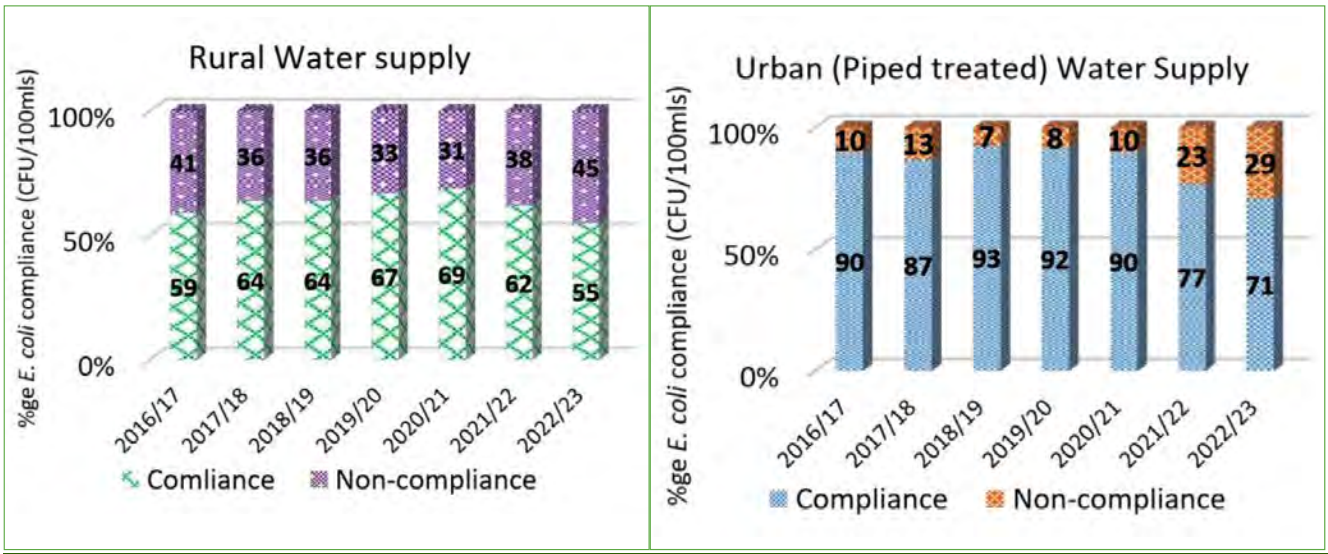


Figure 29*: Compliance trends of rural and urban drinking water to E. coli. Data source (APPR 2023).*

The Uganda Demographic and Health Survey (UDHS) is carried out frequently by Uganda Bureau of Statistics in conjunction with MWE to provide updates on drinking water quality. A recent study carried out in 2022 revealed high concentration of Lead (>10µg/L based on WHO Standard) in drinking water sources in 22% and 32% of urban and rural water samples respectively. The survey revealed that 64% of the water samples from urban areas and 77% of the water samples from rural areas were colored (UDHS 2022).

c) Impacts of polluted waters

The impacts of water pollution vary and includes anoxia (deficiency of oxygen) at the bottom of water bodies due to oxygen depletion by invasive weeds or organic matter, leading to fish mortality as observed in Lake Kyoga, and Lake Victoria.

Poor water quality due to pollution has increased the costs of water treatment, with corresponding high tariffs that are unaffordable by low-income households. To address the problem, National Water and Sewerage Cooperation (NWSC)spent Euros 372 million to construct a new water treatment plant in Katosi, under the Kampala Water Lake Victoria Water and Sanitation (KW-LVWATSAN) Project. Increased water pollution of the Inner Murchison Bay (IMB) due to rapid urbanization and industrial discharge led to change of intake site. But there was also need to expand the Service Area in response to increased demand for piped water supply (NWSC, 2022). Poor households, therefore, opt to consume untreated drinking water from protected springs, dug wells, shallow wells, and boreholes which expose them to risks of suffering from waterborne diseases (APPR, 2023). Eutrophication due to concentration of phosphorus and nitrogen in water has resulted in proliferation of algal blooms that contain toxin-laden cyanobacteria which are a threat to human health. The bacteria also cause a foul smell, and anoxic conditions in the lake bottoms. Deposition of Lead in water is a further threat to human, and animal life as it affects body organs. This situation is fatal especially in infants, the elderly and pregnant women. It also causes stomach pain, asthma, lung cancer and chronic obstructive pulmonary disease (COPD), among others.

d) Responses to water pollution

Ministry of Water and Environment has devised strategies to combat water pollution in the country including:

i) Use of a permit system to guide industries on water abstraction and waste treatment based on national and East African Community standards before being discharged into water bodies. In this regard, in 2021/22 and 2022/23, a total of 793 permits were issued, 419 (245 new and 174 renewal) were issued in 2022/23, compared to 374 in 2021/22. The types of permits and details of compliance with standards are presented in **Table 5.**

Table 5*: Types of permits issued/renewed in 2023.*

Permit type	Permit condition	Permit holders inspected	Permits complying	Compliance (%)
Groundwater	Abstraction within the permitted amount	110	80	73
Surface water	Abstraction within the permitted amount	98	76	77.6
Wastewater discharge	Effluent discharge	30	20	67
Total		**238**	**176**	**72.5**

Data source: APPR (2023)

ii) Ministry of Water and Environment, through NEMA and other agencies, enforces compliance of industries with the standards by carrying out regular inspections and responding to complaints from affected communities on non-compliance with the standards. Industries that do not comply with the standards are warned and can be closed if they remain defiant.

iii) Embracing integrated water resources management (IWRM) approach at the catchment level to mitigate multifaceted pollution. This has been facilitated by the establishment of regional Water Management Zones (WMZs).

iv) Working with other ministries, departments and agencies (MDAs) and organizations to reduce pollution at source. This is a carrot and stick approach, for example, formation of the pollution prevention taskforce, and collaboration with the Uganda Cleaner Production Centre (UCPC) to help industries reduce waste at source. In 2023, 56 participants from Kampala, Wakiso, Mukono, Buikwe, and Jinja industries were trained on resource-efficient and cleaner production (RECP) techniques to create awareness and enhance build capacity in pollution management.

v) Establishment and review of legislative frameworks such as Water and Water Quality policies/Acts/Regulations/Standards. The revision is aimed at making pollution-fines more punitive and widen wastewater parameters used to punish non-compliance.

vi) Establishment of a robust water resources monitoring network to ensure water quality and quantity. Ministry of Water and Environment has set up a water quality monitoring network of over 150 stations, and a 3-tier laboratory network at the Central National Water Quality Reference Laboratory and WMZs (RWQMLs) to collect and analyze water samples for evidence of pollution and design appropriate mitigation measures. The NWQRL is being prepared for accreditation to empower it as a regulator. In addition, the Ministry has purchased a water quality monitoring water vessel for Lake Victoria (**Figure 30**), to facilitate water analysis.

Figure 30 *: Water quality research vessel for monitoring pollution in Lake Victoria. (*Photo Credit*: MWE, 2024).*

vii. A hydrology and hydrogeology monitoring network comprising rivers and lake levels river discharges, and groundwater levels has been established. Some of these networks are telemetric and relay data to the office online, for example, the water level recorder at the source of the Nile in Jinja. The water levels of all the major lakes in Uganda is monitored alongside water quality

viii. Raising awareness among stakeholders involved in water pollution. Local communities have been engaged in the development of catchment management plans and participation in restoration of degraded areas.

ix. Establishment of Water and Environment Information System (WEiS) hub to receive, store and manage data and information from stakeholders such as MDAs, NGOs, CSOs, industries, and the private sector actors. Harmonization of all the water and environmental information in one domain is critical for purposes of sharing and to aid decision-making.

x) Resource/financial mobilization from funding agencies such as GCF, World Bank, WWF, GiZ, and ADB. Additional efforts include working with Lake Victoria Basin Commission (LVBC) and Nile Basin Initiative (NBI), development of the country's Action Plan to combat antimicrobial resistance in the environment. The action plan includes an institutional framework, reporting hierarchy, and collaborative approaches.

xi) Regional interventions on pollution control through regional transboundary organizations such as LVBC and NBI have been implemented to ensure water quality management, mainstream climate change adaptation and mitigation, develop infrastructure and equip regional laboratories.

xii) Government of Uganda is working with other development partners to ensure that the population accesses adequate quantity of quality water. For instance, the Karuma-Gulu water project is aimed at increasing water supply to Gulu City from the current 12,000 liters per day to 22,000 liters per day. As part of this initiative, a 5,300 cubic meter capacity water tank is being constructed at Customs Corner in Bardege-Layibi Division. This includes establishment of a water treatment plant, creation of reservoirs and laying of 72 kilometers of water transmission pipelines (**Figure 31**). Funded by a combination of a grant from KfW and a loan from the World Bank, the project costs 170 billion Shillings. It is being executed by the French construction firms Sogea Satom and Denys NV and is implemented under the Integrated Water Management and Development Project Program (IWMDP).

Figure 31*: Karuma-Gulu city water transmission pipelines. (***Photo Credit:** ***NEMA, 2024).***

3.3 LAND AND SOIL

3.3.1 Overview

Soil degradation refers to change in the status of soil health that results in diminished capacity of the ecosystem to provide goods and services (FAO, 2020). Soil degradation also refers to the physical, chemical, and biological decline in soil quality. Degradation can involve water erosion (includes sheet, rill, and gully erosion); wind erosion; salinity (includes dryland, irrigation, and urban salinity); loss of organic matter; fertility decline; soil acidity or alkalinity; structure decline (includes soil compaction and surface sealing); mass movement; and soil contamination. Soil degradation is a natural process but it can also be caused by human activities.

The effects of land degradation are manifested by decline in crop yields, rural poverty, food insecurity and high cost of food. About 46% of Uganda's soils are degraded and 10% are very degraded. Costs of natural resource (including soils) degradation in the country are estimated at 17% of GDP per year. Key drivers of land degradation and low productivity on small-scale farms include inadequate labor and capital to invest in sustainable land management, poverty, and land fragmentation leading to over-exploitation of land. Stone quarrying immensely contributes to land degradation and it is manifested by erosion, and compaction of soil by heavy machinery

Land resources are crucial to sustenance of household livelihoods in rural areas. Absence of sustainable land management techniques results in rapid and continuous land degradation. Soils are an important component in agricultural value chains and development sectors such as construction and mining. Accurate information on soils is, therefore, a key factor in decision-making and national development. Soil is the "soul" of infinite life and biodiversity and its quality affects nutrient cycling and human well-being. Soil performs various functions, including storage of plant-available water, storage and supply of nutrients and oxygen to roots, provision of favorable seedling establishment conditions, suppression of plant pathogens and immobilization of contaminants.

Land is a primary natural resource used for economic, social, infrastructure, and other human endeavors. Land degradation in Uganda poses a severe threat to rural populations' ability to support themselves and little effort has been made to tackle it. Rapid human population growth, poor farming methods have exerted pressure on soil resources, interfered with soil fertility, made farmers who cultivate in fragile environments experience land degradation and severe decline in crop yields.

3.3.2. Pressures on land and soil

Soil erosion refers to accelerated removal of topsoil from the land surface through water, wind, and tillage (FAO, 2020). Soil erosion occurs naturally under all climatic conditions and on all continents. It is increased and accelerated by unsustainable human activities (up to 1000 times) through intensive agriculture, deforestation, overgrazing, and improper land use changes. Soil erosion rates are much higher than soil formation rates. Soil is a finite resource implying that its loss and degradation is not recoverable within a human lifespan (FAO, 2020).

Highlands are soil erosion hotspots and yet they the most productive areas in the country. Estimates indicate that up to 12% of the gross domestic product (GDP) is lost through environmental degradation and 85% is due to soil erosion, nutrient loss and decline in crop yields (World Bank, 2021). Soil erosion decreases agricultural productivity, curtails ecosystem functions, magnifies hydrogeological risks such as landslides or floods, causes biodiversity loss, damages urban infrastructure, and in severe cases, leads to displacement of human populations.

Land degradation is one of the key causes of natural resource degradation in Uganda, especially in the highlands and cattle corridor. About 41% of the country's land is degraded, out of which 12 % is classified as severely degraded. Soil erosion affects about 85% of degraded land. About 85-90% of the highlands of Kabale and Kisoro are severely degraded while 75-80% of the highlands in Mbale, Rakai, and the cattle corridor districts are badly affected.

Rates of soil loss vary across the country. In the hotspot highland regions, annual soil loss exceeds

30 tons per ha per year. Abundant tropical rainfall, a steep topography and high weathering rates escalate soil erosion in the highlands. High rainfall in the steep and bare slopes of the highlands of eastern, northern, and western Uganda erode soils that are deposited in the central plains of the country and causes siltation of wetlands. Human activities also cause land degradation triggered by soil erosion and nutrient depletion. Poor crop farming methods further contribute to land degradation (**Figure 32**) through soil nutrient mining, slash and burn practice, and limited soil and water conservation practices. Poor grazing practices also contribute to soil erosion in the cattle corridor. (World Bank, 2020). Loss of vegetation cover by termites is common in the cattle corridor especially in Nakasongola. It leaves the ground bare and exposes soil to running water that erodes it (Mugerwa,2015).

3.3.3. State of Uganda's soils

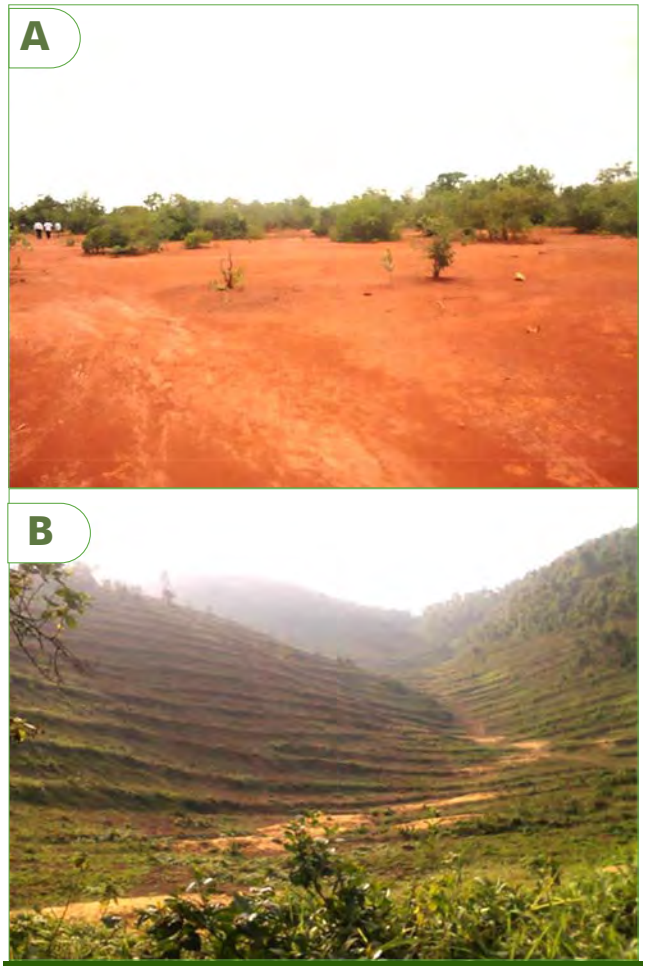


Figure 32: ***Land Degradation in Uganda (Source: Zakayo Muyaka). A: Degradation in the cattle corridor. B: Terraces degraded in western Uganda***

a) Distribution of major soils of Uganda

The different regions of Uganda have varing soil composition.In the central region, Ferralsols dominate, covering 1,473,423 hectares (6.11% of the total land area). The other soil types are Luvisols, Plinthosols, Arenosols, and others. Ferralsols are deeply weathered and chemically infertile. Thus, it requires improvement with fertilizer application, mulching, or agroforestry practices. Plinthosols is the primary soil that covers 1,570,082 hectares (6.51% of the total land area) in eastern Uganda. Other soil types are Andosols, Leptosols, and more. These soils are characterized by fertility, waterlogging and shallow rooting depth that hinder arable farming thus forcing farmers to cultivate in wetlands. The northern region is predominantly covered by Leptosols dominate with 2,097,316 hectares (8.70% of the land area), Andosols, Regosols, and others. Leptosols are found as thin layers over rock surfaces. They are rich in coarse fragments and have fertility potential, especially on slopes. Ferralsols are common in western region covering 3,209,342 hectares (13.32% of the total land area); other soils include Luvisols, Vertisols and Calcisols. Ferralsols in western Uganda are deeply weathered and infertile.

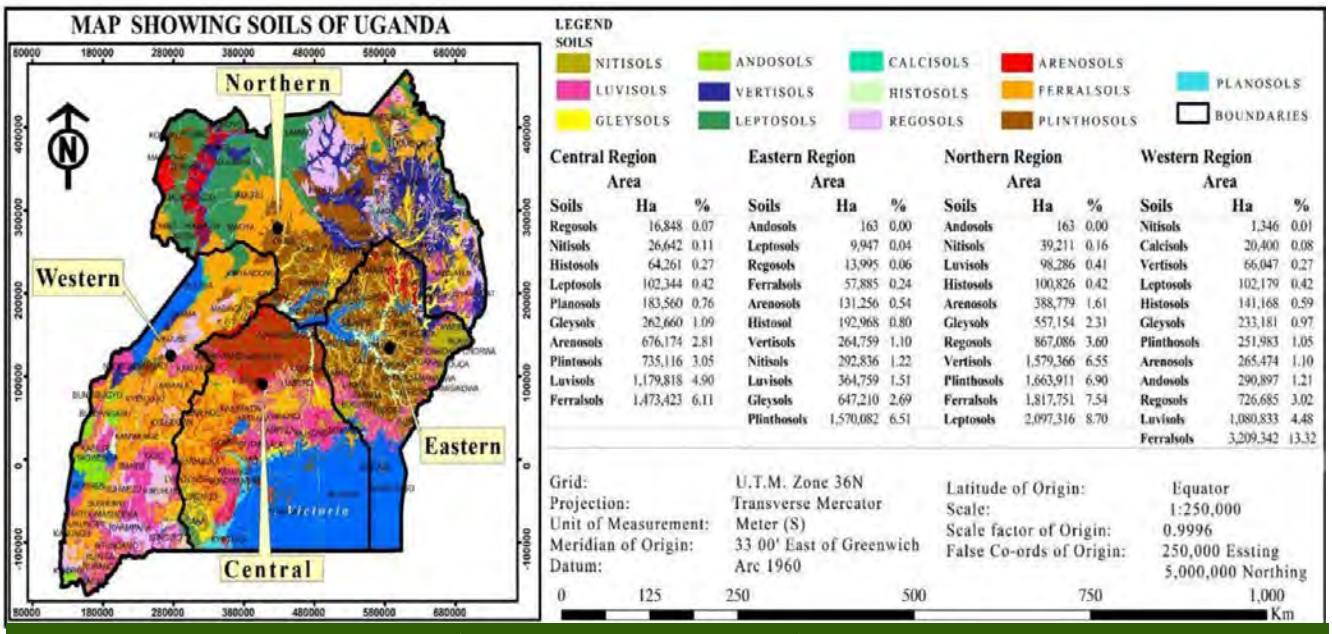


Figure 33: ***Soil types by regions (*****Source*****: NARO-Kawanda).***

b) Soil health

The Intergovernmental Technical Panel on Soils (ITPS) defines soil health as "the ability of soil to sustain productivity, diversity and environmental services of terrestrial ecosystems". In managed systems, soil health can be maintained, promoted, or recovered through sustainable soil management practices. The preservation of soil services involves avoiding and/or combating soil degradation. Healthy soils serve as habitat for macro and microorganisms, act as sponge for holding water, release nutrients for plant growth, serve as a foundation for farm productivity and income and improve environmental health through mitigation of greenhouse gas emission, carbon sequestration and water pollution through runoff and leaching.

In line with a call to action by Lehmann et al. (2020), clear and comparable soil health indicators should be defined to ensure that the soils are sustainably managed and the ecological and socio-economic benefits of healthy soils are preserved for future generations. Soil functions are governed by a suite of chemical, biological and physical properties. Knowledge of the properties, their roles and effect of natural and human-induced change is essential to achieve sustainable production (World Soil Charter, 2015).

Soil sustainability involves carrying out activities that maintain or enhance the supporting, provisioning, regulating, and cultural services provided by soils without impairing the functions that sustain environmental services and support biodiversity.Some of the practices include application of manure, regulating fertilizer use, managing dryland salinity and implementing zoning systems to protect agricultural soils. However, unsustainable soil management practices, including excessive use of chemicals, poor regulation of pesticide use, overuse of fertilizers and poor farming methods lead to soil pollution and the attendant effects that retard soil health and curtail ecosystem functions (FAO, 2021).

The challenge of nutrient-deficient soils particularly affects smallholder farmers who are the majority in Africa where land is degraded and soil nutrients depleted (Haler et al., 2020). In Uganda, soils have been depleted majorly by poor farming practices such as overuse of agro-chemicals (Food Security Centre, 2019). Soil contamination decreases soil biodiversity, fertility, and health thus making it difficult to sustain agricultural productivity. By carrying out sustainable soil management practices, current and future generations can meet their livelihood needs.

As a universal sink, soil bears the greatest burden of environmental pollution. Soil pollution threatens food safety, human health and ecological integrity of ecosystems (FAO, 2015). Toxic substances

are released into the soil by anthropogenic and industrial activities. National State of Environment of Uganda 2016/2017 report highlighted soil pollution as one of the key environmental challenges in the country. It further attributed pollution to poor farming practices including over pesticide use. Increased and injudicious use of pesticides compromises soil health by destroying soil biota that is responsible for preserving soil functions (Tang and Maggi, 2021; Ssemugabo et al., 2022).

c) Low inherent and declining soil fertility

Soil fertility declines when large quantities of nutrients removed from the soil in harvested products exceed quantities applied. In this situation, nutrient requirements of crops are met from soil reserves until the reserves fail to meet crop growth demands. Low inherent and declining soil fertility, and loss of nitrogen, potassium, and phosphorus are estimated at 87kg/ha/year.

3.3.4. Impacts of soil degradation

a) Lower Agricultural Productivity

Land degradation lowers the productive potential of agricultural land, rangelands, and forest resources, reduces biodiversity and food production. In this regard, land degradation implicitly contributes to poverty in rural and urban areas (Turyasingura et al., 2022). Effects of land degradation on livelihoods of local communities are difficult to quantify because they occur over a long-time horizon.

b) Loss of biodiversity (habitat loss or modification)

In Uganda, limited economic estimates of land degradation is due to shortcomings in the gathering or dissemination of information on natural resources by research institutions, which has resulted in biodiversity loss. Famine and starvation have also indirectly resulted from the problems (Turyasingura et al., 2022).

c) Environmental challenges

Severe weather events degraded infrastructure systems and affeced human health, and agricultural productivity thereby compounding the country's poverty situation. Taking no action to mitigate climate change is projected to cost Uganda about 2-4 % of the GDP annually. Damages to agriculture, water, infrastructure, and energy are estimated to cost equivalent to USD 7- 11 billion per annum over 2010-2050 period. The economic cost resulting from crop damage, loss of export crop revenue, loss of livestock, and unmet water demand for production (irrigation and livestock) is projected to be USD 2.3 – 4.2 billion by 2025. The largest drops in crop production are predicted for cassava, potato, and sweet potato, which are likely to decline by about 40% by 2050 (CDKN, 2021).

3.3.5. Response strategies

Government has implemented institutional frameworks and policies for Sustainable Land Management (SLM) and Climate Smart Agriculture (CSA) in different sectors. The Uganda Strategic Investment Framework for Sustainable Land Management (U-SIF SLM) is a multi-sector initiative aimed at establishing an integrated cross-sector approach to address SLM challenges (Kumar *et al.*, 2022).

Government has also developed policies to improve land management thereby creating an enabling environment for sustainable land use. The instruments include National Land Use Policy, Land Policy, Draft National Soils Policy, Prohibition of the Burning of Grass Act, and Cattle Grazing Act. Furthermore, efforts are underway to update the soil map of Uganda from a scale of 1: 1000km to 1: 50,000km and produce soil and crop suitability maps to support land use-based initiatives by government and other agencies.

Deep understanding of the underlying causes of land degradation and promoting strategies to address these issues is essential. Government is already promoting sustainable land management practices and climate smart agriculture, including restoration of degraded lands such as sand pits

and stone quarry sites. In 2023, for instance, a community initiative, supported by NEMA and other stakeholders, restored the Opiyai stone quarry in Soroti City by filling the site with soil excavated during the market construction (**Figure 34**).

Figure 34: ***Restored Opiyai stone quarry site in Soroti city. (*****Photo credit:** ***NEMA (2024).***

Capacity of collaborators have also been strengthened to develop and implement the above strategies through skilling and knowledge sharing to address land degradation challenges and promote sustainable land management practices in the country.

3.4 BIODIVERSITY

Biodiversity refers to the variety and variability of living organisms as well as their interactions. It is manifested at the ecosystem, species and genetic levels. Biodiversity supports human livelihoods by providing essential ecosystem goods and services (Díaz, & Malhi, 2022). However, it faces numerous threats that contribute to its decline. Effective biodiversity monitoring is, therefore, vital for sustainable environmental management, as it helps track changes, elucidate the drivers of biodiversity loss and aid informed decision-making to protect ecosystems.

Uganda has recorded positive trends in the population of flagship flora and fauna species, such as the mountain gorilla and African elephant due to concerted conservation efforts. Despite these successes, Uganda's biodiversity faces immense threats from habitat loss and degradation due to agricultural expansion, deforestation, infrastructure development, poaching and climate change effects. For instance, the population of lions in the country has declined from 490 in 2010 to about 350 in 2022 due to habitat loss, poisoning by livestock farmers and illegal trade in lion body parts (NBSAP III). Data on Uganda's biodiversity is kept at the National Biodiversity Data Bank (NBDB) in Makerere University which holds over 135,000 georeferenced species distribution records. However, much data also exists in various public and private domains, often in incompatible formats and without validation for integrity.

3.4.1. Pressures on biodiversity

a) Climate change

Climate change and variability poses a huge threat to Uganda's biodiversity. Changes in temperature and precipitation patterns affect species distribution and ecosystem dynamics. In addition, climate change impacts availability of water resources, alters habitats and stresses species that are adapted to specific environmental conditions.

Wildlife populations fluctuate from year to year due to seasonal climatic patterns. Climatic factors also regulate wildlife populations through changes in rainfall amounts, temperatures and levels of irradiation. These influence the quality and availability of food for wild animals thus resulting into high levels of inter and intra competition for food and changes in reproduction and survival rates of species. Furthermore, climate change effects such as prolonged droughts and floods, disease outbreaks and proliferation of invasive species lead to wildlife mortality. These changes cause migration of a number of species. For instance, the three horned chameleon found in the Rwenzori Mountains ecosystem has shifted to higher altitudes as a result of increase in temperatures at the lower altitudes (UWA report 2013). According to Ponce-Reyes et al. (2017), the Albertine Rift region, where endemic and threatened species occur, are predicted to experience decline in species numbers and 70% habitat loss over the next 70 years unless the species adapt to rising temperatures. Fourteen of Uganda's wildlife protected areas are found in the Albertine rift graben. Change in climate in the graben will adversely affect critical wildlife habitats.

b) Invasive alien species (IAS)

Introduction of invasive alien species disrupts local ecosystems and they outcompete native species for resources. Invasive plants, animals, and pathogens cause significant ecological imbalances, reduce biodiversity and hampers ecosystem resilience. Spread of invasive alien species is a major concern in the country as it threatens wildlife conservation in protected areas. In this respect, it is important to distinguish between the 'Invasive Alien Species' which are of global concern for biodiversity conservation and indigenous invasive species that can increase and become dominant in their original habitats. Major invasive alien species of concern in Uganda's protected areas include *Lantana camara, Parthenium hysterophorus, Broussonetia papyrifera, Senna spectabilis, Imperata cylindrica, and Mimosa pigra*. These species have invaded habitats that are suitable for native fauna (NARO, 2002).

Species that have been labelled as 'invasive' include Dichrostachys cinerea, Acacia hockii and

Vossia cuspidata. In Lake Mburo National Park, for example, the increasing dominance of Acacia hockii thickets has been treated as an 'invasion' because the wooded grasslands (grazing areas) are gradually turning into woodlands and forcing migration of animals, disrupting animal breeding cycles and destabilizing large areas of grassland ecosystems.

Other invasive alien species include the Water hyacinth (*Eichhornia crassipes* (Mart.) Solms) and Kariba weed (*Salvinia molesta D. S. Mitch.*) which have reduced the diversity of fish and other aquatic species in the country.

c) Agricultural practices

Traditional farming practices such as slash and burn as well as modern agricultural practices have caused habitat loss and ecosystem degradation (**Figure 35**). Modern farming practices include the establishment of monoculture plantations use of agro-chemical inputs that degrade soil quality, reduce species diversity, and incidences of pests and diseases. Sugar cane growing, for instance, has reduced forest cover in the Bunyoro sub region while rice growing in eastern Uganda has reduced wetland and forest coverage.

Figure 35: ***Encroachment of forest edges for subsistence crop farming.*** **(Photo Credit:** ***NEMA, 2024)***

On top of the above, expansion of agricultural activities reduces areas of national parks and wildlife reserves. In fact, large areas of potential wildlife habitats that are found outside protected areas have been fragmented and subjected to incompatible land use options. As a result, habitats have been fragmented into small islands of protected areas with no connectivity to permit movement of wild animals.

d) Degradation of aquatic ecosystems

Loss and degradation of aquatic habitats due to sand mining and agriculture have led to loss of aquatic biodiversity. Increased sand mining using machinery have transformed some wetlands into lakes and disrupting critical habitats that serve as nursery, fish breeding grounds and refugia of endangered species.

Wetland ecosystem services in Uganda face multiple pressures that compromise their functions. Crop cultivation, livestock grazing and vegetation harvesting exert tremendous pressure on wildlife habitats. These activities lead to the removal of native vegetation, soil erosion, and increased nutrient concentrations in soil and water. Such changes compromise wetlands' capacity to regulate water quality, control floods and maintain soil fertility.

Wetland ecosystems services are also hampered by pollution. Industrial discharges, agricultural runoff, and untreated urban wastewater deposit pollutants into wetlands, degrade water quality and harm aquatic life. Discharge of untreated urban wastewater is particularly problematic, as it introduces organic pollutants and nutrients that disrupt the natural balance of wetland ecosystems.

Wetlands across the country are also affected by human population growth that has exerted increased demand for food and arable land. This pressure results in widespread agricultural encroachment into wetland areas leading to extensive conversion of wetlands into farmlands.

Local communities depend on wetlands for subsistence needs. Urban expansion also contributes to wetland degradation, often due to poor waste management practices that pollute wetlands, alter hydrological patterns and increase discharge of pollutants into wetlands.

The combination of agricultural encroachment and urban expansion is compounded by limited

awareness about wetland conservation and weak enforcement of wetland policies. These lead to uncontrolled, unsustainable use and accelerated wetland degradation.

e) Poaching and human-wildlife conflicts

Poaching and illegal hunting contribute to loss of the country species richness and diversity. Poaching remains the most serious threat to wildlife populations and species diversity in the country. Wild animals are poached for meat, wildlife products, and pet trade.

Human–wildlife conflict is the encounter between humans and wildlife leading to negative results, such as loss of property, livelihoods and life. Growth in human population and the need for attaining development have increased human-wildlife conflicts. Crop raiding reduces local food security, makes local people have negative attitudes towards wildlife and reduces tolerance and support for conservation.

f) Zoonotic diseases

Zoonotic diseases such as anthrax can decimate the populations of hippos and buffaloes, scabies affect mountain gorillas, skin disease is common in giraffe and brucellosis and canine distemper virus are common in lions. Other diseases include Avian flu, Marburg and Ebola that cause mortality of wild animals, humans and livestock. Outbreak of anthrax in Queen Elizabeth National Park (QENP) in 2004 manifested the devastating effects of such disease outbreaks (FAO, 2004). About 300 hippopotamuses were killed by anthrax in 2004 while in 2020 an outbreak of the same disease killed over 200 hippos in QENP. The lethal viruses spread through contact with pools of stagnant water, pastures and soils. UWA works with other partners under the One Health platform to address the disease pandemics. In addition, it has established a Biosafety Level II laboratory in QENP to facilitate research on zoonotic diseases and their management.

g) Developments in protected areas

The discovery of oil and gas reserves in protected areas coupled with other industrial developments such as hydropower, mineral exploration and exploitation, continues to exert pressure on wildlife and the habitats. In this regard, there is need to balance development and conservation. Failure to mitigate the negative impacts of such developments would reduce wildlife populations and adversely affect tourism in protected areas.

h) Pollution and nutrient loading

Pollution from industrial, agricultural, and domestic sources reduces water quality and biodiversity of lake and river ecosystems and ultimately affects the health of the ecosystems. Untreated sewage, agricultural runoff, and industrial effluents introduce excessive nutrients (e.g., nitrogen and phosphorus) into the lake, leading to eutrophication and proliferation of algal blooms. These conditions reduce water clarity, deplete oxygen, and threatened the survival of aquatic organisms thereby compromising ecosystem integrity, ecosystems goods and services.

j) Bush fires

There is a general increase in fires that decimate rangelands leading to biodiversity loss. Bush fires are seasonal fires and deplete forage for wild animals and livestock. Uncontrolled bush burning upsets rangelands ecology and reduces available habitats and their sustainability.

3.4.2 State of biodiversity in Uganda

Uganda is rich in biodiversity, encompassing a wide array of species and habitats. The country is home to over 1,040 bird species, 345 mammal species, 165 reptile species, and 86 amphibian species (UWA, 2020). These species inhabit diverse ecosystems, including savanna woodlands, forests, wetlands, and mountainous regions. Key conservation areas such as Bwindi Impenetrable National Park and QENP are crucial refuges for endangered species such as mountain gorilla and African elephant. The savanna ecosystem-based

QENP, Murchison Falls National Park, and Kidepo Valley National Park are habitats for the big five wild animals namely elephants, lions, leopards, buffalo, and rhinos. Despite these efforts, the overall state of biodiversity in Uganda remains precarious, with many species experiencing population declines due to various pressures.

Protected areas in Uganda play a significant role in conserving biodiversity, covering extensive portions of the country's landscape and safeguarding critical habitats. These areas are essential for the survival of many species, offering protection from habitat destruction and human encroachment. Furthermore, over 50% of Uganda's wildlife exists outside protected areas and they face several threats related to anthropogenic activities (UWA, 2020).

a) Ecosystem diversity

Overview

The major ecosystems in Uganda are savanna, forests, aquatic and wetlands, as well as mountains. Uganda's biodiversity is found in diverse ecosystems due to its varied topography, climate, and geography. Land cover land use types from 1990 to 2023 are presented in **Table 6**.

Table 6: ***Land use Land Cover in Uganda from 1990-2023 (in Hectares).*** **Source:** ***NFA (2023)***

LULC class	1990	2000	2005	2010	2015	2017	2019	2021	2023
Broadleaved plantations	18,682	9,844	14,786	20,995	43,733	84,137	228,118	255,527	322,390
Coniferous plantations	16,384	11,498	18,741	43,743	63,546	75,801	86,236	83,028	125,329
THF high stocked	651,106	703,926	600,955	564,948	525,134	524,189	518,073	532,140	560,357
THF low stocked	273,060	226,549	191,693	120,756	104,592	102,150	156,774	125,241	94,246
Woodlands	3,974,498	2,834,730	2,778,044	1,448,869	1,201,985	1,239,176	1,739,958	1,464,973	1,492,251
Bushland	1,422,254	4,007,891	2,968,685	2,371,776	1,970,692	1,664,429	273,405	553,394	359,487
Grassland	5,115,446	2,793,950	4,063,594	5,068,269	5,103,796	5,121,004	5,531,494	4,561,605	5,015,846
Wetland	484,028	838,537	753,038	810,445	716,721	785,703	877,337	964,353	834,647
Subsistence farmland	8,401,550	8,916,053	8,847,640	9,772,224	10,275,557	10,483,258	10,607,875	11,206,541	11,107,071
Commercial farmland	68,446	103,327	106,629	134,915	255,934	182,396	165,003	172,616	187,771
Built up	36,571	26,315	97,270	98,449	135,593	138,722	259,502	279,876	262,738
Water bodies	3,689,580	3,680,870	3,706,467	3,689,346	3,750,237	3,746,221	3,701,338	3,734,250	3,783,293
Impediment	3,741	1,857	7,804	10,614	7,828	8,162	10,235	7,428	10,520
Total Area of Uganda	**24,155,346.98**	**24,155,346.98**	**24,155,346.98**	**24,155,346.98**	**24,155,346.98**	**24,155,346.98**	**24,155,346.98**	**24,155,346.98**	**24,155,944.97**
Status	**1990**	**2000**	**2005**	**2010**	**2015**	**2017-Bias Corr**	**2019**	**2021**	**2023**
Plantations	35,066	21,342	33,527	64,738	107,279	159,938	314,354	338,555	447,719
Natural forest	4,898,664	3,765,205	3,570,692	2,134,573	1,831,711	1,865,515	2,414,805	2,122,354	2,146,853
Forest Cover	4,933,730	3,786,547	3,604,219	2,199,309	1,938,990	2,505,266	2,707,266	2,460,909	**2,594,572**
Land Area	20,465,766.99	20,474,477.38	20,448,880.00	20,466,001.26	20,405,110.01	20,409,126.46	20,454,009.45	20,206,722.75	20,372,652.03
Forest % of land area	24.1%	18.5%	17.6%	10.7%	9.5%	12.3%	13.2%	12.2%	12.7%

Critical ecosystem includes Bwindi Impenetrable National Park and Mgahinga Gorilla National Park that are home to approximately 60% of the world's remaining mountain gorilla population. Kibale National Park supports over 1,500 chimpanzees, while Mabira Forest, one of the largest remaining tropical rainforests that spans over 300 square kilometers in the Lake Victoria crescent, is crucial for biodiversity conservation. Queen Elizabeth National Park covers about 1,978 square kilometers and harbours over 95 mammal species and 600 bird species. Murchison Falls conservation areas covers 5366 square kilometers, includes Murchison Falls, Bugungu and Karuma wildlife reserves. Kidepo Valley National Park harbors about 77 mammal species and over 475 bird species.

Out of a total surface area of 241,551 square kilometers (both land and water), 25,981.57 square kilometers (10%) is gazetted as wildlife conservation areas, 24% is gazetted as forest reserves and 13% is wetlands (Wildlife Policy 2014) comprising of 10 national parks, 12 wildlife reserves, 10 wildlife sanctuaries and 5 community wildlife areas (**Figure 36**).

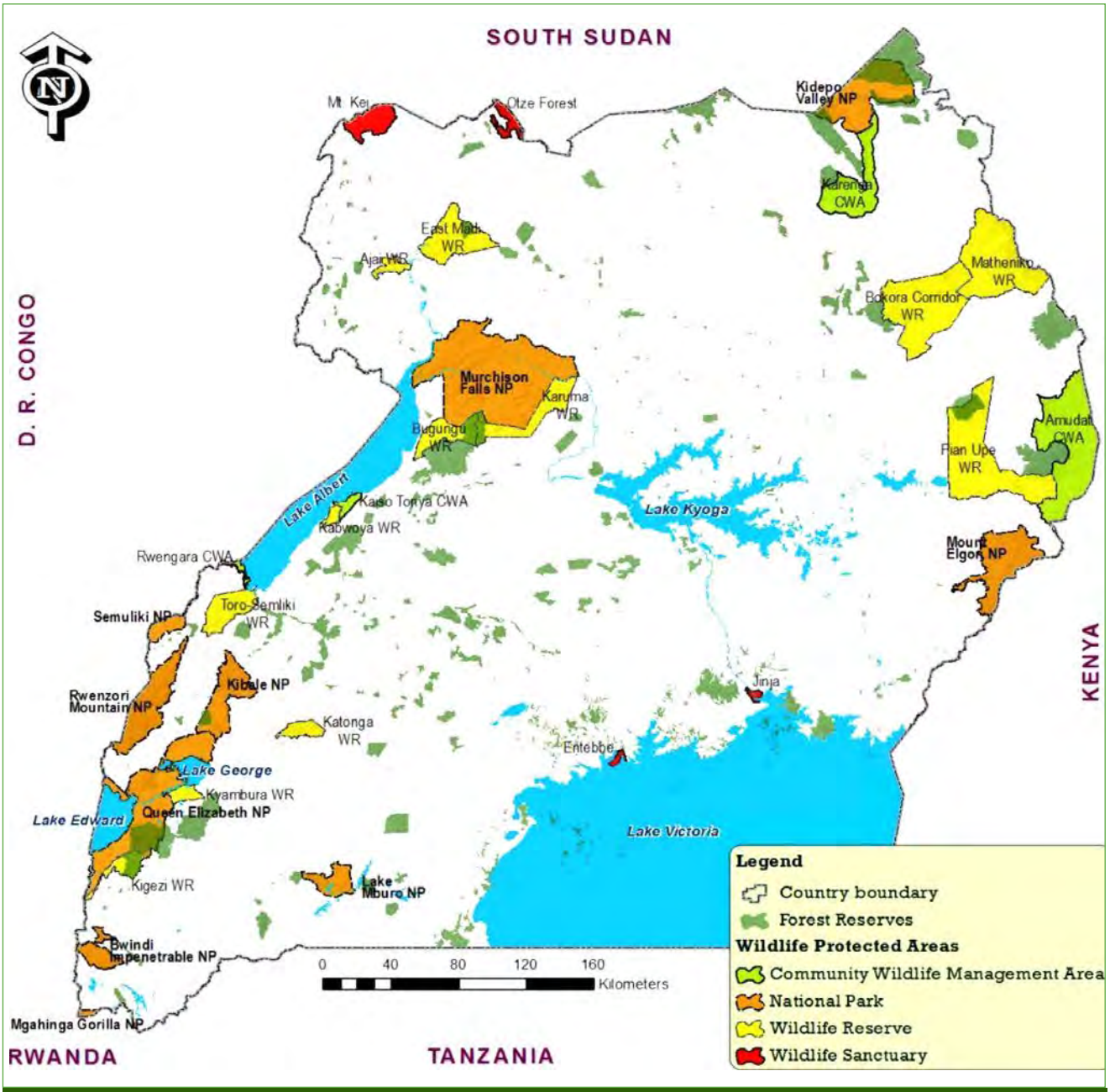


Figure 36*: Protected areas in Uganda.*

i) Forest ecosystems

The forests are complex ecosystems in which trees are the dominant life forms where other plants, animal and micro-organism communities, and their abiotic environment interact as a functional unit (FAO, 2020). Although forests contribute significantly to Uganda's economy and provide livelihoods to most people, especially the rural population that relies on biomass energy for cooking. Deforestation is a major national and global concern inspite of forests' contribution to climate change mitigation. In this regard, it is vital to control and reduce or halt forest loss. Although the government and civil society organizations promote energy saving technologies to reduce deforestation, such interventions are still limited as consumption of wood-based energy is still high. Furthermore, government efforts to scale up rural electrification may take some time to redeem the situation given the high electricity tariffs. Although urban populations have access to electricity, many households still depend on wood fuel for cooking. Ministry of Water and Environment (MWE) .Forestry Investiment Program reveals that there are efforts to re-forest, restore, and/or rehabilitate the deforested areas. Government is committed to halting deforestation through various interventions including support for climate smart-agriculture and

sustainable energy initiatives. These efforts are expected to increase forest cover from an estimated 12.5% in 2020 to 21% in 2030 and 24% by 2040. A 40 million tree campaign was launched by MWE on 2nd March 2021 aimed at forest restoration using indigenous trees (MWE, 2022).

The Uganda National Forestry and Tree Planting Act, 2003, categorizes forests as Central Forest Reserves (CFRs), Local Forest Reserves (LFRs), Community Forests (CFs) and Private Forests (PFs) broadly occurring as either natural or plantation forests **(Figures 37**).

Figure 37*: Kachung Forest plantation in Lira district. (***Photo Credit***: NEMA, 2024)***

Forests and woodlands meet the demand of 94% of the household's cooking energy needs. Effective management of forests involves multiple Ministries, Departments and Agencies, for instance, Ministry of Water and Environment (MWE), National Environment Management Authority (NEMA), Uganda Wildlife Authority (UWA), District Local Governments (DLGs), local communities and other stakeholders. Growth in other sectors such as real estate development, energy generation and cottage forest-based enterprises are thriving due to forestry and forest-based resources. About 61% of Uganda's tourism income is generated by forest-based national parks being managed by Uganda Wildlife Authority. Forests also represent key cultural and livelihood assets for forest-dependent communities. A major concern for sustainable environment management is forest loss, often associated with the land tenure systems (**Figure 38**).

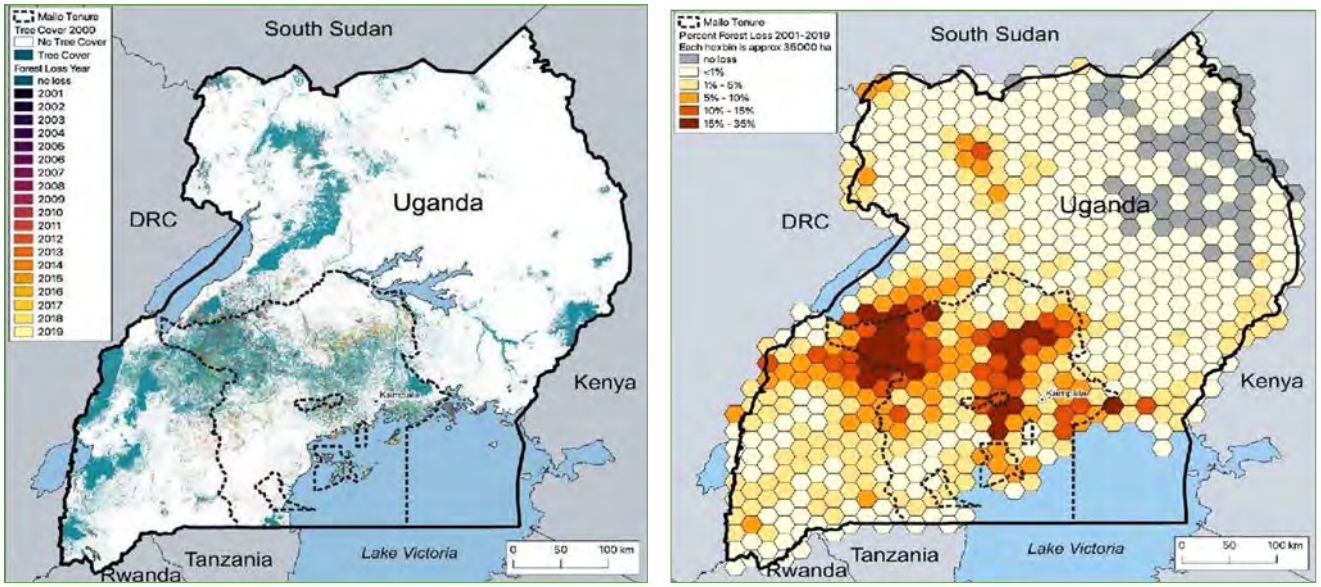


Figure 38*: Relationship between deforestation and land tenure systems in Uganda (Source: Walker et al., 2023)*

Uganda has made tremendous efforts to recover its forest cover. Forest cover increased from just 9% in 2015 to now 12.7% of the land surface of Uganda. Plantation forest area increased from 32,225 to 107,608 ha as a result of 63% additional tree planting in forest reserves and 27% on private land. More efforts are needed to continue the positive trend in national forest cover recovery.

Response strategies to forest cover loss

Production of Tree seedlings

The National Tree Seed Centre (NTSC) raises a variety of tree seedling species for both commercial and community tree planting programs; under the National Community Tree planting arrangement (NCCTP), communities, institutions, and Agencies are availed with opportunities to access free seedlings of the indigenous species to enhance restoration and conservation interventions of the degraded landscapes. The production capacity of NTSC ranges from 5.5 million to 6.5 million seedlings annually. The seedling production is carried out at two nursery sites i.e., Banda and Namanve, with later raising 65% of the annual target. The seedling categories raised include the following; Indigenous (100 species), Exotic species/Soft wood (16 species),
Fruits (23 different species), Ornamental (198 different Spp), and Bamboo (14 different varieties) (**Figure 39**)

Figure 39 : ***Tree seedlings at the National Tree Seed Centre (NTSC), NFA, Namanve (*****Photo Credit:** ***NEMA, 2024).***

The NTSC also collects, processes, and distributes over 100 species of the assorted tree seeds, to various partners within and outside the country. Closely to 50,000 kg of assorted tree and fruit seeds are processed annually. The trend of seedling distribution for three years is shown in **Table 7**.

Table 7*: Seedling distribution over three years.*

No	Category	Tree Species	Quantity (FY21- 22)	Quantity (FY 22- 23)	Quantity (FY23-24)	Total
1	Eucalyptus	E. grandis F2 (South Africa)	622,736	273,768	278,514	1,175,018
2	Pines and Other Exotics	Pinus caribaea	192,085	121,784	431,440	745,309
3	Eucalyptus	E. grandis local	300,658	78,145	143,700	522,503
4	Eucalyptus Clones	GU7	58,101	61,447	121,821	241,369

5	Indigenous	Grevillea robusta	146,824	17,019	64,062	227,905
6	Indigenous	Tectona grandis	9,131	1,313	152,344	162,788
7	Indigenous	Dovyalis caffra	84,831	15,853	27,243	127,927
8	Indigenous	Calliandra	27,498	34,168	58,005	119,671
9	Indigenous	Maesopsis eminii (3" pot)	37,888	24,974	48,807	111,669
10	Indigenous	Bathedavia nyasica	32,506	3,880	53,826	90,212
11	Indigenous	Melia dubia (Volkensii)	20,152	8,125	47,260	75,537
12	Eucalyptus	E. camaldulensis	32,050	5,890	37,035	74,975
13	Indigenous	Prunus africana (3")	45,987	4,248	22,598	72,833
14	Eucalyptus Clones	GC 796/1	-	20,881	46,103	66,984
15	Pines and Other Exotics	Pinus oorcapa	584	382	65,839	66,805
16	Indigenous	Terminalia superba (3")	20,911	8,714	25,481	55,106
17	Indigenous	Markhamia lutea	4,691	247	41,937	46,875

Source: NTSC annual reports, 2024

Apart from the tree seedlings being generated at the NTSC, NFA does generate tree seedlings across the country and this has played pivotal roles in the restoration processes across the country (**Figure 40**).

Figure 40*: Shea tree seedlings at the NFA, Gulu city (***Photo Credit:** *NEMA, 2024).*

Restoration of degraded land (forests)

In May 2024, NEMA launched the Mt. Elgon project during the celebration of International Day for Biodiversity (IDB). The Mt Elgon project is intended to strengthen national policies regarding integrated landscape management, sustainable land management, and climate-smart agriculture. The project will also increase the capacity of authorities to restore degraded farmlands, conserve biodiversity, and promote climate change resilience among vulnerable groups, especially children and women as well as raising awareness about integrating environmental conservation with economic activities among local communities.

The project launch event and celebrations to mark the IDB were preceded by activities of restoring degraded portions of River Kaptokwoi and institutional greening of the Kapchorwa District Headquarters including Elgon Primary school that ran from 15th to 21st May, 2024. A total of 3,877 were planted by NEMA and partner organizations to restore River Kaptokwoi and institutional greening during the IDB in 2024 as shown in **Table 8**.

Table 8: ***The seedlings planted along River Kaptokwoi in Kapchorwa District.***

s/n	Common Name	Scientific Name	Quantity of Seedlings Planted
01	Bamboo	*Oxythenanthera Sp.*	1000
02	Ashok	*Saraca asoca* (Roxb.) Willd.	250
03	Alginia	*Alpinia galangal* (Roxb)	500
04	Podocarpusspp	*Podocarpus macrophyllus* (Thunb.) Sweet	500
05	Black ironwood	*Olea capensis L.*	20
06	Benjamin Tree	*Ficus benjamina L.*	25
07	Broad-Leaved Croton	*Croton macrostachyus Hochst. ex Delile*	800
08	Mimosa or Silk tree	*Albizia coriaria Welw. ex Oliv.*	782
	Total of seedlings		**3877**

Source: NEMA

Restoration of River Kaptokwoi involved planting of bamboo seedlings in a stretch of 8km on either side of the river bank (1.8ha). The aim was to improve on soil and water conservation along the river and reduce the speed of run-off thus reducing soil erosion. On the other hand, institutional greening of Kapchorwa district headquarters and Elgon Primary school involved planting of shade tree species to provide shade and act as wind breakers.

Incentive's framework is being developed to encourage the retention of communal forests, private land forests, and on-farm trees while promoting the establishment and management of mixed forest plantations with indigenous species. Recommendations from Walker et al. (2023) to re-examine land tenure rights to reduce deforestation will be considered. Furthermore, the ongoing review of the Forest Policy 2003 will include incentives for forest conservation, tree planting, dryland forest establishment, and management. Law enforcement and litigation costs for encroachment of CFRs will be increased, and forest boundaries will be opened to discourage encroachment.

The National Forestry Authority (NFA) is strengthening the conservation and management strategies through improved management of central forest reserves, partnership arrangements with stakeholders, equitable supply of forest and non-forest products and services and enhancing organizational sustainability for environmentally sustainable economic and social development.

Response to the urban development

To enable and sustain industrial growth, the country needs to address some challenges, which include; inadequate infrastructure such as transport, electricity supply, water and sewerage services, ICT and telecommunication services, and produced industrial goods. Several cities and districts in Uganda are adopting green spaces as a strategy to mitigate pollution and reduce the urban heat island effect, a phenomenon where heat is trapped in built-up areas (**Figure 41**).

Mbale City

Gulu City

Figure 41: ***Green spaces as a strategy to mitigate pollution and reduce the urban heat island effect.*** **(Photo Credit:** ***NEMA, 2024)***

ii) Wetlands

The National Environment Act, Cap. 181, defines wetlands as areas either permanently or seasonally flooded by water, characterized by waterlogged grasslands, swamps, marshes, and bogs. Wetlands, also referred to as the "kidneys of the earth," support biodiversity, improve water quality, regulate floods, and store carbon. They contribute to the attainment of several UN Sustainable Development Goals, including clean water (SDG 6), life below water (SDG 14), and life on land (SDG 15). Wetlands also sustain household livelihoods through activities such as fishing, farming, hunting, and grazing.

In 2023, 8,614 wetlands were gazetted by government. To date, wetlands cover about 13% of Uganda's total land area. Wetlands in Lake Victoria Basin supports over 200 fish species and numerous bird species. Wetlands around Lake Kyoga and Lake Albert harbor biodiversity, maintain ecological and support livelihoods of local communities.

Despite their importance, wetlands continue to dwindle due to human activities like agriculture, pollution, and resource over-harvesting. Globally, 35% of wetlands have been lost since 1970, with 87% of this loss occurring in the 20th century. Uganda's wetland coverage declined from 15.5% in 1994 to 13% by 2017 and 13.9% in 2021 with only 8.9% remaining relatively undisturbed. Uganda lost 7,500 km² of wetlands from 2000 to 2021, and an estimated 5,000 hectares are lost annually. The loss is attributed to increasing human population, agricultural expansion, urbanization, and infrastructure development (UBOS, 2024). Wetland degradation is especially pronounced in the eastern region and resulted in biodiversity loss, poor water quality and increased flooding.

Pollution from industrial discharges, agricultural runoff, and domestic waste has degraded water quality, causing eutrophication and harming aquatic life. Biodiversity is also declining as habitats are lost and fragmented. Drainage basins of Lake Victoria, Lake Kyoga, and the Albert Nile are crucial for Uganda's water balance. Wetlands in these basins help in flood control, water filtration, and groundwater recharge. However, deforestation, overgrazing, and industrial development have disrupted hydrological regimes thereby increasing sedimentation and nutrient load downstream.
Regionally, wetland conditions vary. The eastern region experiences the highest wetland coverage loss and degradation at 41.0% (**Figure 42**).

Wetlands in the central region, especially around Kampala city are destroyed by urbanization. In the eastern region, Lake Kyoga basin is heavily used for agriculture (rice growing) and fishing, leading to degradation. Wetlands in the northern region, although less densely populated, are being degraded by agricultural encroachment and climate change effects.

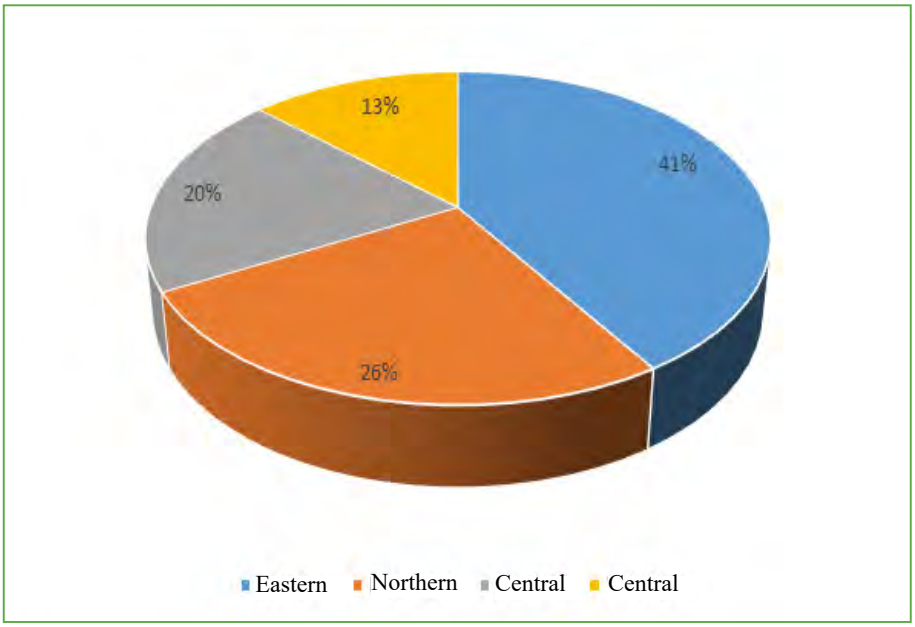
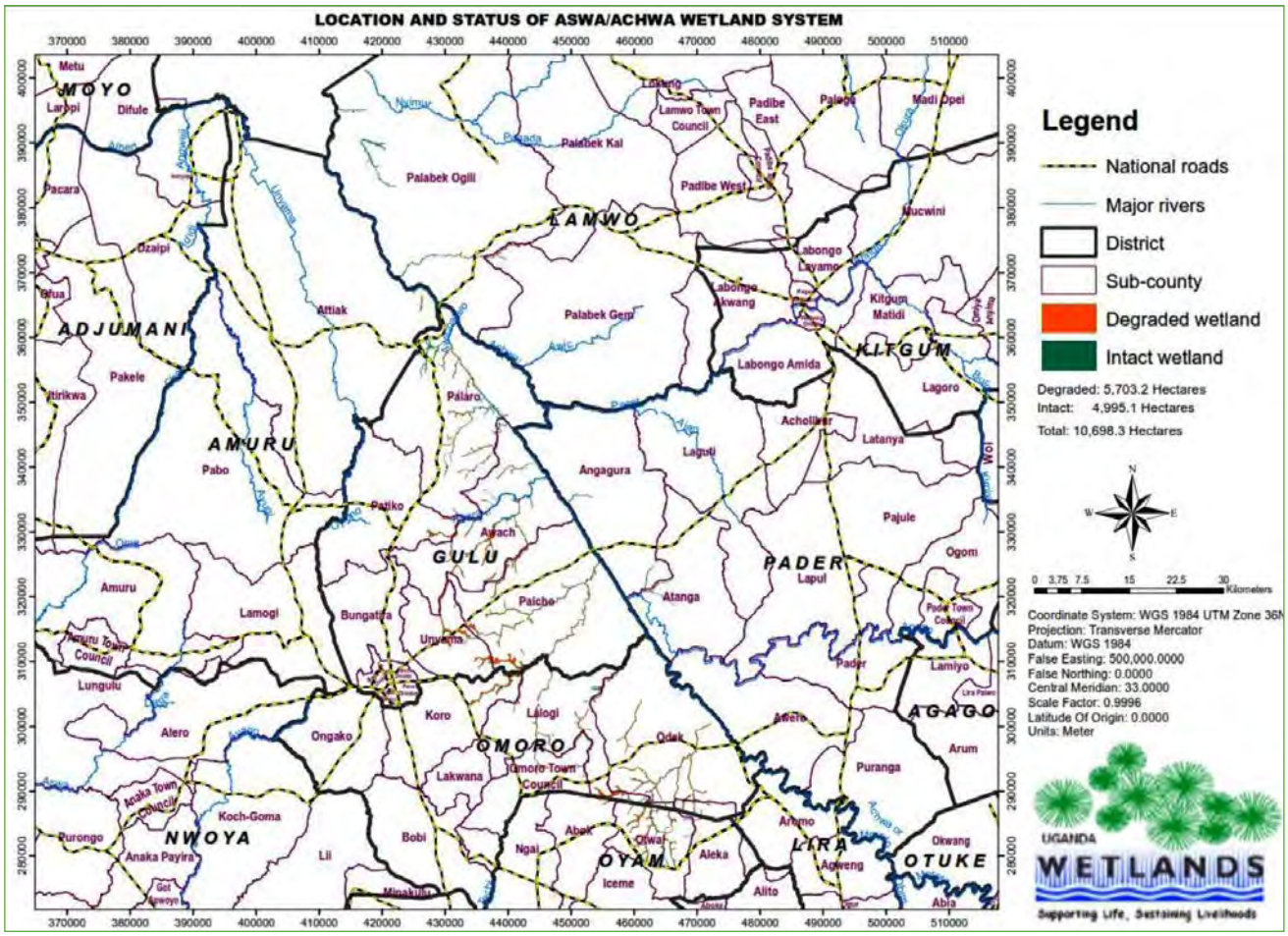
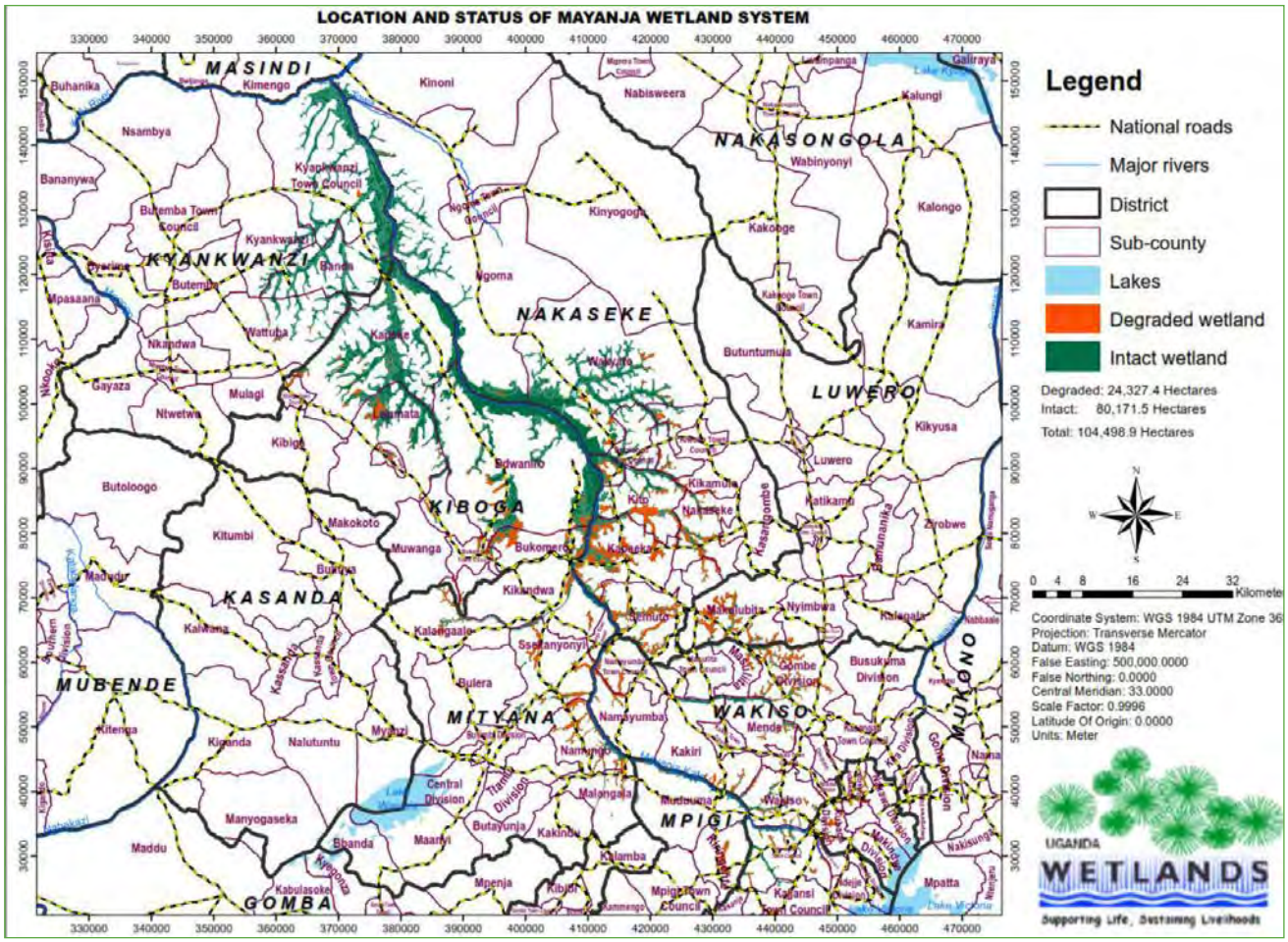


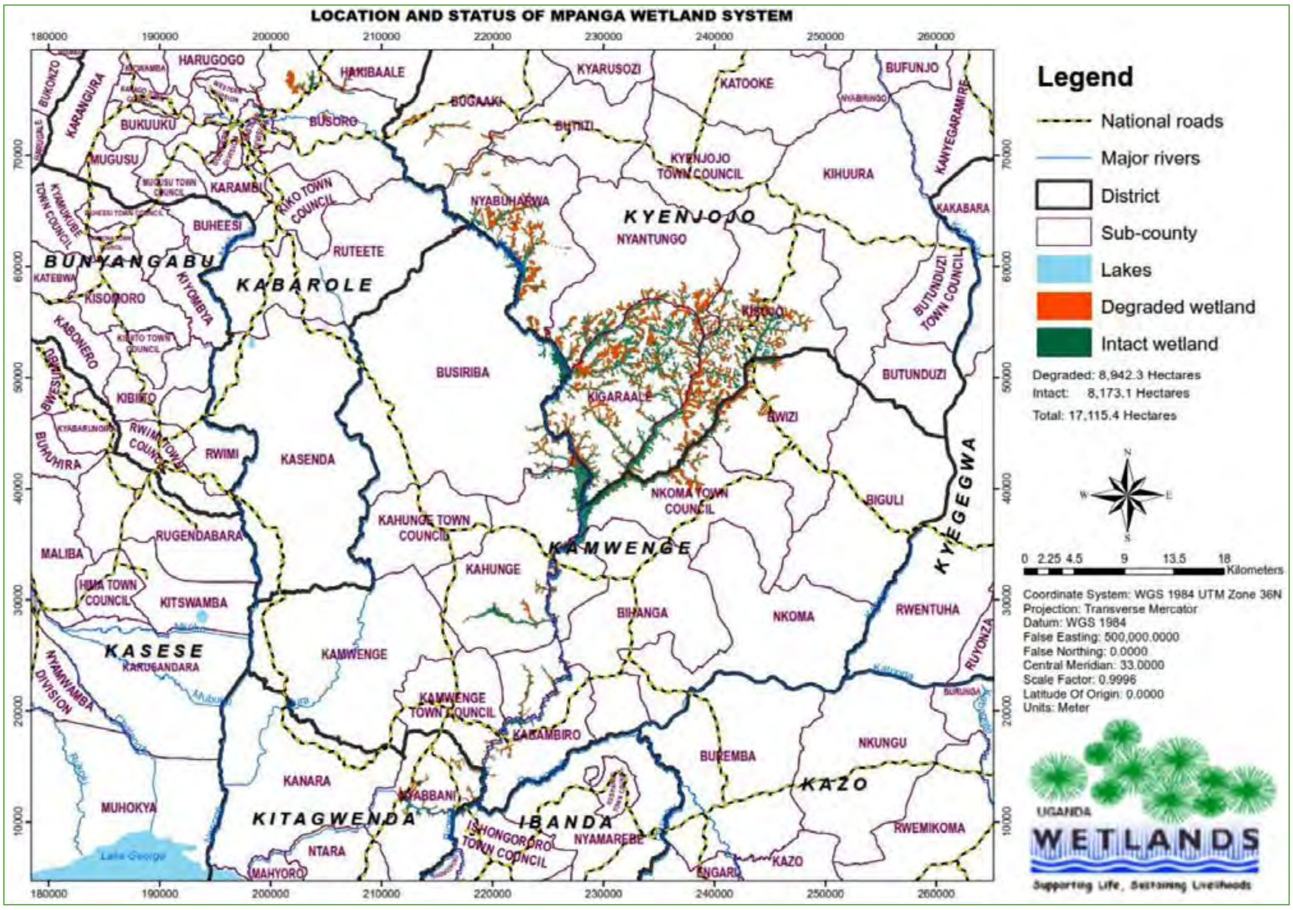
Figure 42*: Percentage wetland degradation per region in Uganda, 2021. (***Source***: MWE, 2022).***

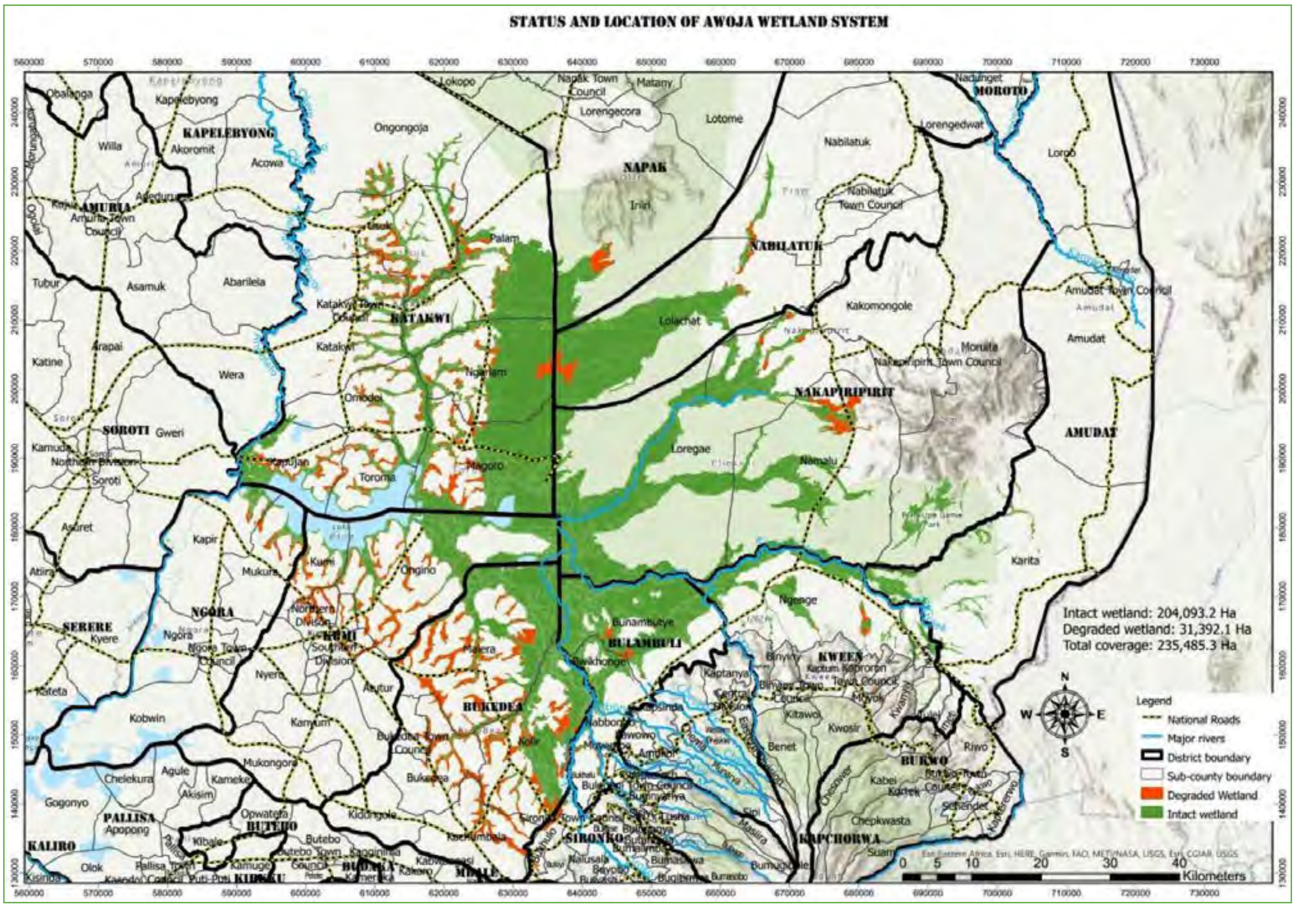
Wetlands demarcated

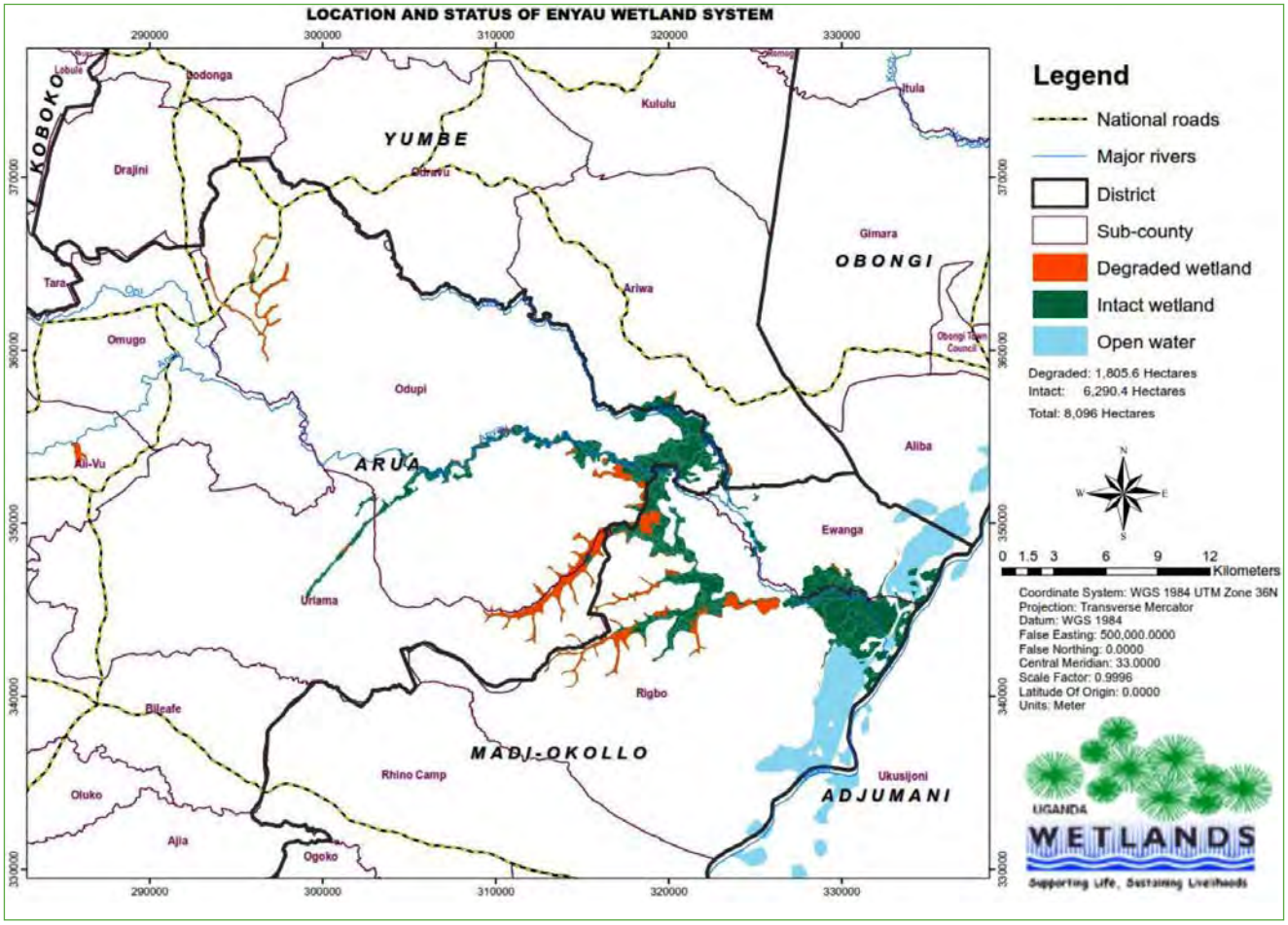
To date, approx. 2,500 km of wetland boundaries in the country have been demarcated with concrete pillars and live markers such as trees planted on the boundary. The boundaries of 10 wetlands have been demarcated in different regions in the country including Aswa/Achwa wetland system; Awoja wetland systems; Enyau wetland system; Kibimba wetland system; Mayanja wetland systems, Lumbuye wetland system; Mpanga wetland system; Muszizi wetland system; Tochi wetland systems and Sezibwa-Lwajali wetland system (**Figure 43**).

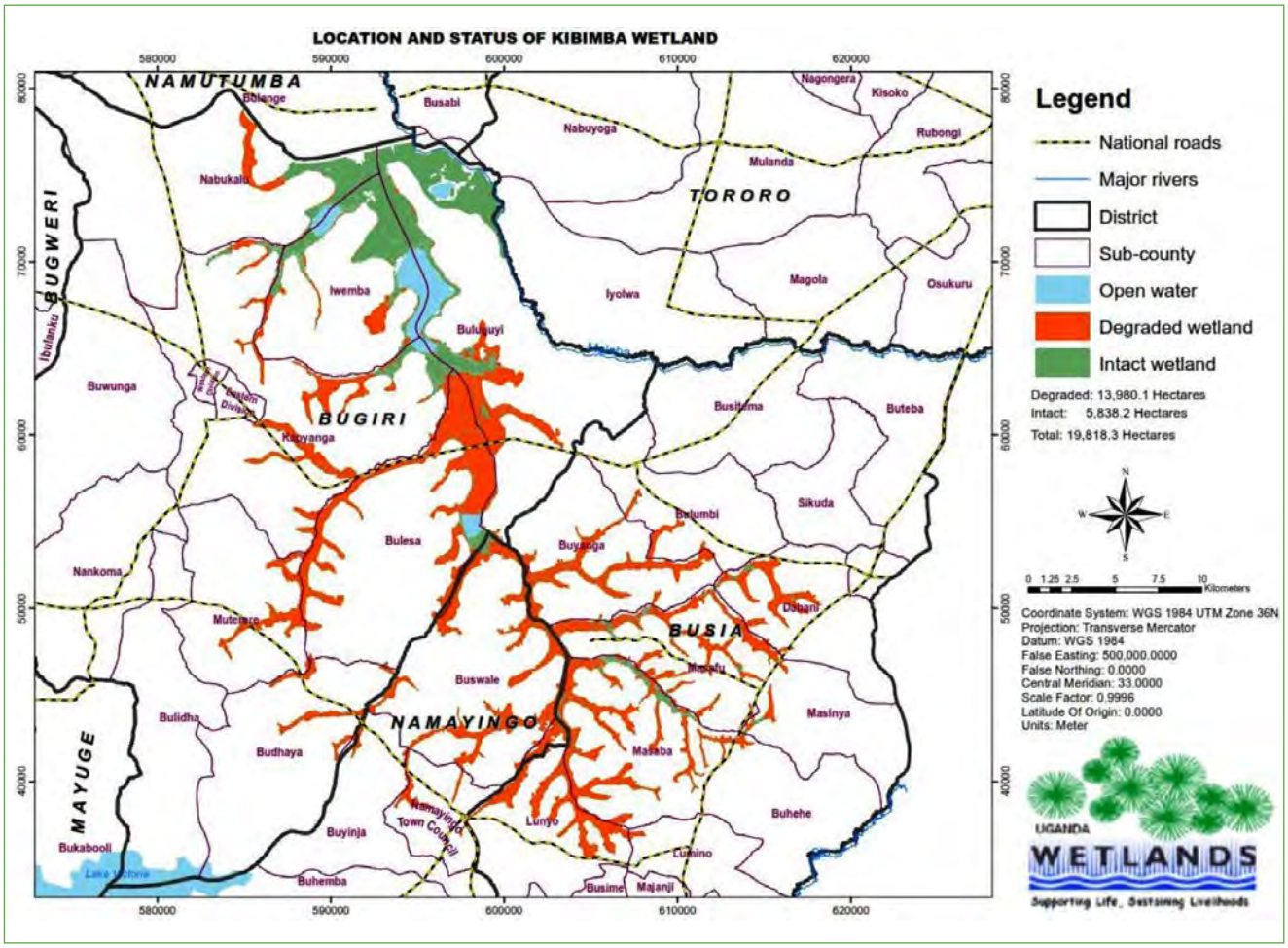

LOCATION AND STATUS OF ASWA/ACHWA WETLAND SYSTEM
MOYO
LAMWO
ADJUMANI
KLTGUM
AMURU
GULU
PADER
AGAGO
OMORO
NWOYA
OYAM
LIRA
OTUKE
Legend
National roads
Major rivers
District
Sub-county
Degraded wetland
Intact wetland
Degraded: 5,703.2 Hectares
Intact: 4,995.1 Hectares
Total: 10,698.3 Hectares
Coordinate System: WGS 1984 UTM Zone 36N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 33.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
UGANDA
WETLANDS
Supporting Life, Sustaining Livelihoods


LOCATION AND STATUS OF MAYANJA WETLAND SYSTEM
MASINDI
NAKASONGOLA
KYANKWANZI
NAKASEKE
LUWERO
KIBOGA
KASANDA
MUBENDE
MITYANA
WAKISO
MPIGI
GOMBA
Legend
National roads
Major rivers
District
Sub-county
Lakes
Degraded wetland
Intact wetland
Degraded: 24,327.4 Hectares
Intact: 80,171.5 Hectares
Total: 104,498.9 Hectares
Coordinate System: WGS 1984 UTM Zone 36N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 33.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
UGANDA
WETLANDS
Supporting Life, Sustaining Livelihoods


LOCATION AND STATUS OF MPANGA WETLAND SYSTEM
Legend
National roads
Major rivers
District
Sub-county
Lakes
Degraded wetland
Intact wetland
Degraded: 8,942.3 Hectares
Intact: 8,173.1 Hectares
Total: 17,115.4 Hectares
0 2.25 4.5 9 13.5 18 Kilometers
Coordinate System: WGS 1984 UTM Zone 36N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 33.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
KYENJOJO
KABAROLE
BUNYANGABU
KAMWENGE
KASESE
KITAGWENDA
IBANDA
KAZO
KYEGEGWA
UGANDA
WETLANDS
Supporting Life, Sustaining Livelihoods


STATUS AND LOCATION OF AWOJA WETLAND SYSTEM
Intact wetland: 204,093.2 Ha
Degraded wetland: 31,392.1 Ha
Total coverage: 235,485.3 Ha
Legend
National Roads
Major rivers
District boundary
Sub-county boundary
Degraded Wetland
Intact wetland
0 5 10 20 30 40 Kilometers
NAPAK
KATAKWI
NAKAPIRIPIRIT
SOROTI
AMUDAT
SERERE
NGORA
KUMI
BUKEDEA
BULAMBULI
KWEEN
BUKWO
KAPCHORWA
PALLISA
BUTEBO
KALIRO
SIRONKO
MBALE
MOROTO
NABILATUK
KAPELEBYONG
AMURIA


LOCATION AND STATUS OF ENYAU WETLAND SYSTEM
290000
300000
310000
320000
330000
370000
360000
350000
340000
330000
KOBOKO
YUMBE
OBONGI
ARUA
MADI-OKOLLO
ADJUMANI
Bodonga
Kululu
Itula
Drajini
Gimara
Tara
Ariwa
Omugo
Odupi
Aliba
Ewanga
Uriama
Rigbo
Bileafe
Rhino Camp
Ukusijoni
Oluko
Ajia
Ogoko
Legend
National roads
Major rivers
District
Sub-county
Degraded wetland
Intact wetland
Open water
Degraded: 1,805.6 Hectares
Intact: 6,290.4 Hectares
Total: 8,096 Hectares
0 1.5 3 6 9 12
Kilometers
Coordinate System: WGS 1984 UTM Zone 36N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 33.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
UGANDA
WETLANDS
Supporting Life, Sustaining Livelihoods


LOCATION AND STATUS OF KIBIMBA WETLAND
580000
590000
600000
610000
620000
80000
70000
60000
50000
40000
NAMUTUMBA
BUGWERI
BUGIRI
TORORO
BUSIA
NAMAYINGO
MAYUGE
Nagongera
Kisoko
Busabi
Nabuyoga
Rubongi
Mulanda
Nabukalu
Iyolwa
Magola
Osukuru
Iwemba
Bulubuyi
Buwunga
Busitema
Buteba
Kapyanga
Sikuda
Bulesa
Buyaga
Nankoma
Dabani
Mutegwa
Buswale
Masinya
Bulidha
Budhaya
Masaba
Buhehe
Buyinja
Lumino
Bukabooli
Buhemba
Busime
Majanji
Legend
National roads
Major rivers
District
Sub-county
Open water
Degraded wetland
Intact wetland
Degraded: 13,980.1 Hectares
Intact: 5,838.2 Hectares
Total: 19,818.3 Hectares
0 1.25 2.5 5 7.5 10
Kilometers
Coordinate System: WGS 1984 UTM Zone 36N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 33.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
UGANDA
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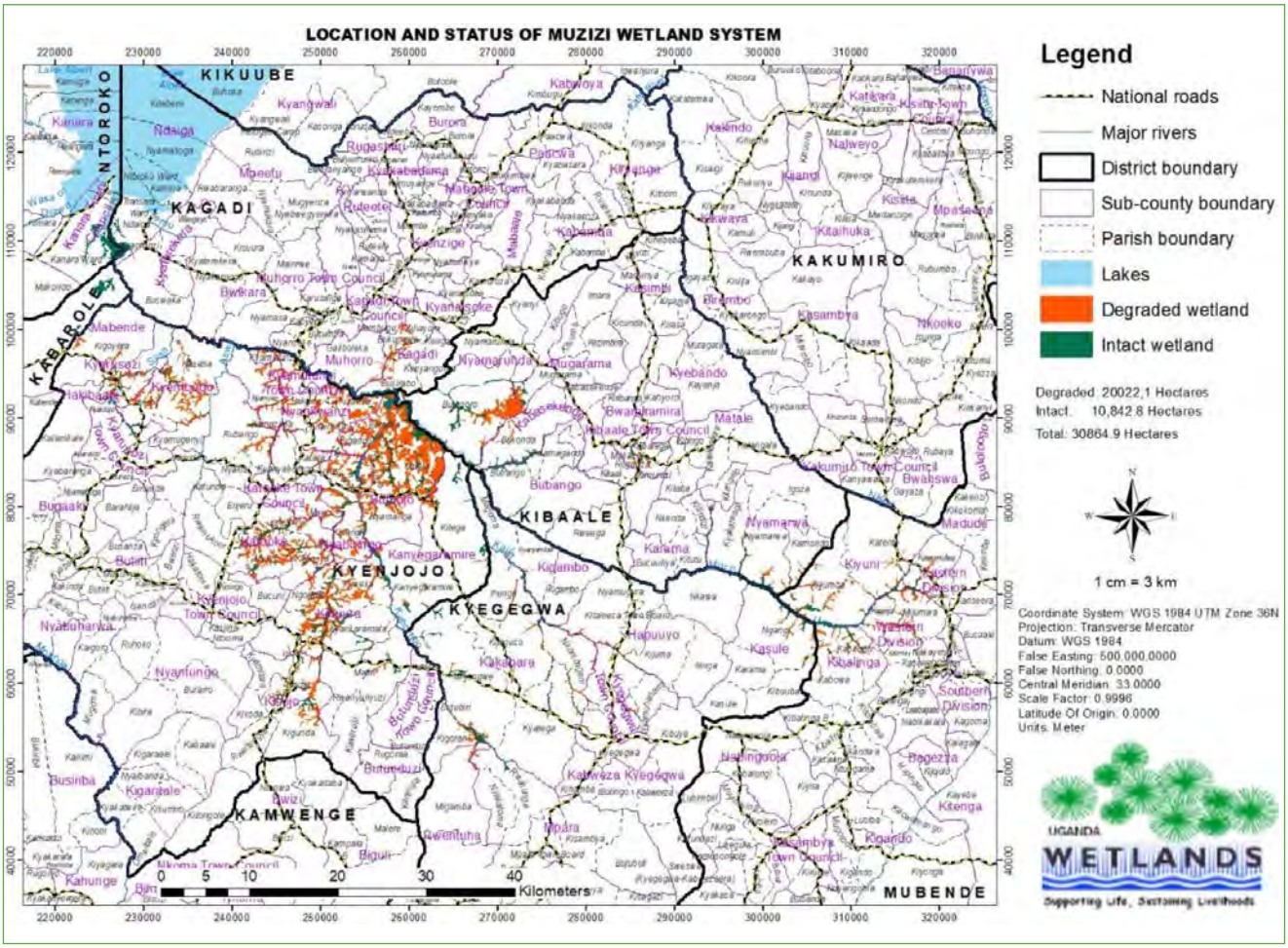
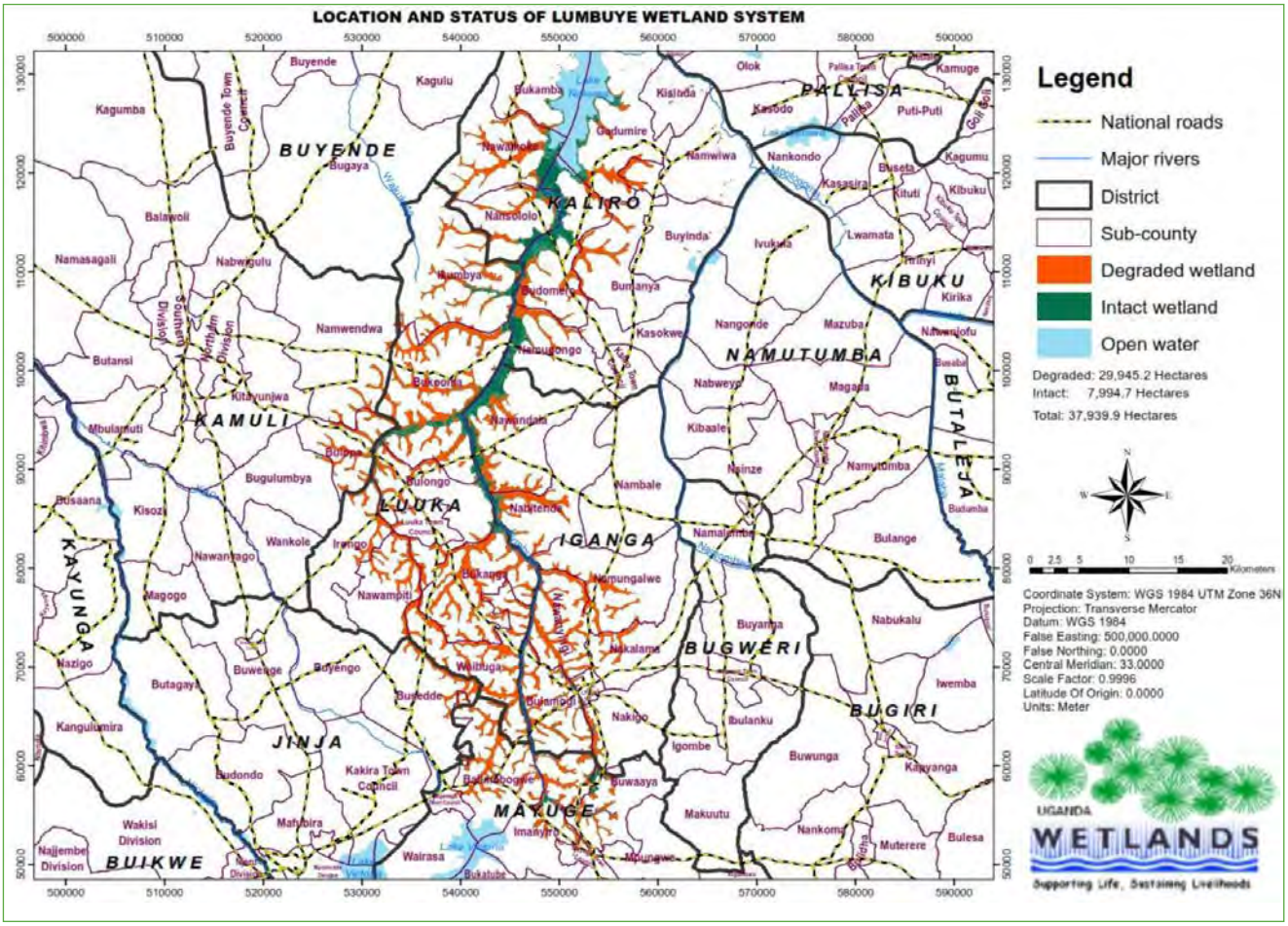
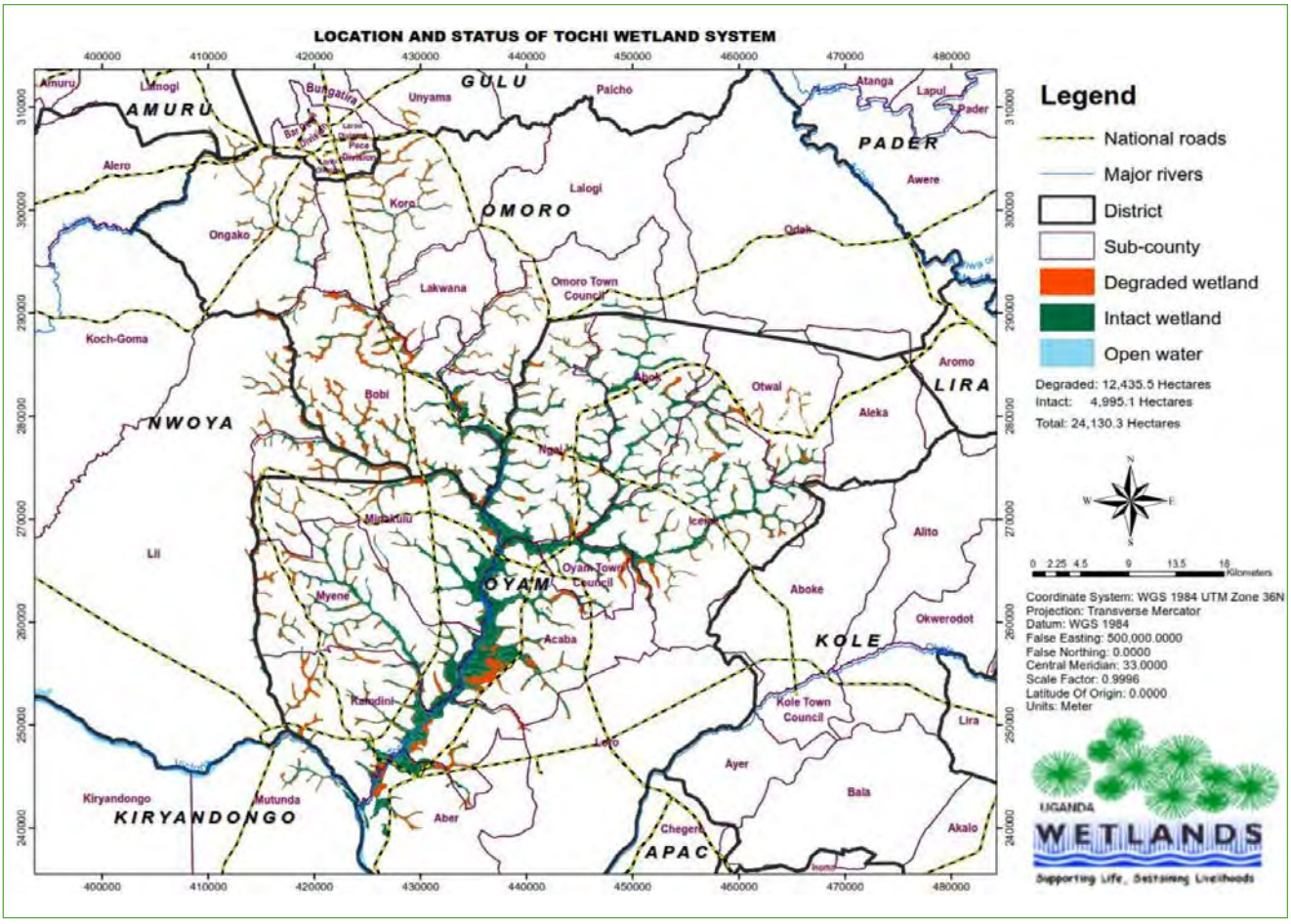

LOCATION AND STATUS OF MUZIZI WETLAND SYSTEM
KIKUUBE
KAGADI
KAKUMIRO
KIBAALE
KYENJOJO
KYEGEGWA
KAMWENGE
MUBENDE
KABAROLE
NTOROKO
Legend
National roads
Major rivers
District boundary
Sub-county boundary
Parish boundary
Lakes
Degraded wetland
Intact wetland
Degraded 20022,1 Hectares
Intact 10,842.8 Hectares
Total: 30864.9 Hectares
1 cm = 3 km
Coordinate System: WGS 1984 UTM Zone 36N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 33.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
0 5 10 20 30 40
Kilometers
UGANDA
WETLANDS
Supporting Life, Sustaining Livelihoods


LOCATION AND STATUS OF LUMBUYE WETLAND SYSTEM
BUYENDE
KALIRO
PALLISA
KIBUKU
NAMUTUMBA
BUTALEJA
KAMULI
LUUKA
IGANGA
BUGWERI
BUGIRI
KAYUNGA
JINJA
MAYUGE
BUIKWE
Legend
National roads
Major rivers
District
Sub-county
Degraded wetland
Intact wetland
Open water
Degraded: 29,945.2 Hectares
Intact: 7,994.7 Hectares
Total: 37,939.9 Hectares
Coordinate System: WGS 1984 UTM Zone 36N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: 33.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter
UGANDA
WETLANDS
Supporting Life, Sustaining Livelihoods



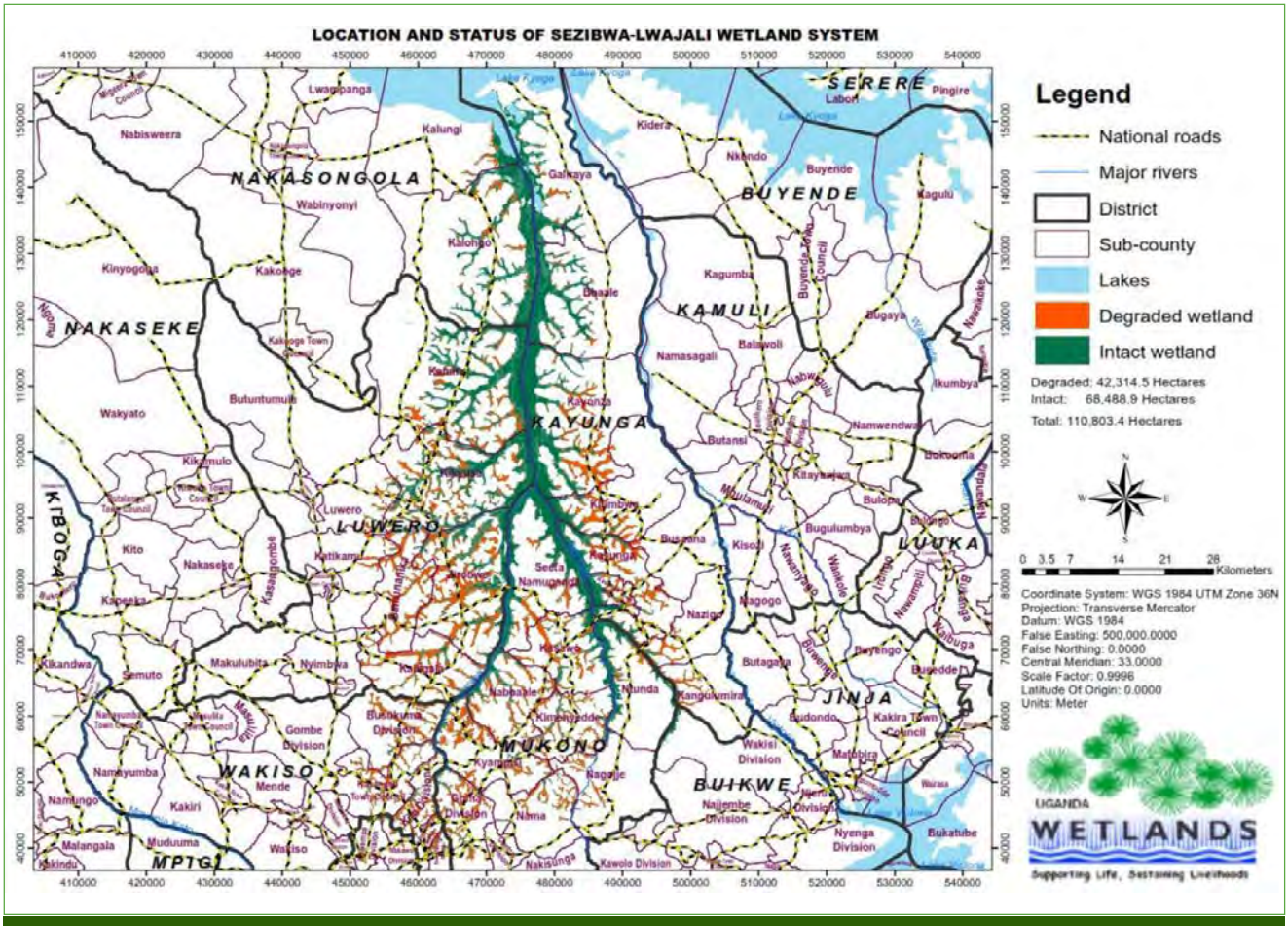


Figure 43*: Demarcated wetlands in Uganda.*

iii) Ramsar sites

Uganda has 12 Ramsar sites including Nabajjuzi, Lutembe Bay, Mabamba, Makanaga, Lake Opeta, Lake Bisina, Lake Nakuwa, Lake Nabugabo, Lake Albert, Nile Delta. These are continuously threatened by human activities. Wetland conditions vary in the regions. The eastern region experiences the highest wetland degradation and loss estimated at 41.% while northern lost 26% of the wetlands. Twenty percent of wetlands in central region are degraded while 13% of wetlands in the western region are degraded (MWE, 2022).

iv) Mountain ecosystems

Mountain ecosystems, such as the Rwenzori Mountains National Park, a UNESCO World Heritage Site, and Mount Elgon National Park, contribute significantly to Uganda's biodiversity. Uganda's rivers and lakes, including the Nile and Lake Bunyonyi, support diverse aquatic life and provide essential ecological services.

v) Agricultural landscapes

Agricultural landscapes, though altered by human activity, contribute to ecosystem diversity through agroforestry practices and mixed farming systems. Uganda faces challenges in conserving ecosystems on agricultural landscapes including mitigation of deforestation, which is estimated at 3.3% annually.

vi) Rangelands

A rangeland, is an extensive area of land occupied by native herbaceous or shrubby vegetation which is grazed by domestic or wild herbivores. The vegetation of ranges may include tallgrass, shortgrass, shrublands, woodlands, and savannas. Tropical forests that are used for grazing as well as timber production can also be considered rangeland.

Worldwide, about 40.5% of terrestrial ecosystems are grasslands while rangelands cover more than 52.5 million km^2. Rangelands cover 44% of Uganda's total land area, sustaining 80% of the national livestock herd and 90% of the cattle. About 13.8% of terrestrial rangelands are woody savanna, 12.7% are open and closed shrublands, 8.3% are non-weedy grasslands, and 5.7% are tundra (Anderson, 2002). Rangelands support livelihoods and contribute to household food security. Water, grass, and shrubs are the most important rangeland resources (Mbolanyi, et al., 2016).

3.4.3. Species diversity

Uganda is home to a wide range of terrestrial species due to its diverse ecosystems, which include tropical rainforests, savannas, and montane regions. This biodiversity, which includes a number of endemic and endangered species, are part of the ecosystem services that are essential for the country's economy and the well-being of the people. However, biodiversity continues to experience pressure from human activities, climate change, and habitat degradation.

Uganda has high biodiversity because of its location at the convergence of Africa's distinct biogeographic regions or phytochoria (White. 1983) between the ecological communities that are characteristic of the drier East African Savanna and the moist West African rain forests. In addition, the country's high-altitude ranges, make it a high biodiversity hotspot. Moreover, the country has unique landscapes including mountains, rift valleys, wetlands, rivers, fresh water lakes, savannas and tropical rainforests (NEMA, 2016).

Uganda ranks among the top ten most bio-diverse countries globally, with 18,783 species of fauna and flora. It hosts 53.9% of the world's remaining mountain gorilla population, 11% (1063 species) of the world's bird species (50% of Africa species), 7.8% (345 species) of global mammal diversity (39% of Africa), 19% of Africa's amphibian species richness, and 14% (165 species) of Africa's reptile species richness, 1249 recorded butterfly species, and 86 amphibian species (NEMA, 2016 and UWA, 2022). The "Fresh water biodiversity portal of Uganda, indicates that 673 fish species are found in Ugandan waters.

However, 537 species are nationally threatened,

including 110 critically endangered, 174 endangered, and 253 vulnerable (NEMA, 2016 and UWA, 2022). According to the Red list of Threatened Species in Uganda Report (2018), the number of species by taxon that are nationally threatened in Uganda are: 77 species of mammals, 83 birds, 31 reptiles, 19 amphibians, 44 dragon flies, 184 butterflies and 99 plant species.

Aquatic Species

Aquatic ecosystems (habitats and organisms) include rivers and streams, ponds and lakes, oceans and bays, and swamps and marshes, and the associated animals (Helfrich et al., 2019). Aquatic species diversity includes the variety of life forms found in freshwater and marine ecosystems. It maintains healthy aquatic ecosystems, support food chains, water purification, and provide resources for human livelihoods.

The biotic communities associated with aquatic ecosystems in Uganda (lakes, rivers and wetlands) include macrophytes, algae, invertebrates, fishes and non-fish vertebrates (LVBC, 2011). The aquatic macrophytes in the Lake Victoria basin, for example, are dominated by grasses (Poaceae) and sedges (Cyperaceae) such as *Miscanthus violaceous, Phragmites maurtianus, Cyperus latifolius, Tyhpha domingesis and Cladium mariscucs spp*, Jamicense with papyrus (LVBC, 2011).

At least 600 species of algae comprising diatoms (Bacillariophycea), blue green algae (Cynobacteria) green algae (Chlorophyea), brown algae (Chrysophyceae) and dinoflagelletes, (Dinophytes), are found in Lake Victoria Basin (LVBC, 2011). Up to 40 aquatic invertebrate species have been documented in Lake Victoria Basin including Cyclopoid, copepods, Chaoborus spp., Chironomus spp. such as nymphs, mollusks, crabs (*Potamon eminii*) and prawns (*Caridina nilotica*).

The lake basin has 183 fish species belonging to 55 genera, 13 families, and seven orders (with 179 fish species in 52 genera and 13 families recorded in the 17 lakes; 39 fish species in 27 genera and 14 families recorded in 10 rivers; and 15 fish species belonging to 14 genera and 9 families recorded in two wetland ecosystems. Before the introduction of Nile perch and Nile tilapia (exotic fishes in the Lake Victoria basin), 500 haplochromine cichlids existed but the population has declined to about 200 only.

Native fishery of the Lake Victoria: comprises Oreochromis esculentus, *Oreochromis variabilis, Mormyrus kannume; Labeo victorianus*. However, *Oreochromis niloticus, Coptodon zilli, Tilapial rendalii, Oreochormis leucosticus* were introduced in the lake in 1950's (LVBC, 2011).

Lake Albert supports the most diverse commercial fisheries in Uganda with at least 55 species. The Kyoga basin lakes have 12 fish taxa recorded in 2024. The fish species include Lates spp.; *R. argentae; Tilapiines; Clarias sp.; Protopterus sp.; Synodontis spp.; Haplochromines spp.; Labeo* spp., Barbus spp.; *Schilbe* spp.; *Bagrus* spp and *Mormyrus* spp. (Bassa et al., 2024). River Nile habours diverse fish populations that support local communities' livelihoods. Insects, particularly butterflies, moths, bees, and other pollinators, play a vital role in maintaining ecosystem health and supporting agriculture.

Populations of fauna

Wildlife populations have steadily increased especially for some key species since the late 1980s despite the decline in numbers observed in the 1970s and early 1980s (**Table 9**). Elephant population, for instance, increased from 2,000 in late 1983 to 7,975 individuals by 2020; buffaloes increased from 25,000 (1983) to over 40,000 by 2020; giraffe population increased from 250 individuals in 1995 to over 2,000 in 2020 and many others. The number of lions has declined from 490 in 2010 to about 300 in 2022 due to habitat loss, poisoning by livestock farmers and illegal trade in lion body parts. Beisa Oryx, Lord Deby's eland, northern white rhino and eastern black rhino became extinct due to poaching in the 1970s and 1980s. Kibale National Park hosts over 1,500 chimpanzees, one of the highest densities globally. Uganda has more than half of the world's remaining mountain gorillas, predominantly found in Bwindi Impenetrable National Park and Mgahinga Gorilla National Park.

Table 9: *Population estimates of selected key wildlife species in Uganda*				
Species	**2011-2014**	**2015-2017**	**2018- 2020**	**2021-2023**
African Elephant	5,739	5,808	7,975	6,464
Bright's Gazelle	57	57	750	756
Buffalo	36,953	37,054	44,163	37,840
Burchell's Zebra	11,888	11,897	17,516	17,762
Chimpanzee	5,000	5,000	5,072	5,072
Common Eland	1,351	1,742	2,492	3,510
Gorilla*	400	400	459	459
Greater Kudu			206	206
Hartebeest	9,667	9,841	17,274	8,154
Hippopotamus	5,838	5,838	10,165	8,226
Impala	33,565	33,565	53,636	22,356
Lesser Kudu			806	806
Lion	493	493	373	314
Ostrich			1,856	1,956
Roan Antelope - Sub-species Langheldi		118	190	352
Rothschild's Giraffe	880	880	2,072	2,414
Southern White Rhino	17	22	35	43
Topi	2,222	2,222	2,713	3,189
Ugandan Kob	77,759	74,702	175,590	174,037
Waterbuck	12,222	12,809	22,244	17,442

*Numbers are records for Bwindi only (UWA, 2023)

Red list for Uganda

There are a number of species considered in the IUCN Red list for Uganda (National Red list for Uganda, 2018) as critically endangered (at risk of extinction), endangered, vulnerable (i.e., vulnerable to extinction) and data deficient describes species for which sufficient data are not available to allow it to be assessed (but are highly likely to be threatened). **Table 10** and **Figure 44** show the numbers of taxa in IUCN Red List for Uganda.

Table 10 *Summary of species in the Red List for Uganda*								
	Taxonomic Group							
	Mammals	**Birds**	**Reptiles**	**Amphibian**	**Butterflies**	**Dragonflies**	**Plants**	**Total**
Critically Endangered	14	9	5	1	44	16	20	109
Endangered	25	24	9	11	69	4	28	170
Vulnerable	38	50	17	7	71	24	40	247
Data								
Deficient	48	32	70	25	235	19	3	432

Source: National Red List for Uganda, 2018

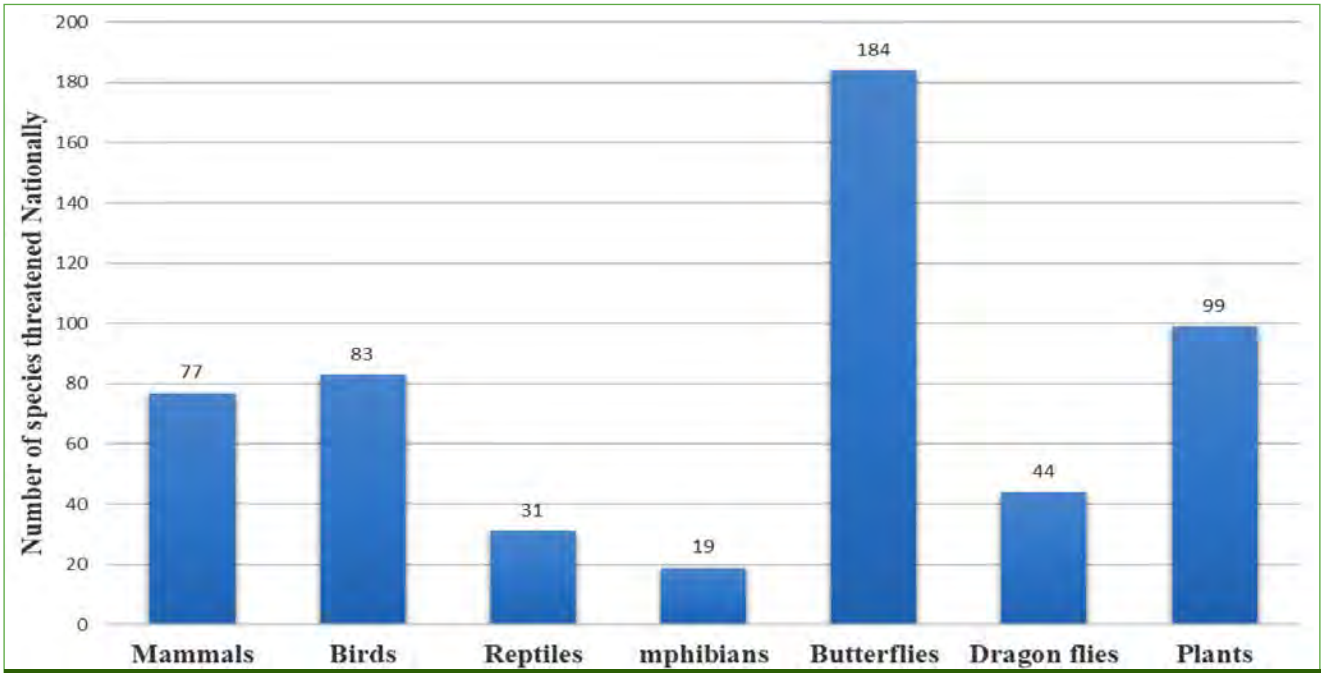
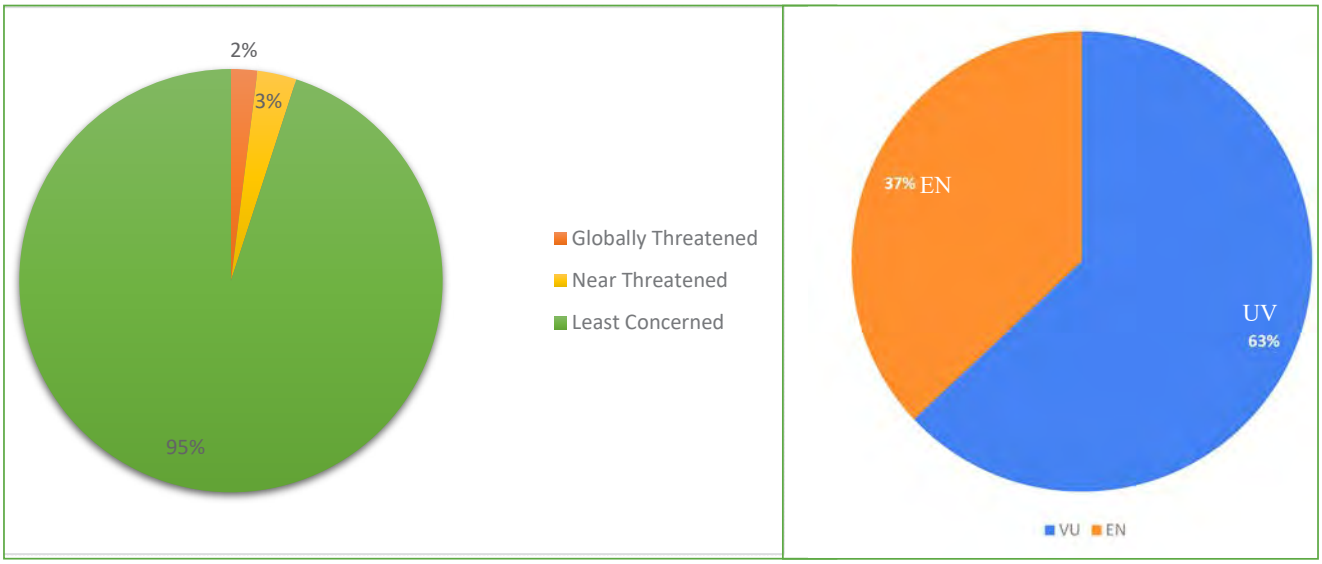


Figure 44*: Number of nationally threatened species by taxon in Uganda.* **Source***: MTWA (2018).*

Birds

Over 1,060 bird species are found in Uganda due to high diversity of habitats that makes Uganda one of the countries with high bird species diversity compared to its size in Africa. According to Birdlife International (2014, 2022), Africa has an estimated 2,477 species of birds, of which Uganda has 24 (2%) globally threatened bird species and 29 (3%) near-threatened species and the rest are of least concern. The globally threatened species include White-backed Vulture, Rüppell's Vulture and Hooded Vulture, and Grey-crowned crane species and 15 vulnerable species (**Figure 45**).



(**Source:** Birdlife International, 2014). Country Profile for Uganda.

Figure 45*: IUCN Red List status for all birds in Uganda (Left); Globally threatened (Right) in Uganda. [1]EN stands for endangered and [2]VU stands for vulnerable..*

Herpetiles (Amphibians and Reptiles)

There are 175 species of Reptilia, 77 genera, 19 families and 4 orders (the Chelonii, Crocodylia, Sauria and Serpentes) recorded in Uganda (Daniel, et al., 2016). The conservation status of these amphibians and reptiles is shown in **Table 11**

Table 11: *Conservation status of amphibians and reptiles.*

IUCN status	Amphibia species	Reptilia species
CR = Critically threatened	01 (Arthroleptides dutoiti)	06 (including Trionyx triunguis)
EN = Endangered	06	04
VU = Vulnerable	06	06
NT = Near Threatened	08	06
LC = Least Concern	48	73
DD = Data Deficient	11	80

(**Data Source**: Hughes et al.,2016)

Insects

Uganda has a wide spectrum of insects with over 1400 recorded butterfly species, over 100 species of emperor moths, over 115 species of hawkmoths, 240 species of dragonflies, 300 species of grasshoppers, several species of dung beetles, several species of bees (including honey bees and 3 stingless bee species) and several species of flies. Insects (e.g. ants, beetles, Lepidoptera and grasshoppers, are potential ingredients for animal feed and human food, provide pollination services (e.g. bees, Lepidoptera, coleopterea and dipteral), biodegradation functions (beetles such as Tenebrio molitor), commercial enterprises (bee hive products, pheromones and sericulture), ecotourism ('buttermonths' excursions, 'odontours' and greenhouse exhibitions), biocontrol agents (e.g. dragoneflies), pests and vectors (veterinary, agriculture and medical) and forensic.

3.4.4 Genetic diversity

Uganda's genetic diversity is crucial for agricultural resilience and ecological stability. The country boasts a rich variety of staple crops, including banana varieties, beans, cow peas, pigeon peas, cassava, maize, millet, sorghum, sweet potatoes and groundnuts among others. The preservation of traditional crop varieties is vital for food security and development of varieties that are resistant to drought, pests and diseases.

In terms of livestock, Uganda supports various indigenous breeds such as the Ankole cattle, known for their resilience to local conditions. Conservation of these genetic resources is essential for enhancing livestock productivity and adaptability. Efforts are ongoing to protect endangered wild species such as the mountain gorilla and Rothschild's giraffe, which helps maintain wildlife genetic diversity. Uganda's national parks and wildlife reserves are instrumental in conserving these genetic resources by providing secure habitats. Aquatic genetic diversity is also significant with great need to protect and preserve fish populations in Lake Victoria and the River Nile basins to prevent genetic erosion due to overfishing and invasive species. Wetlands contribute to genetic diversity by supporting a variety of aquatic plants and animals, essential for overall ecosystem health. Forests are vital ecosystems that are rich in genetic diversity as they host a wide range of endemic tree species. Conservation Programmes in natural forests such as Mabira and Budongo central forest reserves are critical for maintaining genetic diversity which is the foundation for ecosystem resilience and stability.

Government has put in place the Genetic Engineering Regulatory Act, 2018 aimed at regulating genetic engineering activities and facilitating safe development, transfer, application and utilization of genetically engineered materials. The Act also designates a National Focal Point, and establishes a Competent Authority; establishes the Inter-Ministerial Policy Committee on Genetic Engineering as well as a National Genetic Engineering Committee. Furthermore, the Act provides for the establishment of institutional genetic engineering committees; provides mechanisms to regulate research, development and general release of genetically engineered materials among others.

Pressures on genetic resources management in Uganda

i) Need to increase agricultural production

Increasing plant diseases in the country calls for innovative scientific research to increase food production in the country especially as human population grows and land productivity declines.

ii) Environmental changes

Changes in environmental conditions have led to increased plant disease outbreaks. There have also been increased incidences of crop diseases that require robust scientific response including the application of genetic engineering techniques. In addition, introduction of alien invasive weeds in the country has also led to ecosystem degradation e.g., water hyacinth in water bodies that attracted biological control approach to eradicate it.

3.4.5 Impacts of genetic diversity

a) Habitat loss and fragmentation

Habitat loss, fragmentation and degradation are impacts of agricultural expansion, urbanization, and infrastructure development which threaten the conservation of fauna and flora. The wildlife corridors (eg., Murchison Falls to Nimule, Kidepo – Lipan – Karenga to South Karamoja, and Queen Elizabeth – Kibale – Bugoma – Kabwoya – Murchison) have also had human settlements that hamper animal migrations. Animals trapped in these corridors are exposed to hunting and vulnerable to extinction. In addition, loss of forest cover means that animals that live in forests are vulnerable to extinction as well (**Figure 46**).

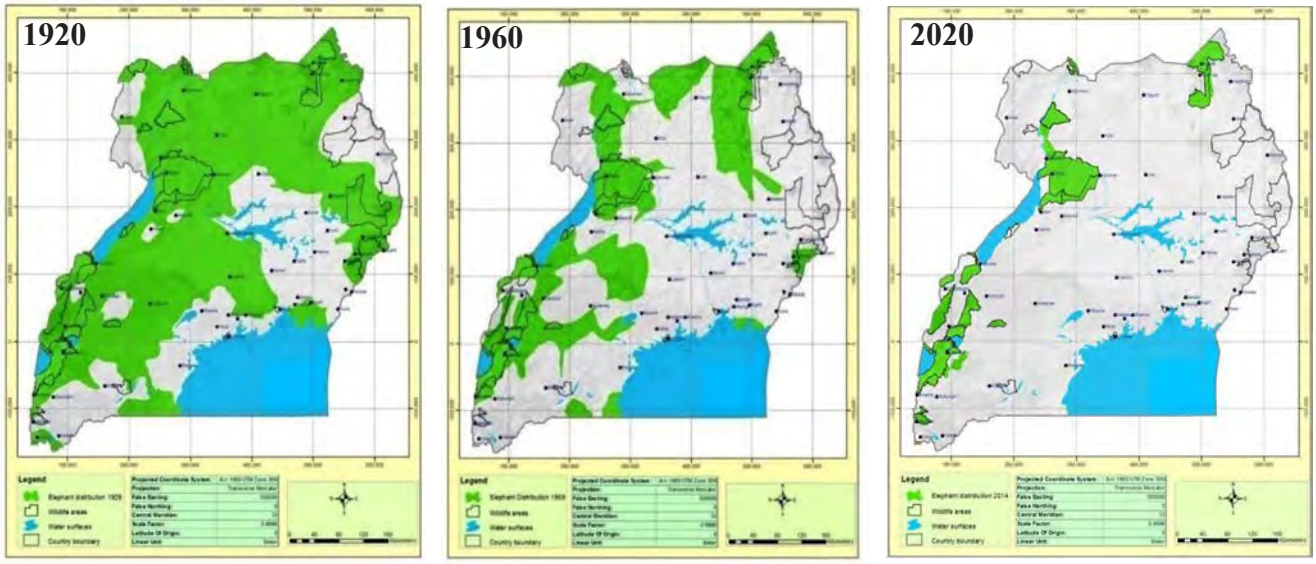


Figure 46*: Map showing elephant habitats and corridors in 1920, 1960 and 2020.*

National parks and wildlife reserves continue to face threats of degazettement due to demand for land for human settlement, ranching schemes and incursions by nomadic livestock keepers.

b) Cultural heritage loss

Wildlife is intertwined with Uganda's cultural values and norms. As such, loss of wildlife species erodes cultural identity and heritage. Many indigenous communities rely on wildlife resources for traditional practices, spiritual beliefs, and cultural expression. Loss of wildlife disrupts cultural identity and threatens the traditional practices of the communities. For example, the Buganda and Bamasaba attach strong cultural value to black and white colobus monkey and the species should not become extinct.

c) Loss of tourism income

Tourism is one of Uganda's biggest foreign exchange earners. Wildlife resources are key tourist attractions. Flagship species such as the Mountain gorilla attract large numbers of tourists and generate large amounts of revenue annually. Loss of wildlife implies loss of revenue to the country.

d) Decrease in agricultural productivity

Uganda's agricultural sector relies on wildlife resources particularly pollinators like bees, bats and birds which play a vital role in maintaining crop yields and quality. These essential pollinators inhabit wildlife habitats, including forests, wetlands, and grasslands. Loss of their habitats due to deforestation, land degradation, and other human activities threatens their existence and would result in low agricultural productivity and food insecurity.

e) Disruption of ecological balance

Genetic diversity supports ecosystem stability and resilience. Its loss weakens species' adaptability, disrupts ecological balance, and reduces essential resources from forests and aquatic systems. This affects food security, water quality, and human health. Protecting genetic diversity is crucial for sustaining ecosystems and human well-being.

f) Deforestation

This leads to habitat destruction/modification thus leaving species vulnerable to loss, displacement, reduced reproductive success, and ultimately, population decline. Deforestation disrupts photosynthesis and results in release of stored carbon into the atmosphere. Loss of trees reduces the capacity of the earth to absorb carbon dioxide and exacerbates the greenhouse gas effect. Forest loss reduces the cooling effect of evapotranspiration and results in change in local climate such as disrupted rainfall patterns and increased temperatures.

g) Decline in fish stocks

Destructive fishing practices cause precipitous decline in key fish stocks in lakes and rivers. In addition, fish requires suitable environmental conditions to live and reproduce. Existence of good fish habitat depends on a number of factors, such as water flow, water quality, availability of sufficient food, and low numbers of predators and competitors. Existence of negative factors lead to the decline in fish number and diversity in the ecosystem.

h) Biodiversity loss

Loss of biodiversity in Uganda has profound environmental, socio-economic, and health related impacts. In terms of environment, degradation of ecosystems hampers pollination, water purification, soil fertility, and climate regulation. On the other hand, deforestation leads to the loss of tree cover and causes soil erosion and diminished water quality, which adversely affects wildlife and livelihoods of local communities. Habitat fragmentation reduces ecosystem resilience and make it vulnerable to invasion by alien species and the negative impacts of climate change. Socio-economically, biodiversity loss directly affects livelihoods of households that depend on natural resources. Households that are involved in fishing, agriculture, and tourism face challenges when the resources they rely on diminish. Overfishing in Lake Victoria has led to declines in fish populations and negatively affected the livelihoods of local communities and threatened food security. In addition, tourism sector, which is a major economic driver for Uganda, suffers when wildlife populations decline, leading to reduced tourist visits and revenue. In terms of health, the disruption of natural habitats increases the risk of zoonotic diseases as humans and wildlife come into contact, while pollution and habitat degradation reduce supply of clean water thereby affecting

human health. Furthermore, wetland conversion for agriculture and urban development as well as removal of natural vegetation along the shorelines disrupts ecological balance, reduces biodiversity, and affects the overall resilience to environmental changes. This is further exacerbated by climate change impacts.

i) Miscellaneous impacts

Decline in biodiversity leads to loss of ecosystem services such as pollination and reduces crop yields. These have a spillover effect on food security and household livelihoods. Ecotourism is a major economic activity in and around protected areas such as Bwindi Impenetrable National Park. Decline in keystone species such as the mountain gorilla directly leads to a downturn in tourist arrivals and revenues. Human-wildlife conflicts also have devastating effects on wildlife and ripple effect on tourism. Disturbance of habitats force animals such as elephants and hippos onto farmlands and cause crop damage and destruction of property. These attract retaliatory killings of wild animals. Biodiversity loss also raises public health risks, as habitat destruction increases the likelihood of zoonotic diseases, such as Ebola, spreading to human populations.

3.4.6 Responses to loss of biodiversity

Uganda has implemented a number of conservation initiatives and policies to mitigate biodiversity loss. Strengthening the management of protected areas is one of the key policy strategies aimed at ensuring that national parks and wildlife reserves effectively conserve critical habitats and species. Uganda is also applying a multi-pronged approach to manage and control the spread of water hyacinth in Lake Victoria and the associated water bodies. Uganda's National Adaptation Plan integrates biodiversity conservation into climate resilience strategies such as wetland restoration.

Community-based conservation initiatives help to engage local communities in sustainable practices and promote biodiversity protection through projects such as community-based forest and wildlife management. Reforestation and habitat restoration programmes aim to rehabilitate degraded ecosystems, enhance biodiversity and ecosystem services. Policy and legislation frameworks are crucial in the fight against biodiversity loss. The National Biodiversity Strategy and Action Plan (NBSAP) provides a framework for conservation, setting of specific targets and actions for protection of biodiversity while ensuring sustainable use of natural resources. Strengthening the enforcement of wildlife protection laws and anti-poaching measures is essential to combat wildlife-related crimes such as poaching and wildlife trade which have severely impacted populations of wild animals such as elephants and rhinos.

Research and monitoring are vital components of effective biodiversity conservation. Biodiversity monitoring programmes provide continuous data on species populations and habitat conditions thus allowing for adaptive management and the evaluation of conservation interventions. Undertaking scientific research on biodiversity and ecosystem services helps to guide evidence-based policy and management decisions. Furthermore, raising public awareness about the importance of biodiversity through environmental education Programmes, media campaigns, and community outreach fosters and sustains a culture of environmental stewardship.

International cooperation enhances Uganda's capacity to conserve biodiversity. Transboundary conservation initiatives with neighboring countries help manage and protect shared ecosystems and wildlife corridors. Access to global funding mechanisms and technical support from international organizations, such as the Global Environment Facility (GEF) and various NGOs, bolsters conservation projects and initiatives. The following strategic interventions have been implemented to prevent further depletion of wildlife populations, enhance conservation and promote development for economic prosperity.

a) Policy and legal frameworks

Uganda has a policy and legal framework for wildlife conservation. Objective XXVII of the 1995 Constitution of the Republic of Uganda obligates the state, including local governments, to create and develop parks, reserves and

recreation areas and ensure conservation of natural resources, promote rational use of natural resources and safe guard and protect biodiversity. It further obligates the state to promote rational use of natural resources so as to safeguard and protect biodiversity. Specifically, conservation of wildlife is provided under Article 237(2b) of the Constitution.

Furthermore, Wildlife Policy 2014 provides for sustainable management and development of wildlife resources in a manner that contributes to national development and the well-being of the people. Parliament passed a number of laws that provide for conducive environment for wildlife conservation including Uganda Wildlife Act 2019, the Uganda Wildlife Conservation Education Centre Act 2015, the Uganda Wildlife Research and Training Institute Act 2016, the National Environment Act, Cap. 181, the National Forestry and Tree Planting Act 2003. These laws and several Regulations and Statutory Instruments provide and promote conducive environment for wildlife conservation in the country which have in turn increased wildlife populations especially in protected areas.

b) Securing the integrity of protected areas

Uganda has established a network of protected areas that cover 17% of the land area, including critical habitats for keystone species such as mountain gorilla in Bwindi Impenetrable National Park, Queen Elizabeth National Park, and Murchison Falls National Park. Reforestation initiatives, such as the National Tree Planting Campaign, aim to restore 2.5 million hectares of degraded forest by 2030. Ant poaching efforts by the Uganda Wildlife Authority (UWA) have intensified supported by increased patrols and drone surveillance.

With increased human population and contraction of wildlife corridors, fencing protected areas is imperative to mitigate human-wildlife conflict. However, resources are still required to fence off about 5000 km of protected area boundary. This requires about Uganda shillings 500 billion and more funds are required to maintain of the electric fences. Negative effects of 'electric fencing' must be taken into consideration including restricted movement of fauna supervised resource access by park dependent communities.

Ministry of Tourism, Wildlife and Antiquities is implementing the Protected Area Systems Plan for Uganda that help in survey, demarcation and marking of all protected area boundaries. With the exception of East Madi Wildlife Reserve, sections of Mount Elgon National Park, all wildlife protected areas have clearly demarcated boundaries. Even where there used to be boundary disputes, the matter has been resolved by establishing well known and respected boundaries between parks and local communities. The isolated cases of boundary disputes are being addressed on a case-by-case basis. This effort has enabled the government to secure wildlife within the protected areas. To date, there are no encroachments on protected area land across the country.

c) Investments in tourism and protected areas

Government protects forests, water, and wildlife on behalf of the citizens while privatizing land in grazing areas. With improved security across the country including protected areas, many local and foreign stakeholders can invest in tourism facilities in protected areas. When UWA was established in 1996, only Uganda Hotels were operating tourist lodges in QENP and MFNP. Over time, the number of tourism concessions have increased to over 30 in all protected areas and more there are more investments in tourism and hospitality facilities in the national parks. This has increased revenues for UWA as Concessionaires market and attract tourists who in turn bring revenue to support UWA's conservation efforts.

d) Conservation outside protected areas

With the support of the National Fisheries Resources Research Institute (NaFIRRI), 196 sites have been identified as potential Key Biodiversity Areas (KBAs) to protect national freshwater biodiversity. The majority (160) of these sites are new, unprotected areas located outside of Lake Victoria, which has existing KBAs. The KBAs enhance or offer new protection to over 76 fish species of fishes, 48 aquatic macroinvertebrates species and five aquatic plant species. Four community-based conservation areas (fishing

exclusion zone, resource use zone, recovery zone, and tourism zone) have also been identified for designation and demarcation on Lake Nyaguo. This is aimed at recovery of endangered fish species including Oreochromis esculentus and aquatic birds such as grey crowned crane (national bird) and the shoebill which are endangered according to the IUCN red list (Olwa et al, 2019). Additional activities included verification/ mapping of fish biodiversity and critical habitats for fish populations including fish breeding areas (FBAs) on Lakes Victoria, Edward and Albert. Lake Kyoga basin has 57 FBAs and 43 FBAs (MAIIF, 2021 & MAIIF, 2023).

e) Inter-Agency cooperation and collaboration

This arrangement has been strengthened at regional and international levels through existing networks and frameworks including the East African Community, the Lusaka Agreement Task Force, the Greater Virunga Transboundary Collaboration (GVTC), the Horn of Africa Wildlife Enforcement Network (HAWEN) and CITES (Convention on International Trade in Endangered Species of Fauna and Flora. Through coordination and cooperation with Judiciary, a special Wildlife, Utilities and Standards Court has been established at the Buganda Road Magisterial Area to prosecute wildlife crime offenders and pass deterrent sentences.

f) Conservation education

Working with UWEC and Wildlife Clubs of Uganda, conservation awareness has been improved in the country through production and distribution of conservation education materials in schools, holding radio and television talk shows and other commercial slots on wildlife conservation.

g) Community Initiatives in biodiversity conservation

There are efforts to co-manage biodiversity with local communities by engaging them in management planning within zones e.g., for fishing exclusion, resource use, recovery, and tourism development. Zoning is aimed at facilitating recovery of endangered species (Olwa et al, 2019). Community-based conservation projects implemented by agencies such as Uganda Community Tourism Association (UCOTA), engage local communities in protecting habitats while benefiting from community-based ecotourism enterprises.

h) Tree growing

The National Tree Seed Centre (NTSC), NFA nurseries and other private nursery operators raise seedlings of several tree species for commercial and community tree planting programs. Under the National Community Tree planting arrangement (NCCTP), for example, local communities, institutions, and agencies are given indigenous tree species seedlings free of charge for restoration of degraded natural landscapes. In addition, NTSC also collects, processes, and distributes seeds of up to 100 species to partners within and outside the country.

i) Restoration

Some degraded ecosystems such as wetlands have been demarcated and restored. Wetlands have been restored by reinstating the natural water flow, replanting native vegetation, and adopting sustainable wetland management practices. The benefits from wetlands justify the investment in their restoration as part of sustainable development. Wetland restoration initiatives have increased coverage from 13% in 2015, to 13.9 in 2023. In the financial year 2023/2024 about 20% of the 1525 ha of Lubigi wetland system (Busega-Bulega section) that is astride the Kampala - Mityana Road was restored. Other efforts to protect wetlands include the cancellation of land titles in wetlands, rejection of Environmental and Social Impact Assessments (ESIAs) for development projects targeting wetlands, as well as gazettement and boundary demarcation of critical wetland ecosystems. These measures, supported by strong political will, are essential to safeguarding wetlands health and functions.

An incentives framework is being developed to encourage the retention of communal forests, private forests, and on-farm trees while promoting the establishment and management of mixed forest plantations with indigenous tree species. Recommendations from Walker et al. (2023) to re-examine land tenure rights to reduce deforestation is being considered by government. Furthermore, the ongoing review of the Forest Policy 2003 will include incentives for forest conservation,

tree planting, dryland forest establishment, and management. Law enforcement and litigation costs for encroachment of CFRs will be increased, and forest boundaries will be opened to deter encroachment.

National Forestry Authority (NFA) is strengthening forest conservation and management strategies through improved management of central forest reserves, establishing partnership arrangements with stakeholders, promoting equitable supply of forest and non-forest products and services and enhancing organizational sustainability for environmentally sustainable economic and social development.

To avert environmental degradation, refugees in Uganda participate in reforestation projects aimed at mitigating deforestation. In Rhino Camp refugee settlement, agroforestry programmes are supported by humanitarian organizations with full involvement of refugees and host communities in planting over one million trees to restore degraded landscapes.

j) Uganda's REDD+ Strategy and Action Plan

Uganda's Reducing Emissions from Deforestation and Forest Degradation (REDD+) Strategy and Action Plan is a comprehensive response mechanism to address deforestation, forest degradation, and climate change. It emphasizes forest conservation, carbon stock enhancement, and sustainable forest management while ensuring the inclusion of indigenous peoples and local communities through safeguards and benefit-sharing frameworks. The development of a Safeguards Information System (SIS) helps monitor compliance with international standards while the Forest Reference Emission Level (FREL) establishes a baseline for assessing the impact of REDD+ activities. This strategy mitigates environmental challenges and supports socio-economic development and equitable resource management.

k) Waste management

Plastic waste management in Uganda, and generally in the Lake Victoria Basin, requires a regional effort. Partner States and regional policies recognize plastic waste and litter as an environmental problem. However, the overriding issue is the absence of, or poorly developed, plastic waste management systems in the basin. Without proper waste management systems in most of the riparian communities, the repository is the dumping site for all domestic plastic wastes.

l) Biotechnology

Climate change and the associated impacts continue to pose immense challenge to food production. However, with the advent of biotechnology, scientists are able to generate plants that can withstand biotic and abiotic stresses, resist diseases and pests, or to be used as bio-factories for pharmaceutical products. Uganda's vision for the agricultural sector is to gradually transform the small-scale peasantry agriculture into modern commercial farming. To realize this vision, several segments along the agricultural production chain must be exploited including the application of new farming and agro-processing technologies using tools such as genetic engineering of plants to increase yield, nutritional, and other value addition qualities.

m) Gene bank

National Agricultural Research Organization (NARO) has the mandate to ensure that Uganda has a gene bank of all the fauna and flora in the country to safeguard indigenous species which may be lost with biotechnology application.

n) Bio-safety policies and laws

The generation, development and application of genetic engineering techniques have biosafety implications that must be carefully managed to ensure that the process and final products are safe for human consumption, the environment, protects indigenous species, and takes into account liability or damage from application of genetic engineering techniques. Uganda currently has a policy on biosafety (National Biotechnology and Biosafety Policy 2008).

o) Responses on rangelands

The responses on rangelands have mostly focused on high economic values species such as *Vitallaria paradoxa* (Shear Butter), Balanites, and other valuable species some of which are on the IUCN Redlist of threatened species.

3.5 RURAL AND URBAN DEVELOPMENT

Rural development refers to sustainable improvement in the living standards of people living in rural areas whereas urban development refers to planned and regulated growth of urban areas (Karine, 2021). Uganda's rural and urban development have key environmental implications. While rural areas host most of the population, urban centers continue to expand rapidly, driven by human population growth, industrialization and other economic activities, migration, and infrastructure development. The growth results in habitat loss, deforestation, and increased pressure on natural resources, including water and land. While urbanization has improved infrastructure and economic opportunities, it poses challenges of environmental sustainability, waste management, and equitable access to basic services such as housing and clean water.

a) Pressures of rural and urban development

Rural development pressures include:

i) *Soil degradation and erosion*: in Uganda, rural development often leads to depletion of soil fertility and erosion, particularly in areas where farming is intensified without application of sustainable land management practices. Activities such as overgrazing, monocropping and inadequate crop rotation degrade soil. Soil erosion is severe in hilly and mountainous areas of the country such as the Kigezi region where agriculture is practiced on steep slopes. Uganda loses 2.4 tons of soil per hectare annually due to erosion and over cultivation. Poor and unsustainable farming practices in rural areas escalate soil fertility loss. Nearly 30% of Uganda's arable land is degraded due to over-cultivation, deforestation, and soil erosion.

ii) *Deforestation and land use change*: forest cover declined from 24% in 1990 to 12% in 2021. An estimated 73,000 hectares of forest are lost annually, mainly due to agricultural expansion, human settlement and fuelwood extraction.

iii) *Water resource depletion*: increased water abstraction for irrigation, livestock and domestic use stress freshwater sources including streams. Many regions in the country experience seasonal water shortages and it exacerbates competition for water resources.

iv) Water and soil pollution: This is mainly a result of increased application of agro-chemicals as part of the effort to boost agricultural productivity. Application of chemical fertilizers, pesticides, and herbicides pollutes surface runoff that end up in rivers, lakes, and wetlands. The chemicals adversely affect land and aquatic ecosystems including the life forms therein.

v) *Loss of wetlands:* Wetlands play a crucial role in water filtration, flood regulation, and biodiversity conservation but are under threat from rural development activities. Rural expansion has degraded 40% of Uganda's wetlands that harbor biodiversity and regulate water. As a result, water and soil are contaminated.

vi) *Land fragmentation*; is a practice that involves farming on a number of spatially divided plots that are owned or rented by the same farmer (Nyanzi and Enginyu, 2023). It is caused by partial inheritance and land shortage due to increased human population. Traditional inheritance practices of transferring property equally to all children in each generation has, over time, divided land in Uganda into increasingly smaller holdings (Nyanzi and Enginyu, 2023). Land fragmentation reduces opportunities for investment in modern agriculture and loss of biodiversity on agricultural landscapes.

vii) *Invasive alien species*: The spread of Cuscuta weed on different plant species poses immense threat to ecosystem health (Wejule, 2023). Parasitic plant invasion especially by Dodder (Cuscuta spp.) and golden dew drop has become a formidable threat to coffee and other ornamental plants. The parasitic weeds disrupt the aesthetic appeal, growth, and functions of ornamental landscapes which is of great concern given the huge potential of the horticultural industry's contribution to Uganda's GDP.

viii) Human-wildlife conflict: as rural areas

expand, agricultural activities encroach on protected areas and wildlife corridors, leading to increased human-wildlife conflicts. Households that live near protected areas such as national parks, game reserves and forest reserves suffer from crop damage by wildlife. At the same time, wild animals may be forced to move close to human settlements which kindles poaching and habitat destruction.

Urban development pressures include:

i) *Loss of green spaces*: one of the most visible impacts of urban development is the expansion of built-up areas, commonly known as urban sprawl. In Kampala, urban sprawl is evident as the city extends into the surrounding agricultural and forested areas. The uncontrolled expansion lead to conversion of valuable ecosystems, including wetlands and forests, into residential, commercial, and industrial zones.

ii) *Air pollution*: As urban population grows, so does the number of vehicles on the roads that cause tremendous amount of air pollution. Vehicle gaseous emissions contribute to high levels of particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NOx), and sulfur dioxide (SO_2). These pollutants create unpleasant environments and cause respiratory diseases in humans. Air pollution may also result from dust blown into the atmosphere during development of infrastructure such as roads.

iii) *Informal and unplanned settlements*: unplanned human population growth translates into informal settlements which accommodate a large proportion of urban population. The informal settlements generate large quantities of solid and liquid waste that pollute the environment. Informal settlements often lack waste collection and disposal services and residents engage in open dumping, burning, or illegal disposal of waste. Such behavior compounds the problem of waste management and undermines efforts to promote cleanliness and sanitation in cities. Sustainable municipal waste management continues to be a major challenge to all cities and towns in the country.

iv) *Encroachment on natural ecosystems such as wetlands, and forests*: Kampala city and other urban areas experience high rates of rural-urban migration that exerts pressure on social services, infrastructure, environment and natural resources (MoLUD 2022). Out of 15 cities approved for development, seven are funded and fully operational while eight are yet to be commissioned. Arua, Gulu, Jinja, Mbale, Masaka, Mbarara and Fort portal cities are operational. In addition, there are 22 municipalities, 174 town councils and 204 town boards spread across the country (Sector Brief Uganda, 2023). The country continues to experience high rates of urbanisation particularly with the introduction of zonal industrial hubs in all regions similar to the Namanve Industrial Park. Such expansion results in encroachment on wetlands, forest reserves and adjacent grasslands leading to loss of biodiversity.

v) *Poor waste management contri*butes to immense environmental pollution (*Ma et al., 2020*), with adverse effects on public health and environment (Hamer et al., 2016). The pollutants can negatively affect the environment, health, hygiene, agriculture and land use among others. Given that poor waste management is common among vulnerable populations, mitigation measures tend to be limited among such populations (Palmiotto et al., 2014). Studies have revealed that biodegradable waste can be used in the agriculture sector (Tibihika et al., 2021).

b) State of rural and urban development

Rural development is characterized by:

i) Subsistence farming which dominates rural households' livelihoods. It involves unsustainable practices such as mono cropping, overgrazing, and improper use of agrochemicals. These practices contribute to soil degradation, reduced water retention and eutrophication of nearby water bodies.

ii) In remote rural areas, market linkages for smallholder farmers are weak or nonexistent (IFAD, 2023). In addition, farmers lack inputs and technology to increase production and reduce pests and disease burdens, and they

have insufficient access to financial services, which would enable them to boost production and incomes.

iii) Natural forests in rural areas have been largely replaced by establishment of monoculture and single-species plantations which reduce biodiversity. For example, the replacement of natural forests by oil palm in Kalangala district has reduced biodiversity of the original forest reserve. At the same time, a number of species, including pollinators and amphibians, are threatened by forest habitat destruction.

iv) Biomass (wood and charcoal) is the primary source of energy for rural households in the country accounting for 89% of the national energy consumption. Such a huge level of dependency on wood biomass for energy accelerates deforestation and greenhouse gas emissions.

v) Over 60% of rural households lack access to safe water, leading to over-reliance on unprotected water sources. In addition, local water sources support farming, for example, encroachment on River Rwizi in southwestern Uganda for agriculture has reduced water flow, degraded water quality and negatively affected downstream users.

Urban areas are characterized by:

i) Improved housing quality and infrastructure: The quality of housing has improved over the years (MoLUD 2022) with a corresponding decline in the use of mud and poles for construction of walls thereby easing pressure on natural forests and woodlands. The change has also resulted in increased mining of clay for making bricks baked with firewood as well as stone quarrying, both of which degrade the environment. In the absence of mitigation measures open clay and stone pits get filled with stagnant water and become breeding grounds for mosquitoes thus contributing to malaria cases. Urbanization has spurred growth of commercial activities in Uganda thus prompting government to construct several markets across the country (**Figure 47**).

Although housing infrastructure has improved,

Figure 47: ***Government-built markets: A. Soroti main market. B. Lira main market Government-built markets:***

over 60% of urban dwellers still live-in informal settlements with limited access to good and decent housing and infrastructure. Kampala's slums, in Bwaise, Katanga and Kalerwe are prone to flooding due to encroachment on wetlands and inadequate drainage systems.

ii) Poor waste management: urban areas in the country generate about 1.2 million tons of solid waste annually and less than 50% of the waste is collected and disposed of. Kampala city alone generates over 2,000 tons of waste daily and much of it is dumped in unregulated landfills leading to soil and water contamination. At the same time, large quantities of electronic waste are disposed of into the environment causing further risks of human exposure to harmful radiations and chemicals.

iii) Increased incidences of floods and drought due to climate change largely driven by anthropogenic factors such as rapid urban population growth which encroach on natural habitats and urban and peri-urban green spaces.

iv) Poor air quality in urban areas is a major environmental concern. Air quality measurements in Kampala show that particulate matter ($PM_{2.5}$) levels which is far above the WHO annual standard of 5 µg/m³. Gaseous emissions from vehicles, industries and open waste burning pollute the air in cities and other urban areas hence adversely affecting public health. This is made worse by the poor infrastructure in urban areas including unpaved roads. These marram roads as a result of constant movement of vehicles stir up dust and spread it over a wide area.

v) The average water coverage in cities and municipalities is estimated at 11% and 5.4% respectively (MoLHUD, 2022). The national average for access to piped water in urban areas in Uganda is 40.7%. Cities have the highest coverage at 47.4%, Municipalities at 43.8%, and Town Councils at 31% (MoLHUD, 2022). Urban roads in Uganda account for 7% of the entire country's road network while stock of tarmac roads is now at 6,199 Kilometers accounting for paved urban roads account for 5.6% of the entire country's urban roads. Six out of the 11 cities have paved roads coverage above the national average (5.6%) (MoLHUD, 2022). The national average for street lighting is 8.2% which is still very low by international standards. Other than Jinja city, all the other cities have less than 10% of the required street lighting coverage.

c) Impacts of rural and urban development

i) Loss of biodiversity due to increased pressure exerted on existing natural resources such as forest reserves and wetlands lead to climate change effects manifested by unusually heavy rains, drought and prolonged dry spells among others. As already noted in the earlier chapters of this report, encroachment on wetlands and inadequate provision of drainage systems increase risks of urban flooding as often seen in Kampala city.

ii) Over the last decade, land degradation has contributed to 15% decline in crop yields. Degraded landscapes are also prone to droughts and floods which exacerbate poverty in rural areas. In response to declining soil fertility, many farmers use chemical fertilizers and pesticides to boost yields. However, excessive use of these chemicals leads to soil pollution and water contamination which in turn reduce crop yields.

iii) Continued open discharge of the waste into the environment leads to accumulation of heavy metals such as Arsenic, Chromium, Lead, Mercury, Copper, Iron, Nickel and Zinc among others (Rautela *et al.*, 2021). Other pollutants include large particles, harmful gases such as carbon dioxide and hydrogen sulfide. These materials pollute underground water, reduce crop yields, contaminate milk and meat products and the overall effect of poisoning human beings, livestock and aquatic life.

iv) Poor waste disposal is associated with risks of deteriorating human and environmental health (Mugambe *et al.*, 2022). The risks include blockage of drainage channels which leads to flooding and creation of breeding sites for vectors such as mosquitoes and flies that cause human diseases (Mugambe *et al.*, 2022). In addition, the risks escalate the transmission

of infectious diseases such as cholera and diarrhea which have been known for a long time as diseases that are common in cities in low-income countries (Mugambe et al., 2022).

d) Response to rural and urban development

i) Government is committed to addressing climate change effects including application of mitigation measures given that it is a signatory to key global agreements, including the United Nations Framework Convention on Climate Change, the Paris Agreement, and the Kyoto Protocol. In line with these global environmental frameworks, government has put in place supportive policies and laws such as the National Climate Change Policy (2015), the Climate Change Act (2021), the Nationally Determined Contributions (2022), and Vision 2040.

ii) Government recognizes the importance of agriculture in the country's development agenda and has implemented a number of initiatives to support farmers to adopt sustainable practices and uptake technologies that enable them to adapt to climate change effects. These include expanding agricultural extension services to provide farmers with up-to-date information on best farming practices, agricultural technologies and innovations, integrated pest and disease management, and access to market information. National Agricultural Research Organization (NARO) conducts research to develop new crop varieties and livestock breeds that can withstand the changing climatic conditions.

iii) Kampala and Entebbe have achieved 30% increase in waste recycling through public-private partnerships. Initiatives such as "Plastics for Cash" in many urban areas including Kampala encourage recycling and reduction of plastic pollution of the environment.

iv) Urban farming, the practice of cultivating crops and rearing animals within urban and peri-urban areas, is common in Uganda. As urbanization rapidly increases with over 25% of the population residing in cities, urban farming has become a strategic response to a myriad of socio-economic and environmental challenges.

v) Rural electrification and subsidized solar energy products have reduced reliance on biomass energy. Over 200,000 households in rural areas of the country have transitioned to use of solar lighting systems and considerably reduced reliance on kerosene and firewood as sources of energy. In addition, solar street lighting in Gulu, Lira, Soroti, Mbale, Fort Portal and Mbarara cities under the USMID programme has reduced reliance on grid electricity and lowered carbon footprints in urban areas. On top of that, a number of initiatives have helped to reduce over exploitation of forest resources for fuel, for instance, adoption of charcoal energy saving stoves and use of briquettes made from agricultural wastes as substitute for charcoal produced from indigenous trees.

vi) Nationwide campaigns to promote sustainable farming practices, environmental conservation and restoration of degraded area have empowered rural communities. The National Tree Planting Campaign has resulted in over 10 million trees planted annually.

vii) To sustain a wide range of ecological and livelihood benefits of wetlands, government has put in place a number of legal instruments to safeguard wetland ecosystems in the country (Matovu et al., 2024). These include inter alia, the Wetland Policy, 1995, the Land Act, 1998, the National Environment (Environmental and Social Assessment) Regulations, 2020, the NEMA Act 2019, and the National Environmental Act 2019 (Matovu et al., 2024). The Uganda Wetlands Management Program oversees and coordinates the demarcation and restoration key wetlands, with notable successes recorded in Eastern Uganda.

viii) Government and NGOs promote sustainable land management practices, such as terracing on steep slopes that are prone to erosion and mass wasting and uptake of agroforestry practices to increase tree cover and provide on-farm forest products for domestic use and sale. Agroforestry practices, contour farming and application of organic fertilizers improve soil health and productivity. Climate Smart Sustainable Agriculture (CSSA) practices

empower farmers to apply local knowledge to mitigate climate change effects and adapt practices to local land use and food production systems.

ix) In the past decade, the Kampala Capital City Authority (KCCA) initiated programmes to support conservation of green spaces in the city. At the forefront of these initiatives was the development of institutional and local capacities for managing green spaces. A recent initiative for sustainable management of the city's green spaces is a collaborative effort among multiple stakeholders to build a sustainable, inclusive and learning City in Kampala and Strasbourg (SLICKS) - a collaborative project between the Cities of Strasbourg and Kampala co-financed by AFD. One of the key outputs of the SLICKS Project is the development of a Blue and Green Infrastructure Master Plan for Kampala Capital City that is vital for ensuring conservation of urban biodiversity in addition to supporting better living conditions in the city. The project seeks to map, restore and conserve green spaces and enhance their connectivity to socio-ecological sustainability of Kampala Capital City.

x) Through NDP III, agro-industrialization for local economic development (Agro-LED) programme seeks to address key bottlenecks in agricultural production, agro-processing and value addition. The bottlenecks include low agricultural production and productivity; poor storage infrastructure and post-harvest management; low value addition; poor market access and low competitiveness of agro-based products in domestic, regional, continental and international markets; limited access to agricultural financial services and critical inputs; as well as poor coordination and inefficient institutions for planning and implementation of agro-industrialization agenda (IFAD, 2023). The Parish Development Model (PDM) is flagship development strategy implemented to create wealth, improve incomes and livelihoods of households still stuck in the subsistence economy.

xi) A number of projects are being implemented to promote rural development including National Oil seeds Project (2019–2028) aimed at enhancing livelihoods and resilience of the small-scale farmers engaged in oilseed production and marketing (IFAD, 2023) (**Figure 48**). The project targets about 350,000 participants in 81 districts. National Oil Palm Project (2018–2029) that costs US$210.4 million aims at sustainably increasing rural livelihoods by supporting an efficient oil palm industry in the country (IFAD, 2023). The project districts are Buvuma, Masaka and Mayuge.

xii) Restoration of the Lubigi and Kyetinda wetlands around Kampala has improved water retention and reduced flooding risks in the adjacent areas.

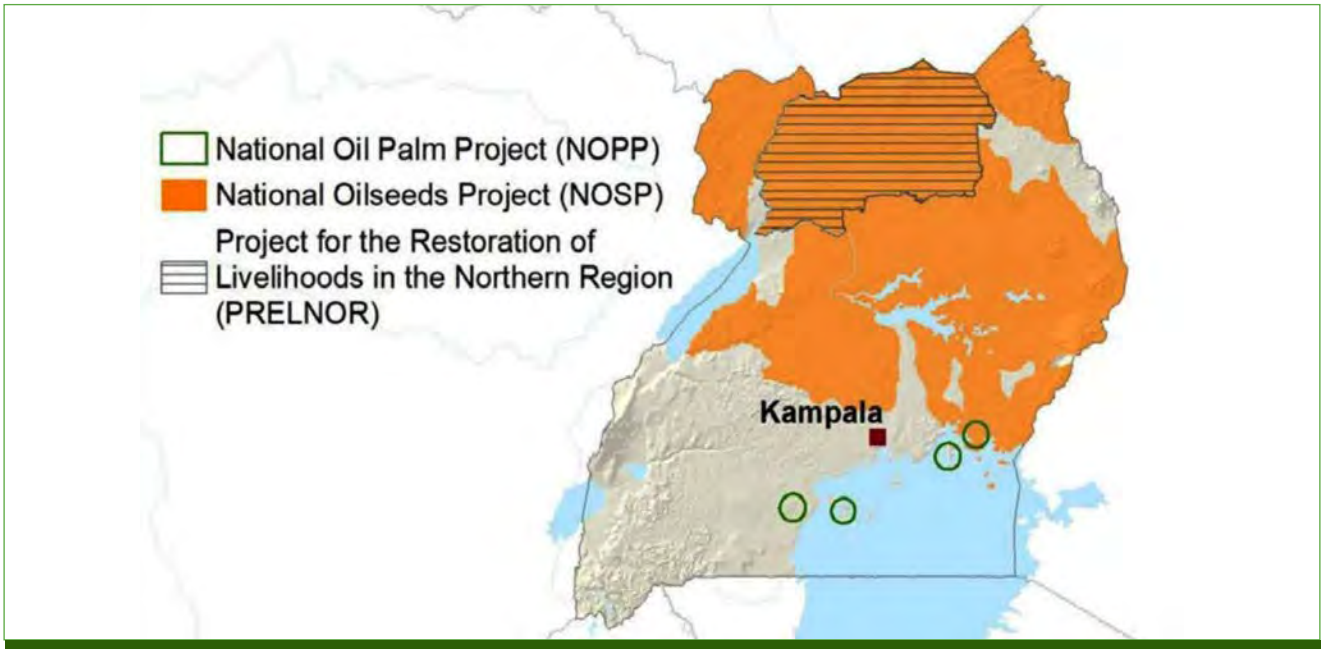


Figure 48: ***Project areas for promoting rural development (IFAD, 2023).***

xiii) A number of cities and districts in the country are adopting green spaces as a strategy to mitigate pollution and reduce the urban heat island effect; this is a phenomenon where heat is trapped in built-up areas and causes discomfort to the residents.

3.5.1. WASTE

This includes organic matter such as food scraps and agricultural residues, plastics, paper, glass, metals, textiles, electronic products and hazardous household materials. It presents an escalating environmental challenge, particularly in urban centers where rapid human population growth, urbanization, and increased consumerism are responsible for surge in waste generation. Waste management is a decentralized function vested in local governments. It involves collection, transportation, disposal, and treatment of waste. However, inadequate funding has forced urban authorities to adopt Public Private Partnerships (PPP) by involving private waste collectors to improve waste collection services. Despite these efforts, waste is still improperly disposed, for example, through open dumping and burning which contribute to environmental degradation, water contamination and atmospheric air pollution. Addressing these issues requires an integrated and multi-pronged approach that strengthens waste collection systems, enhances recycling and composting, promotes sustainable waste management practices to protect public health, natural resources, and positions the country to move towards achieving climate resilience.

a) Pressure of waste management

The direct pressures caused by waste in Uganda stem from the interplay of increased generation, unregulated disposal, persistent plastic pollution, and inadequate management systems. These pressures degrade the environment and create a cascading effect on public health, economic productivity, and quality of life.

i) Increased waste generation

The rising volumes of waste, including solid, liquid, and hazardous types, exert significant pressure on Uganda's environment. Rapid growth in human population and urbanization has led to higher consumption rates and generation of large quantities of household and industrial wastes. The increase in waste generation surpasses the capacity of available waste management systems hence waste accumulation.

ii) Unregulated dumping

Open waste dumping is a common practice, particularly in urban and rural areas where formal waste collection systems are limited or non-existent. Waste is often discarded in wetlands, rivers, roadsides and other ecosystems that are seen as wastelands thereby disrupting the ecological balance of such ecosystems.

iii) Plastic Pollution

Production and large-scale use of non-biodegradable plastics are a major environmental concern in Uganda. These materials are often carelessly thrown in the environment in residential areas, schools, hospitals, trading centres, markets, on the streets, roadsides and in drainages that get blocked and lead to flooding. Floodwaters damage infrastructure and create public health hazards by spreading contaminants. The long lifespan of plastics in the environment magnifies and sustains their impact as they persist for decades without decomposing thereby accumulating over time and creating unpleasant scenes.

iv) Inadequate waste management systems

Limited capacity for waste collection, transportation, and recycling aggravates environmental pressures in the country. Many urban areas, including Kampala city, lack comprehensive systems to manage large volumes of waste leading to careless disposal methods. Waste recycling infrastructure is underdeveloped, resulting in low recovery rates of valuable materials like plastics, polyethene, metals, aluminum, rubber and paper. In addition, lack of waste sorting systems means that biodegradable and non-biodegradable wastes are often mixed together. This reduces the efficiency of potential recycling and composting initiatives. Poorly managed landfills and dumpsites frequently leak into the surrounding soils and water sources and deepens environmental degradation.

b) State of waste

Waste management in most urban centres is characterized by non-separation of waste at both source and final disposal. According to KCCA, Kampala generates between 2000 to 2500 tons of waste per day but it is only able to collect and dispose an average of 1300 to 1500 tons per day implying approximately 50% of the waste is either uncollected or improperly disposed. Furthermore, KCCA collects 20%-35% and the Private contractors 65-80% of the waste generated. Among private companies, the highest waste quantities in tons were collected by Nabugabo (NUJV) (33%) followed by Homeklin (29%), KSWMC (21%). The rest (17%) was ferried by non-concessionaires. KCCA through their section of SWM indicates that, a total of 388,307 tons of garbage were collected by July 2023 and all disposed of at the landfill. This was a decline by 11% compared with that of July 2022, attributed to the decreased waste collection and transportation. An average tonnage per trip of 6.0 was registered in Kampala (**Table 12**). Relatively, there was a higher efficiency by the KCCA directly managed trucks compared to the private companies. Among the Divisions of Kampala, the highest efficiency (10.8 tons per trip) in terms of tonnage per trip was registered in Nakawa Division whereas the least efficiency (9.2 tons per trip) in terms of tonnage per trip was registered in Lubaga Division.

Table 12*: A breakdown of Tonnage of garbage collected by KCCA and trip status for FY22/23*

Division	Vehicles (No.)	Trips (No.)	Quantity (Tons)	Tons per Trip (Efficiency)
Central	7	2998	30203	10.1
Makindye	6	2272	23572	10.4
Nakawa	6	2189	23613	10.8
Lubaga	5	2967	27444	9.2
Kawempe	6	3062	30561	10.0
KCCA(Total)	30	13,487	135393	10.0
Private Companies (Total)	173	51370	252914	4.9
Grand Total (KCCA & Private companies)	203	64857	388307	6.0

Source: KCCA, July 2023

A total of 388,307 tons of garbage was disposed of at the landfill from all the divisions of KCCA in 2023 with the waste collector trucks making 64,857 trips (**Table 12**). In comparison with the FY 2021/22, there was a (11%) decrease (from 435,179 tons to 388,307 tons) attributed to the decreased waste collection and transportation due to increased fuel prices affecting both KCCA and Private companies. As a result, this affected the performance of the KCCA trucks as there was a significant percentage decrease (11%) by waste collected and dumped at the Landfill by the trucks in comparison with the previous FY 21/22.

The increase in the waste generated throughout the years corresponded to a 15% population increase within the same period. Projections of annual waste generation in Kampala are likely to increase by approximately 60% by 2030 in Kampala. In Kampala City, there are no weighbridges at the landfill site, and the waste collection amount is estimated by the number of incoming vehicles to Kitezi landfill. It is estimated that by 2028, the total waste collected shall be 2046 tons/day as shown in **Figure 49**.

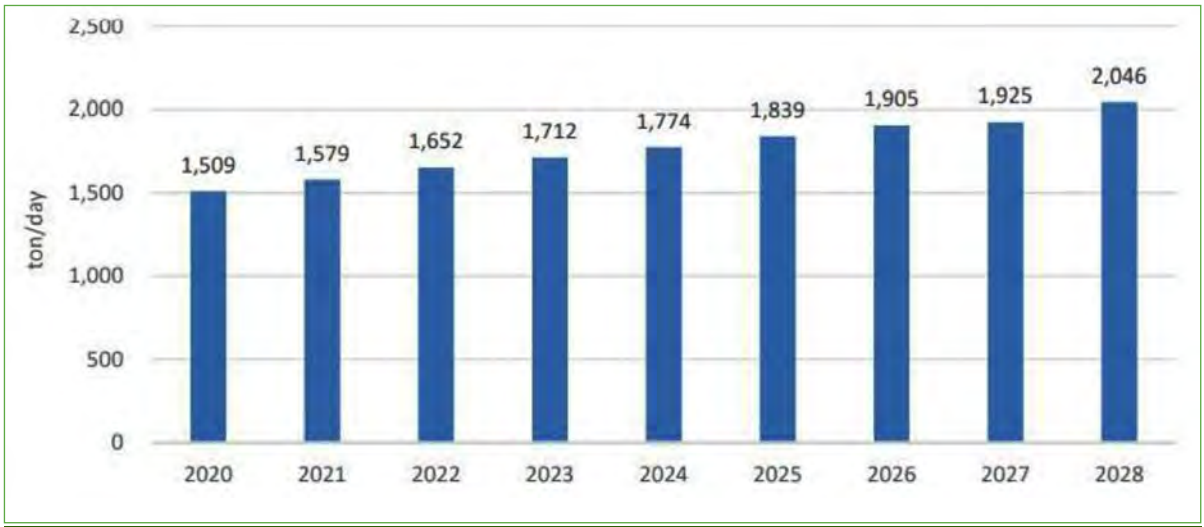


Figure 49: ***Estimated waste generation over the years (Kampala Waste ppp project).***

In various cities, polythene bags and other forms of plastics pose a significant challenge in waste management. Some urban areas (e.g., Mukono Municipality and Lira City) run Clean Development Mechanism (CDM) solid waste management plants. These have employees to do onsite waste sorting. The increasing volumes of unsorted waste is a major challenge to the CDM plants. Addressing the issues surrounding polythene bags and mixed waste is crucial for enhancing environmental sustainability and public health. Other cities (e.g., Masaka and Mbarara) do not have compost plants thus they carry out open dumping (**Figure 50**).

Figure 50: ***Waste dumping in*** **A** ***(Masaka City, Bulando-Buwunga) and*** **B** ***(Mbarara City, Kenkombe)*** ***(*****Photo Credit*****: NEMA, 2024)***

i)Medical waste

Healthcare waste poses a significant risk as it contains potentially harmful microorganisms that can infect hospital patients, healthcare workers, and the general public. Therefore, effective management of medical waste is essential. Health regulations mandate that all hospitals and health centers must have incinerators to properly dispose of this waste. However, a 2024 survey by the Daily Monitor reveals that this requirement is often unmet, leaving many health facilities grappling with a growing medical waste management crisis due to a lack of incinerators. For example, Kabarole District has only two incinerators, located at Kijura Health Center III and Ruteete Health Center IV, to serve its entire healthcare system. Similarly, Bunyangabu District, with 20 health facilities, relies on just two incinerators situated at Kibiito Health Center IV and Rwimi Health Center III. This shortage of incinerators is a widespread issue nationwide. As a result, many health facilities have resorted to open burning as a makeshift and harmful method of disposing of hazardous medical waste, exacerbating public health and environmental risks.

ii) E-waste

Uganda grapples with the challenge of managing electronic waste, exacerbated by inadequate systems for quality control of imported electronic devices. This has led to a significant influx of sub-standard and counterfeit devices into the country (Uganda Communications Commission, 2023). Annually, Uganda generates 41 million kilograms of e-waste, yet only 0.2 million kilograms are formally collected and recycled. This occurs despite the existence of a national e-waste policy (The Global E-Waste Monitor, 2024).

ii)Petroleum waste

Waste generated from oil drilling activities mainly consists of a mixture of rock cuttings and drilling fluid. In Uganda, Water-Based Mud (WBM) is most commonly used due to its environmental benefits over Oil-Based Mud (OBM). The waste from drilling sites is stored at designated consolidation locations. These sites include Ngara and Bugungu for wells drilled in Buliisa district, Tangi in Nwoya district for wells drilled north of the Albert Nile, and Kisinja for wells drilled in the Kaiso-Tonya area of Hoima district. The sites are equipped with specially designed pits to store solid and liquid waste separately. Monitoring boreholes are drilled around the perimeter of each pit to detect potential contamination and NEMA has licensed more than twelve companies to manage oil drilling waste at various stages, including transportation, treatment, and disposal (MEMD, 2019).

Waste motor vehicle oil has been reported as a major source of petroleum hydrocarbon contamination in urban runoff with large volumes entering aquatic ecosystems and Oil-changing operations are mostly conducted at garages and at fuel stations. (Ssempebwa *et al., 2009*)

Uganda currently lacks specific rules and regulations for managing used motor oil, leading to inconsistent disposal practices. This oil, contaminated with harmful heavy metals and persistent organic substances, poses significant risks to the environment, including water sources and agricultural land. Vehicles are a major contributor to used oil generation, and public awareness about proper disposal remains limited (Mugasha, 2023).

c) Impact of waste

Landfills adjacent to wetlands pose significant dangers due to their impact on water quality. As solid waste decomposes, it produces a polluted liquid called leachate, which seeps into the water bodies. This leachate, often brownish to black in color and emitting a rotten smell, contains high concentrations of organic pollutants, including ammoniacal nitrogen. The presence of plastics, metals, and other hazardous materials in the waste increases the toxicity levels, severely affecting aquatic life and human health. Additionally, the unregulated and mismanaged disposal of waste releases heavy metals and other toxins, degrading both the environment and vital water resources.

Management of organic waste is a challenge, largely due to methane gas produced during anaerobic decomposition. It is a greenhouse gas and has an unpleasant smell, which can be a neighborhood nuisance. Waste has significant environmental, social, and economic impacts in Uganda, affecting public health, ecosystems, and economic productivity. Improper waste management practices such as open dumping, burning, and poor disposal in landfills contribute to severe environmental degradation. For instance, leachate from improperly managed dumpsites pollutes soil and water sources, threatening biodiversity and agricultural productivity. Plastic waste, in particular, clogs drainage systems, exacerbating urban flooding during heavy rains and leading to infrastructural damage.

The landslide at the Kiteezi landfill in August, 2024, triggered by weeks of heavy rain, claimed the lives of more than thirty people and buried homes, forcing many residents to evacuate their homes. This tragic incident highlights the urgent need for improved waste management practices and infrastructure in Kampala and other cities.

The health implications of unmanaged waste are profound. Accumulated waste creates breeding grounds for disease vectors such as mosquitoes and flies, increasing the prevalence of diseases like malaria and cholera. Additionally, the burning of waste, especially plastics, releases harmful toxins

into the air, contributing to respiratory diseases among nearby communities. Further, although landfills provide a source of income for vulnerable groups, informal waste pickers often work without protective equipment, exposing them to health risks from hazardous materials and sharp objects.

Economically, waste impacts Uganda's productivity and resources. Cleaning up littered environments, managing floods caused by blocked drainage systems, and addressing health crises caused by waste-related pollution impose significant financial burdens on local governments and communities. Unregulated waste dumping diminishes the aesthetic value of urban areas, deterring tourism and investment opportunities. Furthermore, the loss of recyclable materials due to poor segregation systems limits opportunities for economic gains through recycling and resource recovery.

d)Response strategy to waste management

Waste that is generated can be tackled through a coordinated approach involving infrastructure improvement, policy reform, public awareness, and the promotion of sustainable consumption and production practices. Some of the responses are:

i) The National Environment Management Authority (NEMA) is mandated to license all waste handlers in Uganda. The licensing covers all aspects in the waste value chain from generation, collection, transportation, storage, treatment and disposal. All waste handling within the economy as well as transboundary movement of waste are regulated by the Authority. The implementation of the National Environment (Waste Management) Regulations No. 49 of 2020 ensures efficient management of wastes to prevent harm to human health and the environment. The wastes are categorized as hazardous or non-hazardous. The regulation requires that anyone who wishes to be engaged in the business of collecting, transporting, storing, treating or disposing of waste applies to NEMA for a license. The application for waste handling is accompanied by a certificate of approval of the environmental and social impact assessment. The licenses are issued with a set of conditions attached to them which the waste handling entities must comply with at all times. Waste transporters are required to keep a copy of the license in the vehicles at all times. The licenses are issued for a period of two years for waste transportation and three years for storage, treatment or disposal. Waste handlers are required to apply for renewal of the license at least 60 days prior to the expiration of the current license. The technical committee on pollution control sits quarterly to discuss and make decisions on the applications received for waste handling.

The number of licenses for waste handling issued by NEMA from 2021 to 2024 are shown in ***Table 13*** and a graphical representation for each yearly total displayed in ***Figure 51***. Many of the licenses issued are for transportation of waste. Between 2022 and 2024, over 65% of the licenses issued were for transportation of waste. The total number of licenses issued in 2024 is 202, higher than in the previous years. This is partly because of the massive enforcement by the Environment Protection Force of NEMA following audit of the activities of the companies.

Table 13*: Number of licenses for waste management issued by NEMA*

Activity	**Year**			
	2021	2022	2023	2024
Transportation	69	17	36	137
Storage	09	04	10	09
Waste treatment + Disposal	34	02	04	56
Total	**112**	**23**	**50**	**202**

Transportation ensures that waste is moved from its source of generation in homes, hospitals, places of work, etc. to waste recycling, treatment, storage or disposal facilities.

NEMA approves storage facilities for waste handling for a period not exceeding one year to accumulate quantities of waste materials that can be transported for recycling, treatment or disposal

where the waste streams involved are small or the production processes generating these waste streams operate intermittently. Waste storage facilities should store not more than three tonnes of waste at any given time.

Waste treatment facilities are required to take reasonable measures to determine the composition, nature and properties of the waste before treatment through physical, chemical or biological analyses. This enables tailoring the treatment to the waste characteristics and ensuring compliance with set standards. Some waste components may also be recovered or recycled when these analyses are conducted beforehand. Additionally, these analyses can help to extract valuable materials, reduce environmental impact and promote circular economy practices.

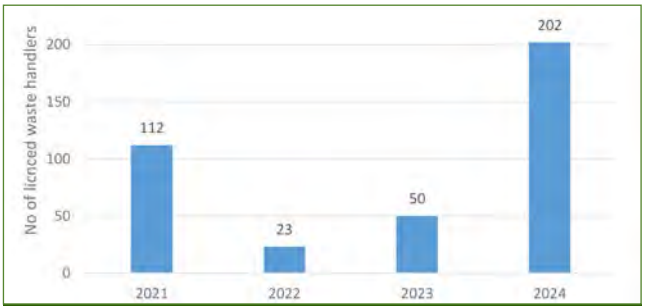


Figure 51*: Waste management licenses issued by NEMA.*

There is also inadequate infrastructure for undertaking standardization, testing and quality management including certification and accreditation of the locally manufactured goods, limited access to credit, inadequate skills, lack of technology and inadequate physical infrastructure such as electricity, transport and water that afflict the sector (NEMA 2014).

ii) According to Section 73 of the National Environment Act (NEA) 2019, the Authority is empowered to issue licenses for waste management operations. To facilitate this, the National Environment Management Authority (NEMA) established a Technical Committee on Pollution Control, which provides guidance on the issuance of waste management licenses. From the fiscal year 2021/22 to the present, a total of 152 waste management licenses have been issued—65 in FY 2021/22, 35 in FY 2022/23, and 52 in FY 2023/24. In response to the challenges facing waste management, the Kampala Capital City Authority (KCCA) and various stakeholders are implementing several initiatives aimed at improving waste management practices and encouraging sustainable behaviors among residents. Key strategies include enhancing waste collection and disposal systems, expanding recycling and waste-to-energy projects, and increasing public awareness regarding the importance of waste reduction, segregation, and proper disposal.

ii) Partnerships with private sector organizations, civil society groups, and community organizations are utilized to mobilize resources, expertise, and innovative solutions to effectively tackle waste management issues. A notable initiative advancing waste management in Kampala is the integration of technology-driven solutions, such as waste collection tracking systems, mobile applications, and geographic information systems (GIS), which enhance efficiency, transparency, and accountability in waste management operations. These digital tools enable real-time monitoring of collection routes, optimize resource allocation, and support data-informed decision making, thereby improving the effectiveness and reliability of waste management services while minimizing operational costs and environmental impacts.

iii)Community-based approaches such as neighborhood clean-up campaigns, waste segregation at the source, and community composting initiatives-empower residents to take ownership of waste management, fostering a cleaner and healthier urban environment. By cultivating a sense of collective responsibility and environmental stewardship, these grassroots initiatives complement formal waste management systems and promote sustainable behaviors that decrease waste generation and enhance resource conservation.

iv) NEMA is reinforcing public education and

awareness programs through various media, including radio and information, education, and communication (IEC) materials. Campaigns and public education initiatives have included infomercials and radio talk shows, as well as the distribution of IEC materials such as calendars, diaries, newsletters, posters, branded tents, tear-drop banners, pull-up banners, seasonal cards, exhibition tablecloths, and brochures for public environmental education and awareness campaigns.

v) Efforts to enhance environmental education and awareness are exemplified by campaigns like the "Taasa Obutonde media initiative", which seeks to raise public awareness about the environmental risks associated with improper use and disposal of plastics, in collaboration with Vivo Energy, Next Media, Uganda Breweries, Airquo, Stanbic Bank, KCCA, and NEMA. Nationwide awareness campaign focused on litter and waste management, known as the "Yonja Uganda Tour Campaign," was launched in 2023 to engage the public and stakeholders in discussions about litter and waste management for environmental protection. This tour has been conducted in various regions, including Masaka District, Mbale, and Tororo, with expansion plans.

vi) The Authority also continues to publish articles that provide insights into environmental issues in the country, particularly regarding restoration efforts and wetland abuse. Several articles have been released, including statements on World Wetlands Day and discussions about litter and waste management, highlighting case studies from Mbale City and environmental prosecution cases.

vii) The introduction of the Komptech Cribus 3800 (**Figure 52A**) in the Mukono Landfill and Jinja City Landfill represents advancement in waste sorting and processing technology for municipal solid waste and recycling operations. It features a modular design that can be easily customized to meet diverse operational requirements by employing screening technology effectively separating materials by size and weight. It can manage large volumes of complex materials. Lira City has newly constructed incinerator for management of medical waste (**Figure 52B**).

Figure 52: A *(Komptech Cribus 3800 waste sorting and processing technology);* B *(Newly constructed incinerator facility for management of medical waste in Lira City).* (Photo Credit: *NEMA, 2024).*

3.6. AGRICULTURE

Agriculture is one of the four leading critical sectors in Uganda (Agriculture, ICT, Minerals, petroleum, and manufacturing-industrialization) that is a backbone for realizing wealth through job creation as enshrined in the Uganda Vision 2040 (NDP III 2024). It includes farming, fishing, and forestry – which form the backbone of Uganda's economy (Bamwesigye et al., 2020). It remains a fundamental sector in Uganda, deeply intertwined with the country's socio-economic fabric (Bamwesigye et al., 2020). Its contribution to GDP is significant at 24.1%, employs approximately 72% of the population, and contributes to livelihoods, especially in rural areas (Trading Economics, 2024). Important crops in Uganda are coffee, bananas, and oil seed crops (sesame, soybean, sunflower, etc.), tea, cotton, organic cotton, tobacco, cereals, fresh foods and vegetables, and nuts (UA-EO, 2024). The country has planned to add value to agricultural exports and increase foreign exchange earned from US$ 0.935 billion in 2019/20 to US$ 2.7 billion in 2024/25. Uganda's main export crop is coffee, where Uganda ranks second in Africa after Ethiopia (UA-EO, 2024).

Agricultural land use in Uganda is extensive, with a significant portion of the land dedicated to farming activities. About 71% of Uganda's total land area is used for agriculture. This includes both smallholder and commercial farms. The vast majority of agricultural activities are carried out by smallholder farmers who rely on traditional farming methods. Efforts to modernize agriculture through mechanization and improved farming techniques are ongoing, aiming to enhance productivity and sustainability. Food security remains a critical issue in Uganda, with agriculture playing a central role in ensuring adequate food supply. Despite the substantial agricultural output, food insecurity affects about 30% of the population. Factors such as climate change, pests, diseases, invasive weed species, and market access issues contribute to food insecurity. Initiatives to improve food storage, distribution, and access are vital to addressing these challenges.

The agriculture sector in Uganda faces several challenges but also holds significant opportunities for growth and development. Key challenges include land degradation, climate change impacts, water scarcity, pest and disease outbreaks, and limited access to markets and finance. Addressing these challenges requires coordinated efforts from the government, private sector, and international partners. Opportunities for growth in the sector include increased investment in agricultural research and development, adoption of modern farming techniques, expansion of irrigation infrastructure, and enhanced market access through value chain development. The promotion of climate-smart agriculture and sustainable farming practices also presents significant opportunities for improving resilience and productivity. There has been considerable expansion of irrigation infrastructure with a coverage of 23,141 hectares with a total of ninety two (92) solar powered irrigation schemes

a) Pressures

These include the following:

i) Deforestation: Most of the forests in Uganda have been degraded/deforested for agricultural reasons: There is a shortage of land for agriculture, yet it is a backbone of the economy.
ii) Over-exploitation of vegetation: the shortage of land for agricultural purposes, has resulted in the clearance of vegetation and bushes for agricultural production.
iii) Overgrazing: This is especially observed in the nomadic and cattle corridors of Uganda. In Karamoja, Teso, Western, and Northern regions, the high number of cattle and other domestic animals has resulted in overgrazing of the vegetation, including wetlands.
iv) Discharge of non-point, point-source, and airborne pollutants: agricultural production involves the use of agrochemicals that are a danger to the environment, water, and human health. The prevalence of pests and diseases has increased due to climate changes and insufficient pest control measures, posing a continuous threat to crop and livestock productivity.
v) Wetland degradation: One of the land use

types that has been converted to agricultural production is wetlands. These are fertile ecosystems that farmers exploit for crop and animal production, leading to their degradation.

vi) Climate change: This manifests through altered weather patterns, including increased frequency of droughts and floods, adversely impacting crop yields and livestock health. Water scarcity, driven by competition for water resources between agricultural and other sectors, leads to inadequate irrigation, further stressing the agricultural system.

b) State of Agriculture

Agriculture, being the backbone of food security and the biggest employer especially in rural areas is increasing at the expense of other land uses especially Bushland in the country, due to the increased demand for food and livelihoods (**Figure 53**). This increase in agriculture has resulted in soil erosion, reduced fertility, and deforestation, which threaten the sustainability of the sector.

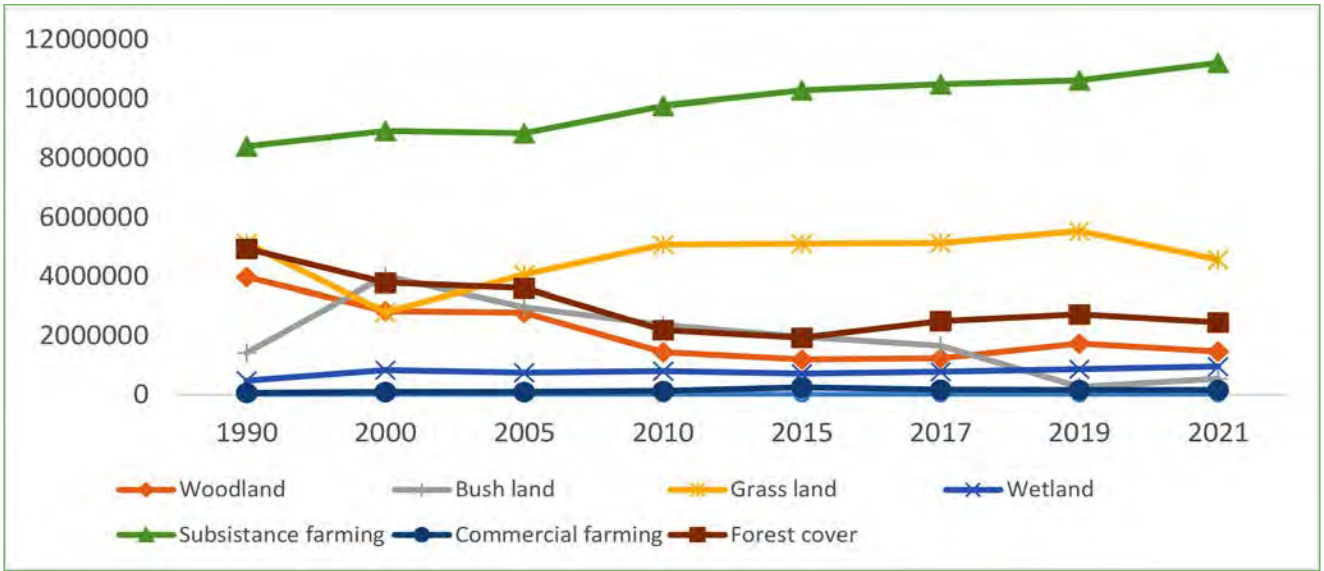


Figure 53: ***Land cover and land use over the years.*** **Source:** ***UBOS, 2024***

ii) Crop production

Uganda's agriculture is characterized by diverse crop production, with staple foods such as maize, bananas, and cassava playing critical roles. In 2022, Uganda produced approximately 4.8 million tons of maize. Maize is a staple food and a crucial crop for food security and export. By 2023, production slightly increased to around 5 million tons, indicating a stable trend in maize cultivation despite challenges such as climate variability. Uganda is one of the largest producers of bananas globally. In 2022, banana production stood at approximately 2.8 million tons. This figure remained stable in 2023 and is projected to increase slightly in 2024 due to improved agricultural practices and increased investment in banana production. Similarly, cassava production was about 2.5 million tons in 2022. It is a critical food security crop, especially in semi-arid regions. The production remained consistent in 2023, with marginal growth expected in 2024 due to efforts in disease-resistant varieties and better farming techniques. Coffee remains Uganda's leading export crop. In 2022, Uganda produced about 6.5 million 60-kg bags of coffee. This production level experienced a slight increase in 2023, reaching approximately 6.7 million bags. This is driven by favorable weather conditions and expanded coffee plantations. The increase in coffee production continued until 2024 when production surpassed 7 million bags amidst increasing global demand for Ugandan coffee (UBOS 2024; UA-EO 2024).

A majority of farmers are engaged in food crop production, which has varied over time. The most common food crops grown include root crops (sweet potatoes, Irish potatoes, and cassava), followed by bananas, and then cereals (millet, maize, sorghum, and rice) (**Figure 54**).

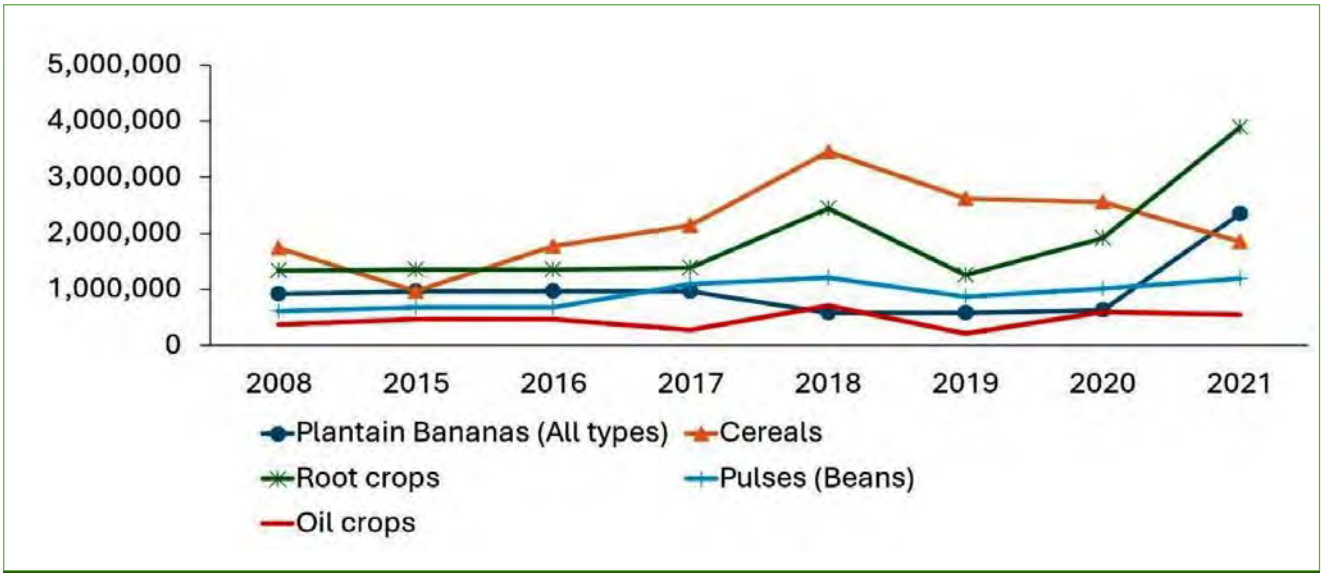


Figure 54*: Area planted for selected food crops, 2015-2021.* **Source:** ***UBOS, 2024***

iii) Animal and fish production

The livestock sector in Uganda is significant, contributing to both food security and income generation. Uganda's cattle population in 2023 was around 14 million and was projected that these numbers would continue to increase in 2024 and beyond due to enhanced veterinary services and better livestock management practices. The goat population in Uganda was approximately 17.4 million (UBOS 2024). Goats are essential for meat production and are a vital source of income for many rural households. The total pig population was 7.1 million in 2024. Poultry farming is one of the fastest-growing sub-sectors in Ugandan agriculture. In 2023, the chicken flock population reached 57.8 million (UBOS 2024), reflecting significant growth from previous years, driven by rising consumer demand for poultry products and improved poultry farming techniques. Fish production is a crucial component of Uganda's agricultural sector, with the country benefiting from numerous water bodies. . This sector has faced challenges such as overfishing and environmental degradation. However, initiatives to promote sustainable fishing practices and aquaculture are expected to stabilize and potentially increase production in 2023 and 2024.

iv) Agricultural productivity

It is important to note that while agricultural productivity can vary depending on the type of crop that is grown and the scale of productivity, the available evidence points to a reduction in agricultural productivity largely due to the limited use of improved farm inputs such as fertilizers and improved seeds by farmers. This is due to limited credit or financial support for farmers to be able to acquire these improved farm inputs (Asia Farming, 2024). Besides, changes in the climate patterns in terms of rainfall patterns often create drought periods, flooding, or erratic rains which often disrupt crop growth. Poor infrastructure to aid transportation of farm produce, equipment, farm supplies, and input often makes it difficult for farmers to farm, and access markets on time, and this affects productivity. Other factors that affect agricultural productivity include a loss in soil fertility, water scarcity, lack of irrigation services, pests, and diseases (Uganda Bureau of Statistics, 2022b; Wanyama et al., 2017).

c) Impact

Agricultural sector affects i) food security, ii) economic contribution, iii) biodiversity, and iv) rural poverty alleviation. While agriculture contributes substantially to the food supply, food insecurity remains an issue, with about 30% of the population experiencing some level of food insecurity. The sector v) contributes around 24% to Uganda's GDP and vi) employs over 70% of the workforce, illustrating its critical economic role. However, agricultural expansion and practices vii) contribute to habitat loss and declining biodiversity, posing environmental

challenges. Despite its importance, the sector faces challenges that perpetuate rural poverty, including low productivity and market access issues, impacting the socio-economic well-being of rural populations. Viii) The use of agrochemicals in the sector has resulted in the pollution of water resources through runoff from agricultural land (non-point source) pollution.

d) Responses

The government of Uganda has laid plans in NDP IV, and Vision 2040, to add value to the cash crop harvests to increase the revenue earned. These include:

i) Policy interventions, the National Agriculture Policy and Uganda Vision 2040 aim to transform the sector through modernization and commercialization.
ii) investment in research and development, enhancing agricultural research to develop resilient crop varieties and sustainable practices is crucial for long-term productivity,
iii) capacity building, and training programs for farmers on best practices and sustainable farming techniques improve knowledge and implementation of efficient agricultural methods.
iv) infrastructure development, improving rural infrastructure, including roads and irrigation systems, supports agricultural activities by enhancing access to markets and resources, and
v) climate adaptation strategies are key responses in Uganda, this involved implementing climate adaptation measures, such as promoting drought-resistant crops and efficient water use, that helps mitigate the effects of climate change on the sector.
vi) Establishment of initiatives for improving livelihoods including National Agricultural Advisory Services (NAADS), Parish Development Model (PDM), and 4-Acre Model. Operation Wealth Creation (OWC), and Presidential Initiative on Banana Production.
vii) Rolling-out irrigation at small and large-scales using solar-powered pumps in different parts of the country. This will reduce crop loss due to prolonged sunshine caused by climate change. Most farmers rely upon rainfall to produce crops.
viii) Provision of agricultural extension services to the farmers at a local level. This allows the farmers to access vital crop and animal production advice and guidelines. Currently, extension services are at a county or sub-county level, and all farmers are not getting extension services when they need them.
ix) Re-establishment of cooperatives to allow farmers to have a collective bargain for good prices and storage of agricultural produce. The government has established a Ministry of Trade Industry and Cooperatives (MTIC) to handle this challenge.
x) The practice of green/smart agriculture (cities and rural) economy including green manuring, conservation agriculture (rotations, intercropping, mulching, and reduced tillage), and agroforestry are among the most common climate-smart practices being promoted to improve productivity, food availability and resilience to climate hazards.
xi) Promote sustainable fishing and aquaculture to stabilize/ increase production in 2023/24.

3.6.1. FISHERIES

a) Pressures in the fisheries industry

i) Persistence of un-sustainable fishing practices

Overexploitation of fish species threatens long-term sustainability. This is one of the most serious factors affecting the fisheries of Uganda. The problem lies in the use of destructive fishing gears and methods as well as deployment of excessive fishing effort on the water bodies (use of more than the optimal number of gears). Over exploitation is driven by increasing domestic and foreign demand for fish. This demand is attributed to population growth, better incomes and nutritional literacy of consumers. A high level of demand in turn triggers higher market value and raises the propensity for good and bad fishing practices. This comes against the backdrop of inelastic capture fisheries. Destructive fishing gears currently in use include undersize mesh nets, seine nets, cast nets, undersize hooks, and others. On the other hand, the main destructive methods in use include seining and tycoon Ing. These together constitute bad fishing practices that involve catching of immature fish and excessive extraction of fish of which the most affected species are Nile perch and silver cyprinid. The Marine unit has been at the forefront to curb this kind of illegalities on various lakes in Uganda.

ii) Pollution

The fisheries are also threatened by pollution from various sources including agricultural runoff, industrial discharges, untreated sewage, solid and non-solid waste, which contaminate water bodies and fishing grounds across the country. Nutrient run-off and sedimentation from nearby agricultural activities contribute to various ecological changes in the water bodies. Pollution introduces solids and soluble toxic chemicals (such as heavy metals and excessive nutrients) which degrade water quality and its ability to support fish and other aquatic life.

Developing countries especially in East African region, are facing challenges in managing the rapidly growing volume of plastic waste. This has a major impact on human health and aquatic ecosystems, as it affects the value of ecosystem goods and services. With no proper waste management systems in most riparian communities, the rivers and lakes remain the repository and dumping sites for all domestic plastic wastes.

In addition, pollution from industrial, agricultural, and municipals/domestic sources pose a significant threat to the water quality and biodiversity of aquatic systems. Untreated sewage, agricultural runoff, and industrial effluents introduce excessive nutrients (e.g., nitrogen and phosphorus) into the lakes, leading to eutrophication and harmful algal blooms. These conditions reduce water clarity, deplete oxygen levels, and negatively impact on the survival of aquatic organisms thereby compromising ecosystem integrity, ecosystems services and goods therein.

Increased human activity around and within Lake Albert, especially oil and gas exploration, may pose threats to the wellbeing of the lake, its diverse fish communities, and its fishery.

iii) Invasive plant species (water weeds)

Many of Uganda's water bodies are currently affected by epidemic masses of water weeds. The two most important weeds are the *Water hyacinth (Eichhornia sp)* (**Figure 55**) and Kariba weed (Salvinia sp.). The water hyacinth covered large areas of the lake surfaces, reducing sunlight penetration and oxygen levels, and negatively affecting native aquatic species. The proliferation of weeds is a result of the interconnected nature of the water bodies and excessive nutrients in the water. The weeds themselves degrade water quality and hence impact negatively on fish productivity, and block fishing grounds, transport routes and landing sites.

Figure 55*: Water Hyacinth on Lake Victoria at Rippon Pier-Jinja City (***Photo Credit:** ***NEMA, 2024)***

iv) Climate change impacts

There are various manifestations of climate variability and change impacts such as fluctuations in water levels (**Figure 56**), rising temperatures, altered rainfall patterns (e.g., El Niño-related rains that exacerbate water level fluctuations, increasing habitat stress) and others, whose net effects on the fisheries are variable and need concerted investigation. For example, over the past few years flooding and unseasonable weather patterns have led to destruction of fish handling facilities, mass fish kills and proliferation of invasive weeds.

Figure 56*: Rising water level at Katosi landing site-Mukono District (***Photo Credit:** ***NEMA, 2024)***

v) Post-harvest losses

Uganda suffers significant post-harvest losses due to bad post-harvest handling. Empirical evidence indicates, for example, that the losses for silver cyprinid harvests during the rainy season are as high as 90%. For Tilapia and Nile perch, this loss is estimated at 15% to 25%. There is inadequate and poor sanitary infrastructure (at landing sites and marketing centers) for post-harvest fish handling.

vi) Insufficient data on fisheries sub-sector

There is a widely acknowledged lack of sufficient comprehensive information on fisheries along the value chain. The data gaps range from ecological, biological, and physical parameters of aquatic ecosystems, to economic and business as well as socio-economic parameters of the sub-sector. This has resulted in such effects as the under-estimate of the contribution of fisheries to national GDP and insufficient bench marking for decision making on regulatory and investment options.

vii) Construction and operations of hydroelectric power dams

These have altered water flow, disrupted habitats and reduced connectivity, especially downstream.

viii) Habitat loss

In Uganda we have loss of aquatic species' habitats that have been fragmented by dams and water diversions. These fragments of habitat may not be large or connected enough to support species that need a large territory where they can find mates and food. In addition to anthropogenic activities along the shores has also affected the habitat loss more especially the destruction of shoreline areas such as the buffer zones and the wetlands. The rapid growth of human settlements and agricultural activities around the lakes has resulted in the loss and degradation of critical habitats, such as wetlands and riparian zones.

Increased sand mining activities, especially in the various parts of the lakes, have extended from the wetlands into the lake using machinery of different types and capacities, thus disrupting critical fisheries habitats that serve as nursery and fish breeding grounds as well as refugia of endangered species. Wetland conversion for agriculture and urban development, as well as the removal of natural vegetation along the shoreline, disrupts the ecological balance, reduces biodiversity, and affects the lake's overall resilience to environmental changes. This is further exacerbated by climate change impacts

b) State of aquatic resources

i) The Fisheries Production and Productivity in Capture Fisheries

The status of fishing on the major water bodies is indicated in **Table 14**. The major water bodies have nearly 1000 fish landing sites, with more than 50,000 fishing vessels. The total crew of fishers employed on these vessels is 146,437 (DiFR, 2023, Nakiyende et al., 2019).

Table 14: ***State of fishing activity on major water bodies, 2023***

Lake	No of sites Landing	No. of vessels fishing	Fishers
Victoria	455	30,000	70,000
Albert and Albert Nile	238	8,000	35,030
Kyoga	285	13,000	40,000
Edward	5	299	917
George	8	209	414
Kazinga Channel	2	38	76
Total	**993**	**51,546**	**146,437**

Source: Compiled from frame survey data at DiFR, 2023.

There is improvement in the production of fish from the water bodies, with total output rising from 621,987 tons in 2021 to 728,369 tons in 2023. The increase in performance has partly been a result of the government focus on gazetting of fish breeding grounds, enforcement of fisheries laws and regulations, provision of quality fingerlings and fish feed and providing an enabling environment for private sector to invest in aquaculture. The value of fish consequently also improved from 1,875 trillion in 2021 to 2,200 trillion in 2023 (**Table 15**). Lake Albert contributes at least 30% of the national fish production (Wandera and Balirwa, 2010; Nakiyende et al, 2021, DiFR, 2023).

Table 15: *Trends in annual capture fisheries production, 2021, 2022 and 2023*							
Water Body	**Annual catch estimates (MT)**				**Annual beach value ('000' Ushs)**		
	2021	**2022**	**2023**		**2021**	**2022**	**2023**
Victoria	241,744	256,865	269,708		860,090	913,888	959,582
Kyoga	31,362	38,987	85,000		95,977	119,312]	260,100
Albert	323,292	331,160	347,718		819,526	839,470	881,444
Edward, George & Kazinga channel	6,461	5,832	6,124		39,996	36,103	37,908
Albert Nile	5,062	5,062	5,315		13,504	13,504	14,180
Wamala	5,236	5,116	5,372		15,708	15,348	16,115
Others	8,830	8,697	9,132		30,5615	30,102	31,607
Total	**621,987**	**651,719**	**728,369**		**1,875,365**	**1,967,729**	**2,200,938**

Source: Directorate of Fisheries Resources (2023)

Expansion of capture fisheries productivity and production

The Fisheries and Aquaculture Policy (2018), envisaged combined production from the fisheries sub-sector is 1,700,000 tons of which 700,000 will be from capture/wild fisheries and 1,000,000 from aquaculture. The current scenario is indicated in **Figure 57**.

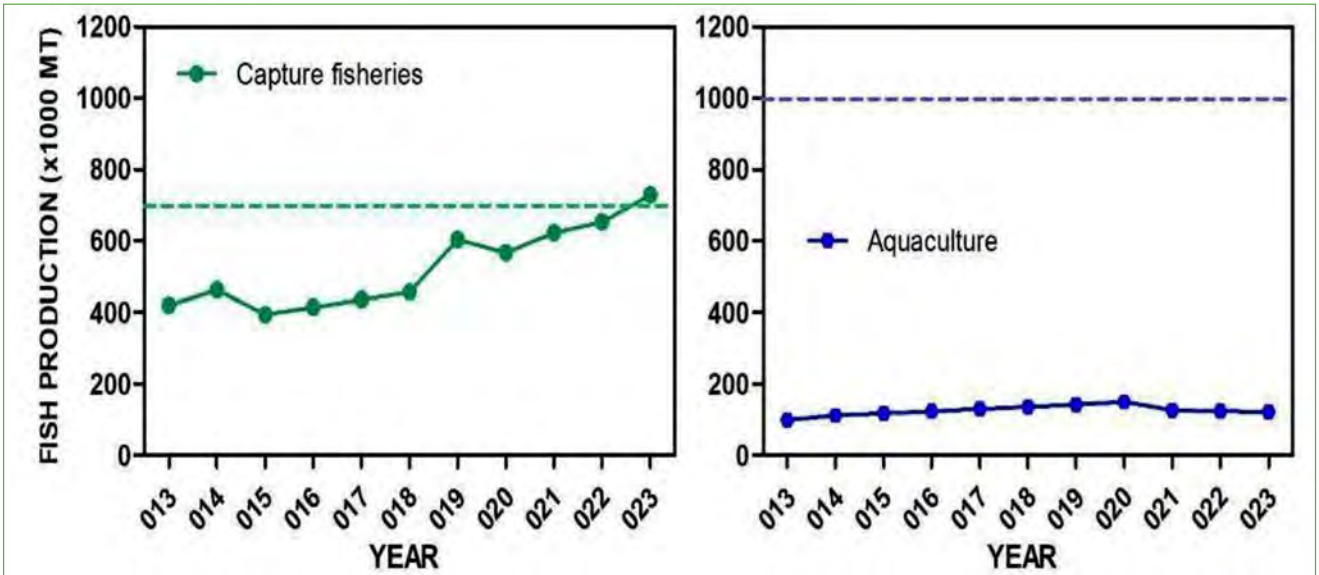


Figure 57: ***Trends in capture fisheries and aquaculture production. Horizontal dotted lines show the targeted fish production compared to actual production;*** **Source,** ***DFRi, 2023.b***

In order to boost capture fish production, the Government prioritized the identification and protection of critical fish habitats which are also fish breeding and conservation areas in lakes Victoria and Kyoga. Deliberate stock enhancement has been undertaken in various natural water bodies and valley dams, through stocking with indigenous species to expand the overall area fish production area (DiFR, 2023).

Standing stock of Nile perch, Rastrioneobola argentae and Haplochromine fishes from Hydro acoustic studies on Lake Victoria

In Lake Victoria, hydro-acoustic surveys have been conducted since 1999 to estimate the standing stock and distribution of major fish groups (Nile perch, Haplochromines, other fish, and the freshwater prawn Caridina nilotica covering Uganda, Kenya, and Tanzania waters. Data were collected and analyzed using standard operating procedures, and the results contribute to a time series analyzed using a consistent approach, enabling direct comparison of biomass estimates across various years. Unlike previous surveys that presented biomass estimates as standing stock (i.e., instantaneous biomass or biomass at any given point in time), the 2022 survey further processes the estimates to reflect the total biomass for the entire year (i.e., annual production), accounting for growth and recruitment. Subsequently, we compared this total annual biomass (production) with the total annual landings from Catch Assessment Surveys (CAS) reported for the same period, to determine the exploitation rate. These exploitation rates are then compared with benchmarks from literature to assess whether fishing is sustainable or unsustainable. The results from the 2022 survey indicated that:

a) The standing stock (instantaneous biomass) was 2.23 million metric tons (t), which was 20% lower than that recorded during the 2021 survey.
b) silver cyprinid constituted 47% of the standing stock, followed by Caridina nilotica (23%), the "Haplochromines" (15%), and Nile perch (15%).
c) The mean standing stock of Nile perch was 333,341 tons, which is equivalent to annual biomass (production) of 736,683 tons. This biomass was 33.72% lower than that in 2021, and the reduction was highest in Tanzania and least in Kenya, while Uganda recorded a slight increase in biomass. Considering the average catch of 250,000 tons, the 2022 annual biomass translates to an exploitation rate of 34%, which may be higher than sustainable levels of 25-30%.
d) In addition, the size structure of Nile perch was dominated by smaller sizes less than 50 cm, which could be attributed to concentrating fishing effort on big size, especially those above the upper slot size limit of 85 cm total length.
e) The mean standing stock of silver cyprinid was 1,060,589 t which, which is equivalent to annual biomass of 4,189, 327 t. This biomass was 14.3% (on average) higher than that from the 2021 survey, but the increase was observed only in Uganda, while Kenyan and Tanzanian portion of the lake recorded a decrease of up to 46.15% and 2.53%, respectively. Considering the average catch of 900,000 tons, the 2022 annual biomass translates to an exploitation rate of 21%, suggesting that the catch for silver cyprinid can be doubled without negatively affecting the stock.
f) The estimated standing stock of haplochromines and other unidentified fish was 331,709 t, which is equivalent to total annual biomass of 779516 t. This biomass was 44.8% lower than that estimated in 2021, with the largest decline observed in the Tanzanian portion of the Lake. Considering the average catch of 60,000 t, the exploitation rate is approximately 8%. Although this exploitation rate is substantially low, we advise not to increase it beyond 10% given that the species is an important prey for Nile perch, which supports a highly lucrative Nile perch fishery.
g) The mean standing stock of Caridina nilotica was 509,183 t which translates into annual biomass of 5,840,329.01 t. This biomass was 35.42% lower than that recorded in 2021, and the decline was observed across all the three countries.
h) Time series data demonstrated interannual variability in biomass for fish groups, but no major changes in trends were observed, suggesting that the fisheries are still resilient to the current exploitation rates.
i) Thermal stratification patterns were evident in the lake-wide Conductivity Temperature Dissolved Oxygen (CTD) sampling sites, particularly in the northwestern and north-eastern sectors. The Dissolved Oxygen (DO) profiles were much lower than the optimal for fish.
j) Generally, the biomass for all fish groups positively correlates with dissolved oxygen and transparency, while it negatively correlates with temperature, chlorophyll a, and turbidity. However, in 2022 this study was not carried out due to logistical constraints.

ii) Electronic systems for fisheries research and management

The NaFIRRI operationalized the Freshwater Biodiversity Portal for Uganda and this allows for the full access to freshwater biodiversity data and information. As evidence of use, the portal automatically monitors user locations and usage statistics. The visitor locations and user statistics show increasing popularity of the portal with over 16,000 accumulated views. This is strong evidence of use. Additional modules have been completed including the stock status indicator that incorporates data and information on fisheries statistics and another that will incorporate range maps of fish species from the National Red List. NaFIRRI compiled the first national Red List for fish species of Uganda covering 693 fish species (Natugonza, & Musinguzi, 2021).

In addition to that, NaFIRRI, developed and launched an electronic (mobile and computer based) data collection tool dubbed the eCAS system, which is currently used by the trained community-based enumerators to collect and submit catch and effort data electronically in real time (LVFO, 2020). This has been explored on Lake Albert and Lake Victoria and currently working effectively and has helped on the CAS, data collection fund.

iii) Aquaculture Development in Uganda

There are over 25,000 smallholder ponds, averaging 500 square meters each, and 4,500 commercial fish cages, primarily located on Lakes Victoria and Albert. Additionally, more than 40 private hatcheries, operated by the private sector, supply fish fingerlings to farmers. Commercial farmers often run their own on-farm hatcheries. The Kajjansi Aquaculture Research and Development Centre (KARDC), under NARO, serves as the main hub for foundational technology development in aquaculture in Uganda (MAAIF 2023).

Several interventions have been undertaken in aquaculture:

a) A national macro-aquaculture suitability assessment which has indicated that about 70% of the country is geo-physically suited for aquaculture development.
b) Model aquaculture production sites have been established in conjunction with the private sector and other agencies, to showcase aggregated commercial production systems. These include Kembogo Aquapark in Kiboga, Kiryabishoro Aquapark in Ibanda, Limoto wetland restoration project in Palissa district and Kamusala community pond facility in Serere district.
c) Up to 120 aquaculture producer cooperative societies have also been established to mobilize and aggregate the efforts of smallholder farmers in Western, Central, South-western, and Eastern, Northern and West Nile regions of the country. Aquaculture production is currently estimated at 124,000 tons (main species include Nile Tilapia and African catfish). However, this is behind the estimated output of 136,000 tons in 2019 (DiFR, 2023). The decline in production resulted from the effects of Covid-19 pandemic that locked down movement of labour, imported critical inputs and services and access to consumer markets in the region (esp. Kenya and DRC). The post-covid Ukraine-Russia crisis caused an increment in prices of fine quality imported feeds and further compounded the negative situation on the commercial fish farms (DFRi, 2023).

Kajjansi Aquaculture Research and Development Centre (KARDC), under NARO has developed faster growing Nile tilapia (Oreochromis niloticus) strain from a rate of 0.52 g/day to 2.47g/day. Improved tilapia seed has been distributed to 10 hatchery operators as improved brood stock for use in seed multiplication in 8 districts and to over 7,000 farmers throughout the country. The Institute NaFIRRI has developed guidelines for Nile tilapia and the African catfish seed production, brood stock management and hatchery management (NaFIRRI, 2024).

iv) Fish processing

There are currently 13 industrial fish processing factories, indicating a steady recovery from the 6 factories in 2016. It should be recalled that in 2010, the country had 21 operating factories. Even then,

the plants are operating at 45-50% of installed capacity due to inadequate raw materials. There are many artisanal points at landing sites and urban centers which are involved in primary processing (drying, salting, smoking, deep frying). For example, women groups in Katosi landing site (Mukono district) and Lambu landing site (Masaka) are involved in primary processing of silver cyprinid and mass market access. These products should now be lifted to transformation through industrial processing (DIFRi, 2023).

v) Market Access and Competitiveness for Fish and Fish Products

In general, Uganda's fish exports include processed and non-processed fish products (fresh fish, fish fillet, dried fish, and smoked fish). The sub-sector has been able to maintain the stringent sanitary entry requirements to the EU, American and Japanese markets for Uganda's processed fish of which the European Union is the main importer, accounting for 75% of the total exports. Nile perch fillet is the backbone of the international export market. The fish maw from Nile perch is emerging as another major international export product, whose main market destination is China. The main destinations for other products are regional markets (especially Kenya and DRC). However, the maw still has the challenge of illegal smuggling to Tanzania and Kenya where the official tax regime is much lower than in Uganda (Kenya has zero charge and Tanzania only USD 2.5 per kg, while Uganda charges 8% of the total batch value). Overall, Uganda currently generates about USD 200 million in fish exports, making it the 2nd largest export commodity after coffee. The fastest growing export markets for Fish Fillets of Uganda between 2021 and 2022 were Israel ($6.43M), Spain ($3.75M), and Italy ($3.58M). **Table 16** shows the volume and value of fish and fish product exports for 2023 (DFRi, 2023).

Table 16*: State on fish exports*

Product	Export quantity (Tons)	Value (Ugx) (000,000)	Chargeable Tax (Ugx) (000,000)
Fish export	20,910	366,214	2,937
Fish maw	356	128,541	10,283
Totals	**21,266**	**494,755**	**13,220**

Source: Directorate of Fisheries Resources (2023).

vi) Fish Value Chain Nodes in Lakes Albert and Victoria Regions

Studies undertaken in lakes Victoria and Albert, showed that the Landing sites visited on the two ecosystems were composed of heterogeneous communities, with Lake Victoria having 85% Baganda, and Lake Albert 33.6% Alur. Diversity of tribes had a lot of implications on choice, preferences, and consumption of fish. Education level of respondents was low, most respondents around the two lake systems had not studied beyond primary level. Mukene, Muziri and Ragogi fishing/production was a male dominated domain in all the landings visited on the two lake systems.

The average catch varied and respondents reported an average of 57 kilograms of fresh Mukene per day and a mode of 100 kilograms on Lake Victoria. Over 93% sold their fish mainly in fresh forms to processors cum traders (87%). Buyers of such fish included feed millers and consumers (Akumu, et al. 2023). The main challenges faced by the fishermen were bad weather (57.1%), and low returns which majorly resulted from poor fish catches. Other challenges were expensive fishing inputs, theft of fishing gears and poor enforcement of fisheries laws and regulations (Akumu, *et al.* 2023).

Communities of Lakes Victoria and Albert landing sites indicated that processing of Mukene, Muziri and Ragogi was considered a women's job and men always shunned it for different socioeconomic/ cultural reasons. All processors interviewed on Lake Victoria sun-dried mukene on bare ground (69.7%) while some few dried Mukene on nets (24.2%) and 6.1% used raised racks. Muziri, and Ragogi, were commonly processed at Lake Albert. The largest tonnage of Muziri/Ragogi (91.7%) at Lake Albert was

dried on nets, 75% of the Ngasia was smoked. All the Nile perch, and 50% of Tilapia were smoked. The purpose for which Mukene, Muziri and Ragogi was intended largely determined the way of drying it. Those for livestock and poultry were dried on bare ground, those for human consumption were cleaned properly to increase acceptability. On average, postharvest losses at the processing node were 120 kilograms on Lake Victoria and 11 kilograms on Lake Albert and this was mainly due to bad weather (90.9%). Other causes were: poor storage and delayed landing which made the fish rot while on the boat.

In order to minimize post-harvest losses, fishers were encouraged to land early, use proper storage, effective sun-drying facilities (raised racks), and cover fish with polythene during rain, and sort contaminants from fish after drying among others strategies Marketing/trading of the small pelagic was being done on small, medium and large scale for the two lake systems. Men dominated the large-scale category of trading in all the landings sampled on lakes Victoria and Albert because of their high economic powers; Women lacked collateral/security for loans as most properties belong to men, so could not afford big loans and hence operated on small scale. Fish consumption was slightly higher at landing sites compared to the 50km+ distance. Mukene was mainly consumed in the Lake Victoria region followed by tilapia and Nile Perch because it was affordable compared to two species. For the Albert region, the main fish species consumed were Tilapia, followed by Nile Perch; this was partly due to the high composition of immature fish in the catches which were sold at relatively low prices.

Consumption of fish was generally impeded by socio-cultural, institutional, geographical, and economic factors (Akumu et. al, 2023). A lot of infrastructure was required to improve post-harvest handling of fish, including fish handling slabs and cold chains in upstream and market segments. Enormous opportunities also lie in further diversification of the menu of processed fish and fish products. Beyond fish fillet, other value addition opportunities lie in processing of fish meal, skins, scales, and oils. As already mentioned above, products of primary processing (drying, salting, smoking, deep frying) should now aim to be transformed through industrial processing (DFRi, 2023).

vii) Utilization of Fisheries

The fisheries sub-sector is made of wild fisheries and aquaculture. About 20% of Uganda's surface area is covered by freshwater. There are five major water bodies including Lakes Victoria, Kyoga, Albert, Edward, and George and more than 160 water bodies (lakes, rivers, and wetlands) (**Figure 58**). All of these provide enormous potential for capture fisheries and aquaculture. Capture fisheries production accounts for ~80% of total production. Aquaculture production (~20%) is mainly through cages and ponds (DiFR, 2023; LVFO, 2022b; Nakiyende, 2019).

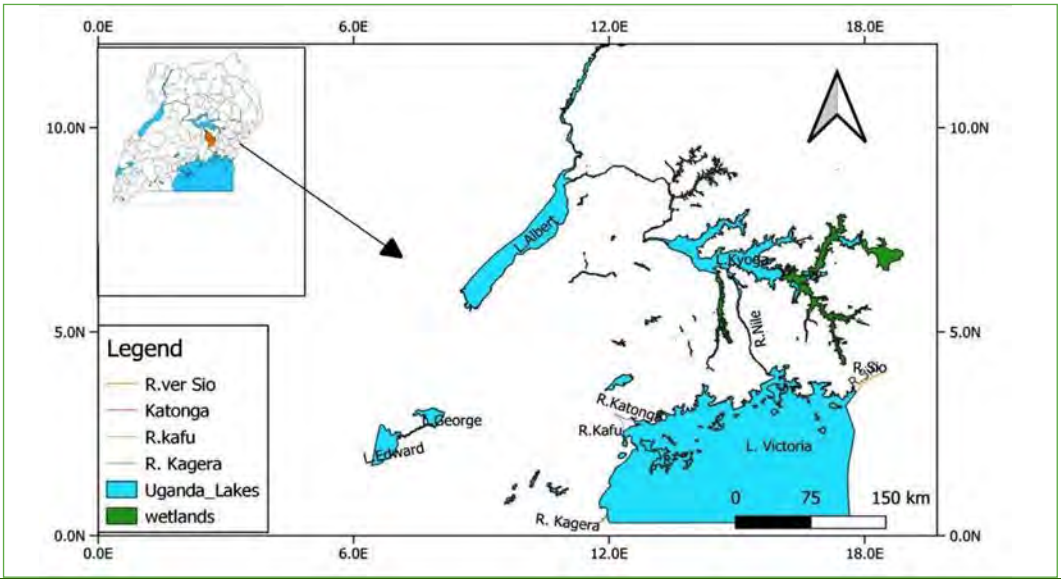


Figure 58*: Major water bodies in Uganda*

The fisheries sub-sector contributes 3 - 6% to National GDP and 12.6% to the agricultural GDP; providing direct employment to ~3 million people and essential nutrition. Production from capture fisheries ranges between 600,000 – 700,000 tons, with aquaculture contribution at ~120,000 tons. However, production is far below the national target of 1 million tons from aquaculture and 700,000 tons from capture fisheries by 2030. Exports to international markets were estimated at 27,173 tons worth 177.6 million in 2019 but declined in 2020, mainly due to Covid, with the regional trade estimated at 19,000 tons (Worth $55m). Over 75 % of the world's capture fisheries are considered fully or overexploited. However, aquaculture is the world's fastest-growing food production system, increasing at a rate of 8% annually and is expected to cover the gap in the total fish food requirement (DiFR, 2023; LVFO, 2022b, Nakiyende et al., 2019). The contribution is likely to be much greater, given that a significant part of the fisheries is categorized as "illegal, unrecorded and unregulated" (IUU), meaning fish are largely caught, moved, or traded without going through official records. It is further estimated that the sub-sector supports the livelihoods of over 5.3 million Ugandans and provides direct employment to about 1.5 million people working directly in capture fisheries and aquaculture. An estimated 15,000 people are employed directly as fishermen, operating more than 60,000 fishing vessels/boats on the five major water bodies in Uganda. Another 5,000 people are engaged in fish processing segments (DiFR, 2023; LVFO, 2022a, Nakiyende *et al.,* 2019).

c) Impacts on the fisheries sub-sector

i. Overexploitation of larger individuals has affected the healthy size structure within the fisheries population. This is due to the use of inappropriate fishing gears, thus high bycatch and the capture of undersized fishes leading to low fish production.
ii. High post-harvest losses and poor preservation facilities have led to high losses in the fisheries value chain thus less income to the fisheries communities due to low shelf life of the fishes.
iii. Fishermen sometimes face bad weather, and this has always led to low returns which majorly resulted from poor fish catches. In addition to expensive fishing inputs, there is theft of fishing gears in the lake (Akumu, et al. 2023).
iv. Inadequate research funds to provide timely information has also led to in fisheries gap information from some waters thus affecting the information flow and management measures in such water bodies.
v. Encroachment on the wetlands and buffer zones have also affected the breeding zones (critical habitats, such as inshore and coastal areas) of such fishes thus affecting the fisheries production.
vi. The relationships between predators and prey play an important role in structuring ecological communities, with predators influencing the dynamics of their prey in ways that cascade through ecosystems to affect processes such as productivity, biodiversity, nutrient cycling, disease dynamics, carbon storage, and more.
vii. The urban and industrial development along the shores of the lake ecosystem such as Lake Victoria and improper disposal of wastes into the lake has also led to some fish species disappear and some becoming extinct.
viii. Developments by the human such as hydropower dams, cultivation along the buffer zones on the ecosystems and wetland destruction has led to fish species loss in addition to the exploitation of the fishery.
ix. Ecological impacts, trends, and management responses to Hydroelectric Power Dam Construction

An April 2024 ecological monitoring report of the Upper Victoria Nile (UVN) by NaFIRRI (focussing on impacts of the Bujagali Hydropower Project) shows that the Hydropower Project has significantly altered the ecology of UVN, with positive and negative outcomes (**Table 17**). While some species and habitats have shown resilience, pressures from hydropower operations, fishing, and climate variability, there is demand for proactive management.

Table 17. ***Ecological Impacts, Trends, and Management Responses to the Bujagali Dam on the Upper Victoria Nile***

Parameter	Water Quality	Remarks
Dissolved Oxygen (DO)	Average concentrations (7.1 mg/L)	> NEMA minimum threshold of 3 mg/L, indicating healthy conditions for aquatic life
pH	Slightly alkaline (8.7 to 8.8)	> permissible range of 6.0 to 8.0, suggesting potential ecological stress Poor water quality (e.g., high pH levels, affects fish health and productivity
Temperature	(25.9°C to 26.3°C)	Stable, within the permissible range Water temperature fluctuations create unsuitable conditions limiting fish growth
Nutrients	ammonium, nitrite, nitrate, and total nitrogen	Concentrations remained below permissible limits, though spatial variations were observed
Total Suspended Solids (TSS) and Clarity	Slight increases downstream	Remained below harmful levels
Algae	Dominated by blue-green algae, with richness declining upstream Bio-volume peaked in mid-reservoir, reflecting favourable nutrient accumulation	Seasonal variability influenced composition, with blue-green algae maintaining dominance
Zooplankton	Richness range: 13 - 21 species (maximum abundance upstream) Copepods (e.g., Thermocyclops neglectus) were dominant, with reduced numbers downstream	Reduced abundance downstream is attributed to altered water flow
Benthic Macro-Invertebrates		
Gastropods and Bivalves	-Increased densities of gastropods (e.g., Bellamya unicolor) upstream; declined downstream -Bivalves (e.g., Byssanodonta parastica) exhibited similar spatial trends	Reduced richness and abundance of organisms downstream

Insect Larvae	Primarily upstream, with species like mayflies indicating better habitat conditions. Reduced abundance downstream highlighted stress from fluctuating water levels	The larvae are more abundant upstream due to higher oxygen levels, stable water flow, and lower pollution, while their reduced presence downstream reflects environmental stress from fluctuating water levels, pollution, and habitat degradation.
Fish Species and Catch Composition		
Richness and Abundance	11 fish taxa were recorded (including Nile perch, haplochromines, and Labeobarbus altianalis) Richness stabilized, below pre-dam levels There were declines in key species like Nile perch and haplochromines Labeobarbus altianalis showed recovery upstream	Alterations in water flow and habitat structure have led to changes in species composition, particularly downstream
Fishing Effort	Number of fishing boats rose by 59% compared to December 2023, reaching 102	Increased fishing activities with diverse gear types, especially in upstream and mid-reservoir zones
Dietary Shifts	Nile perch diets shifted to smaller fish species like Rastrineobola argentea Insectivorous diets dominated for Mormyrus kannume and Labeobarbus altianalis	Nile perch shifted to feeding on smaller fish like Rastrineobola argentea due to prey depletion and competition, while Mormyrus kannume and Labeobarbus altianalis retained insectivorous diets due to their specialized feeding adaptations and habitat preferences.
Commercial Fisheries	Pelagic species (e.g., Rastrineobola argentea) increased in yield Nile perch and Nile tilapia declined Recovering species like Bagrus docmac had positive trends but still vulnerable to overharvesting.	Socioeconomic effects: changes in fish stocks and habitat have impacted local livelihoods dependent on fishing Productivity correlates positively with profitability, where higher yields reduce production costs significantly

d) Responses

i. Fisheries surveillance and enforcement to ensure compliance to sustainable fisheries. Reduce illegal fish maw handling and trade that threatens the future of international trade. It is necessary to regulate the fishing based on proposals to limit overfishing and allow recovery of critical species.

ii. Control of invasive water weeds to safeguard the health of aquatic water habitats and infrastructure around water bodies.

iii. Research and development in aquaculture technologies and resource monitoring in wild fisheries has been done by the research scientists in fisheries and aquaculture. It is necessary to carry out continuous ecological monitoring to track changes and inform adaptive management.

iv. Interventions in aquaculture are required to create alternative sources of fish, employment and income and expand the export base. This has been the focus in addition to promoting investments in feed and seed production and aggregated production systems.

v. Investments in the post-harvest handling facilities for fish and fish products to improve quality for market needs.

vi. Institutional development of community/ farmer organizations in capture fisheries and aquaculture has been done by the research and extension services. Community engagement is necessary to promote sustainable fishing practices and involve local communities in conservation efforts. It is important to educate farmers on best management practices, species selection, and feed management.

vii. Raising awareness about the importance of environmental parameters on fish abundance can help fishers to support for management actions and encourage responsible fishing practices. Site optimization is required to align farming practices with ecological suitability to maximize yields.

viii. Multisectoral Approach: National Fisheries Resources Research Institute works in partnership with both state and non-state actors both at national and regional levels.

ix. Habitat Conservation: Recommendations to stabilize downstream flow regimes and improve habitat connectivity.

x. Policy Interventions can affect the fisheries sector. Fluctuations in production have been linked to policy changes and input subsidies. Aquaculture production in the South Eastern Agro-Ecological Zone, for example, declined between 2010 and 2013 due to reduced government support. Production, however, rebounded after 2014 following new government programs like "Operation Wealth Creation," achieving 1084 metric tons in 2015. Moreover, there are calls for enforcement of environmental regulations to address pollution and habitat degradation. In March 2023, the Fisheries and Aquaculture Act was enacted to guide the conservation, development, marketing, and utilization of fisheries resources. The process of preparation of operational guidelines has started to guide operationalization of the act in different areas including but not limited to aquaculture development, fishing technology and methods, fish habitat protection areas, fish quality assurance, community participation in fisheries management, fisheries surveillance and enforcement and others (DiFR, 2023; LVFO, 2022a).

3.7. TOURISM INDUSTRY, CULTURE AND HERITAGE IN UGANDA

Uganda's tourism industry offers a rich tapestry of natural wonders, cultural heritage, and adventurous experiences and key to the country's economy as the leading foreign exchange earner (Bugonga et al.,2022). According to UTSA (2023) the direct contribution of tourism to GDP (3.64%) was comparable to that of livestock (3.6%), forestry (4.0%), and education (4.3%), while surpassing sectors such as transportation and storage (3.4%), human health and social work activities (3.2%), and financial and insurance activities (2.7%). Uganda has a rich tourism product ranging from protected areas including national parks, forests, game reserves, rich attractions, vibrant markets, religious and historical sites that provide immersive experiences. As one of the most ethnically varied nations globally, Uganda is home to 56 different ethnic communities, each contributing its own distinct customs, traditions, and languages. (Ssali, 2017). Uganda's tourism industry is heavily dependent to on environmental natural resources such as wildlife, lakes, rivers, mountains and valleys. It has rich archeological sites, cultural and heritage sites, and being home to three United Nations Educational, Scientific and Cultural Organization (UNESCO) world heritage sites Bwindi impenetrable National Park, Rwenzori Mountains National Park, and the Tombs of Buganda Kings at Kasubi. Heritage sites with various significant importance including:history, culture, archaeology, and science (Taylor, 2013).

a) Pressures on Uganda's tourism recovery

Growth of tourism activities has resulted in unnecessary pressure on natural resources, culture and heritage.

i) In the face of rapid development, urbanization, armed conflict across the borders and climate change, the preservation of culture and heritage is under serious threat, some cultural heritage sites are being demolished to make way for contemporary structures, there is increasingly loss of historical buildings in cities like Jinja and Mbale (CCFU report,2022).

ii) Waste management poses a significant challenge in areas with high tourist activity, with improper disposal practices severely degrading natural resources, particularly water. The rise of aesthetic pollution, driven by inadequate land-use planning, has emerged as a critical threat to Uganda's natural landscapes, undermining its environmental integrity and the appeal of its tourism sector. This is more evident on beaches.

iii) Un regulated -tourism frequently leads to the commercialization of local culture, where customs, traditions, and heritage sites are altered to meet the demands of tourists. In destinations such as Bujagali falls, sacred ceremonies and spaces are increasingly packaged as entertainment, eroding the genuine essence of these cultural practices. This threatens the integrity of its rich cultural heritage and pristine natural environment.

iv) Unsustainable tourism development frequently ignores the cultural and ecological limits of given areas. This usually leads to over construction and a breakdown in the balance of local ecosystems most especially for natural resources near urban areas

v) Increasing pressure from the expanding human populations resulting in human wildlife conflicts; illegal activities such as poaching or killing wildlife outside park boundaries, climate change, as well as habitat destruction and invasive species have affected the wildlife populations in protected areas, the main attraction for tourism in Uganda (MTWA, 2024)

vi) Multiple licensing frameworks and taxes making tourism business less competitive; as well as gaps in critical infrastructure such as regional aerodromes, tourism roads; internet coverage; limited extension of water and electricity to tourism sites; gaps in skills and quality standards (MTWA, 2024)

vii) The influx of many tourists and tourism developments in protected areas, ecologically affects the natural habitat of many wildlife populations through increased fragmentation, waste accumulation, and stress to animals, habituation of species like gorillas, and chimpanzees, affects their natural behavior. Unsustainable tourism practices, such as off-road driving in parks, disrupt ecosystems, exacerbating the loss of biodiversity.

viii. Emerging disease outbreaks including Ebola in 2023 and Monkey pox in 2024, disrupt tourism travel, COVID 19, Ebola significantly affected tourism numbers and hold potential of zoonotic diseases to wildlife.

b) State of tourism industry in Uganda

Uganda tourism industry has undergone significant growth and recovery in 2024 post the COVID-19 pandemic. In 2024, tourist arrivals increased by 7.7% compared to the previous year,2023 a sign of the sector's resilience after the global pandemic. The international tourist numbers continued to exceed the one million mark of 1,371,895 in 2024 and 1,274,210 registered in 2023, compared to 814,085 in 2022 as shown in **Figure 59**.

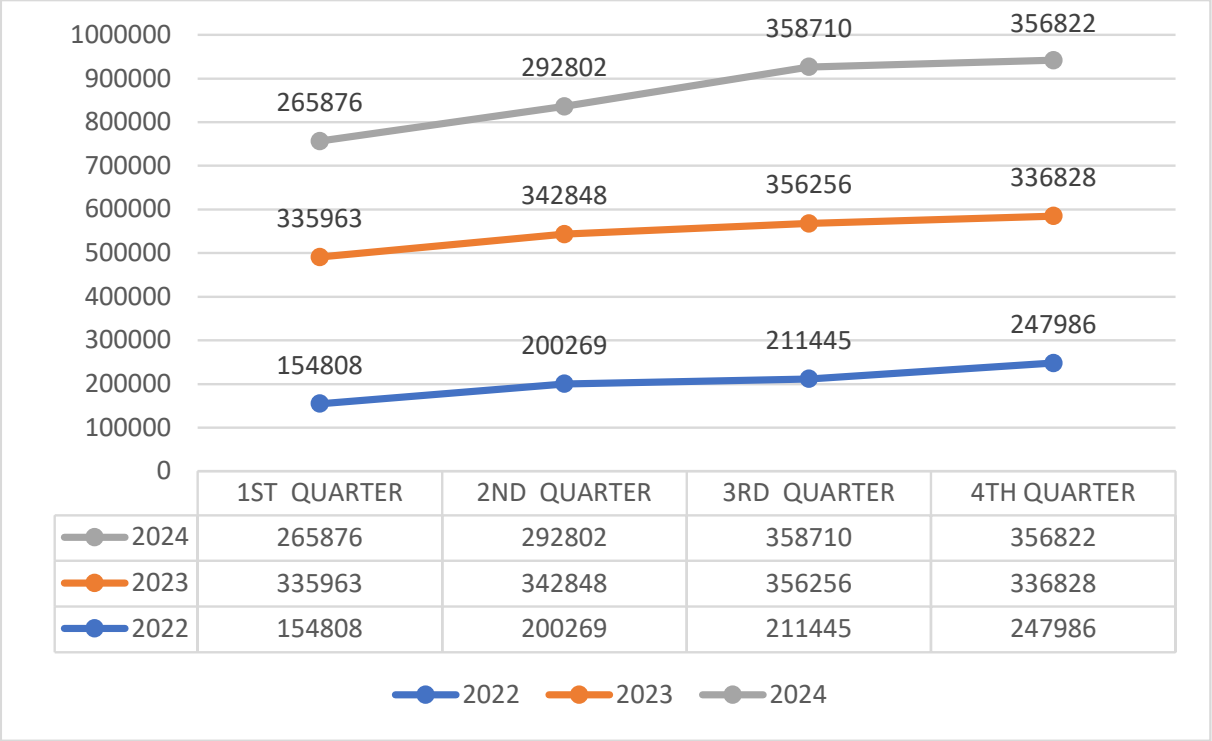


Figure 59*: International tourist arrivals to Uganda, 2022-2024 (***Source***: UBOS using PISCES System 2024, Ministry of Internal Affairs)*

Africa remains the main source of visitors with 89.2% of arrivals, **Table 18**. International tourist arrivals reached 82.6% of pre-pandemic levels, a significant milestone (MTWA,2024).

Table 18*: Tourist arrivals by Source region, 2022-2024*

REGION	2022	2023	2024
Africa	714576	1136216	1223678
America	17590	23643	28751
Asia	40172	55975	64535
Europe	27814	39596	37679
Middle East	3472	3983	4033
Oceania	1614	2939	2413
Unspecified	8847	11858	10806
Total	814,085	1,274,210	1371895

Source: UBOS using PISCES System 2024, Ministry of Internal Affairs.

Uganda boasts of 10 National Parks, 12 Wildfire Reserves, 5 Community Wildlife Management Areas, and 13 Wildlife Sanctuaries. In 2023, over 1.1 million tourists explored these destinations, with the Uganda Wildlife Education Centre (UWEC) taking the top spot with 619,164 visitors (MTWA,2024). The country has designated more tourists' sites in the country including the Kasese Equator monument point in 2024 aimed at attracting more tourists in the country (**Figure 60**)

Figure 60: ***The Equator monument in Kasese District in Western Uganda (*****Photo Credit:** ***NEMA, 2024)***

c) Impact of Uganda's tourism industry on the environment

The development of Uganda's tourism sector has had both positive and negative impacts on the environment and the economy. Uganda's tourism industry is heavily dependent on the environment with main attraction including wildlife protected areas cultural and archeological sites.

i. The influx of arrivals contributed to record-breaking tourism revenue totaling Shs105 billion in the 12 months leading to June 2023, underscoring the sector's significant contribution to the country's economy (UWA, 2022/23). Uganda collects a lot of revenue for the country which in turn supports wildlife conservation activities, 20% of gate collections is given back to the community to influence community's support for wildlife conservation.

ii. Increasingly, there is more conservation of the environment natural resources on private land due to the benefits of ecotourism, there is increasingly more interest in community conservation areas for example Bigodi wetland around Kibale national park under Kibale Association for Rural and Environmental Development (KAFRED) has conserved the wetland which has significantly contributed to the community development.

iii. Furthermore, tourism has played a vital role in Uganda's economy and generating over 610,806 jobs; in 2022 a 6.5% increase compared to 2019, highlighting its importance in driving economic

growth, supporting livelihoods, and reducing poverty. However, regional disparities in occupancy rates underscore the uneven recovery within Uganda's tourism industry (MTWA, 2022/23). UWA has more than 1500 rangers that protect and conserve wildlife.

iv. The tourism sector though a blessing to the economy, uncontrolled tourism has negative impacts to the environment, infrastructure development such as hotel and road construction has affected the land use and land cover changes, it's associated with land clearing, soil erosion and disruption of wildlife habitat quality. The road developments in national parks have increased animal risks to road accidents for example in November, 2024, a speeding truck killed an elephant in Murchison falls national park.

e) Responses to tourism challenges (on the environment/biodiversity)

In response to the challenges facing Uganda's tourism industry, various strategies have been employed to sustain its growth momentum and enhance the country's attractiveness as a tourist destination.

i) Improved Wildlife, Cultural and heritage site Management in Uganda as a result of several measures and strategies for management of biodiversity hotspots, cultural and religious sites of great significance in the country (Hoşkara et al,2023). There are improved management of wildlife conflicts such electric fences, combating illegal wildlife hunting and invasive species control to increase and maintain wildlife populations. Furthermore, the cultural and religious institutions have been empowered to maintain, protect and conserve cultural norms and values (Feuerbacher *et al 2021*).

ii) Sustainable tourism policies, Uganda has invested in policies, regulations and laws to enhance sustainable tourism development. Different stakeholders in the tourism sector have put up regulations, guidelines, dos and don'ts for responsible tourism, these have also increased trainings for sustainable tourism.

iii) The tourism stakeholders are increasly promoting responsible ecotourism which aims to have minimal environmental impacts with high tourism benefits, this has been done through eco-lodges.

iv) Environment education and sensitization; Efforts have been taken to educate citizens and tourists on the importance of conserving the environment. This has been done through tourism guiding, social media, trainings, and print media

v) Developing and enforcing comprehensive environmental management strategies, including regular compliance inspections and conservation programs, can reduce the ecological footprint of tourism activities. The National Environment Act Cap 181, and other related tourism management plans have been developed and implemented to guide the sustainable tourism development in Uganda.

vi) Emphasizing Uganda's status as one of the best MICE (Meetings, Incentives, Conferences, and Exhibitions) destinations has attracted business travelers from the East African Community (EAC) and leisure travelers from the US and the UK.

vii) Efforts to attract tourists from diverse markets such as the United States, the United Kingdom, India, and China though extensive marketing have also been evident, contributing to the sector's resilience and recovery.

3.8. ENERGY AND EXTRACTIVES

3.8.1 ENERGY

Access to energy is necessary to enhance human survival and to achieve economic, social as well as environmental aspects of human development (Mianimo et al., 2022). The overall consumption of energy worldwide is continuously increasing and expected to increase by 53% in 2035 (Watundu et al., 2022). Usually, about 6.6 billion metric tons carbon equivalent of greenhouse gas (GHG) emission are released in the atmosphere to meet this energy demand (Kapusuzoglu and Karan, 2013).

In Uganda, energy consumption is still much lower than the international standards, despite a rise in industrialization efforts and income levels of the population, yet the country is endowed with renewable and non-renewable energy resources. The renewable energy resources in Uganda include: biomass (firewood, charcoal and cogeneration), hydrological (water), solar energy, geothermal energy, and wind energy resources while the non-renewable energy resources, include crude oil, peat, and nuclear energy (Agerit et al., 2022).

The Renewable Energy Policy 2007 for Uganda as per Uganda Vision 2040 indicates that the country's total renewable energy power potential is estimated at 12,700 MW: 4500 MW (hydropower), 1500 MW (geothermal), 1700 MW (biomass), and 5000 MW (solar PV). It is important to note that the current total Installed electricity Generation Capacity has grown from 400 MW in 2000, and to currently 1247 MW, derived from four (4) Energy Sources: Hydro (1023.59 MW); Thermal (100 MW); Cogeneration (63.9 MW); and Grid-connected Solar (60 MW) (Wabukala *et al.*, 2021), **Table 19**

Table 19*: Present and future cumulative power generation in Uganda*

Source of energy	Current installed capacity (MW), Jan 2020*	Proposed installed capacity (MW), 2040**
Hydropower	1 004.3	4 500
Geothermal energy	0	1 500
Bio energy	50.8	5 000
Biomass energy	96.2	1 700
Peat energy	0	800
Nuclear	0	24 000
Thermal	101.1	4 300
Total	1 252.4	41 800

*** ERA, 2020; **Uganda Vision 2040 document (pages 73-74)**

a) Pressures

Biomass energy: There is desire to meet the planned Uganda Vision 2040. The government of Uganda National policies like the NDP III and Vision 2040 emphasize the importance of increasing electricity access and promoting sustainable energy sources. Besides, there are the National Environment Act, Cap. 181, and the Uganda Climate Change Act, 2021 that support renewable energy initiatives. The current Uganda Energy Transition Plan 2023 outlines strategies for transitioning to sustainable energy sources. Due to increasing population and economic activities, there has also been an increase in demand for electricity over time in Uganda in recent year. About 79.6% of the population is still left out in terms of access to electricity in Uganda. There are increasing efforts to scale down CO2 emissions. Indeed, there is a desire to safeguard the environment and control missions in Uganda. The Government of Uganda approved the National Energy Policy (Power sub-sector reform) to stimulate provision of sufficient, consistent, and cost-effective power supply in Uganda to meet the increasing energy demand (Mutumba, 2022).

The main pressure of biomass energy forest is increasing population that results in increased energy demand. Increased demand for biofuels and bio-based materials increases the pressure

on agriculture to produce biomass. There is also employment created by charcoal production for income generation in Uganda.

Hydropower projects, which play a dominant role in Uganda's electricity generation, exert several pressures on water resources. The main pressures include water abstraction, which reduces water availability downstream, and changes in the timing of river flows due to reservoir operations, which alter natural flow regimes and affect ecosystems.

Construction activities and operations of hydropower projects often lead to pollution, degrading water quality. Additionally, there is competition with other water users, such as agriculture, domestic supply, and industry, leading to conflicts over water rights and allocation.

Despite these advancements, the electricity sector in Uganda faces several challenges. Vandalism of the grid is a persistent issue, causing disruptions in power supply and incurring significant repair costs. On the other hand, climate change poses another major challenge, with variations in hydrology, flooding, and other climate-related issues damaging infrastructure and reducing power generation efficiency. Furthermore, floating waterweeds, particularly on the River Nile, obstruct water flow and affect the performance of hydroelectric power plants. Delays in project implementation due to land acquisition issues and compensation disputes also pose significant challenges, slowing down the progress of vital energy projects.

In terms of solar power, clearance and use of large areas of land for solar power facilities can adversely affect native vegetation and wildlife, causes reduced agricultural land, soil compaction, alteration of drainage channels and increased erosion. Clearing land for a power plant may have long-term effects on the habitats of native plants and animals. Solar power investment also brings increased use of batteries that are difficult to dispose. The PV cell manufacturing process includes a number of hazardous materials used to clean and purify the semiconductor surface like hydrochloric acid, sulfuric acid, nitric acid, hydrogen fluoride, 1,1,1-trichloroethane, acetone, allium arsenide, copper-indium-gallium-diselenide, and cadmium-telluride which pose serious environmental or public health threats.

Wind energy projects can negatively impact the surrounding environment and the animals who live there. Mortality from collisions with wind energy plant can results in increased death of bird. The most critical environmental impact of wind turbine is the noise pollution.

Security of fuel supply is an important issue and a forceful driver of nuclear energy development in Uganda with electricity demand that has been growing at an average of 10% per year. Uganda also undertook a number of reforms to promote growth in the energy sector.

b) State of energy

i) Biomass Energy

Biomass energy is the process of cutting down trees, turning them into wood pellets, and then burning them for power. Uganda's energy sector is still dominated by the use of biomass with fuel from firewood (wood), charcoal, briquettes, and agricultural residues (Amerit *et al., 2022*). The use of biomass energy in Uganda accounts for more than 90% of total energy consumption with firewood contributing 78.6%, charcoal (5.6%) and crop residues (4.7%). Uganda's biomass energy potential is estimated at 1800MW. The current available sustainable wood biomass supply is about 26 million tons. Biomass energy is generated wood, (forest residue and shrubs), primary and secondary mill residues, wood cuttings, and briquettes, fast-growing crops grown specifically for energy use (fast-growing trees, grasses), energy crop waste, agricultural and animal residue, and food waste (Mutumba, 2022). Currently, wood fuel for example is used extensively to heat and to fuel brick-burning, tea drying, cement, titles, and lime production. Meanwhile processing solid biomass into charcoal has been one of the strategies to provide less emission cooking fuel for urban people. Charcoal is used by the population majorly living urban and peri urban settings. However, charcoal production from the forest is often not

effectively regulated and thus contributes to forest degradation, deforestation, and GHG emissions, as well as climate change. The use of firewood and charcoal combined is responsible for over four million deaths annually due to indoor air pollution. It is projected that production of biomass resources is carried out using unsustainable and inefficient production methods (Katutsi et al., 2020). For instance, 1 square kilometer of forest cover is required to produce 50 tons of charcoal (Katutsi et al., 2020). With an annual growth in energy demand of 7.5%, Uganda's biomass resources are unlikely to be sustainable.

ii) Hydro Electric Power (HEP)

There are three kinds of hydropower generation plants in Uganda: (i) run-of-river (where the power is generated by the flow of a river) (ii) reservoir (where the power is generated by the release of stored water) and (iii) pumped storage (where stored water is backed up into the reservoir in order) to be pumped again. The large hydropower potential in Uganda along River Nile is estimated at about 2000 MW. Hydropower contributes less than 2% of the national energy in Uganda with 93% of rural households without access to electricity. However, Uganda's electricity generation capacity has experienced significant growth over the past decade, from a modest capacity of 464.32 MW in 2009 to an impressive 2,047.50 MW by the end of 2023, **Figure 61**.

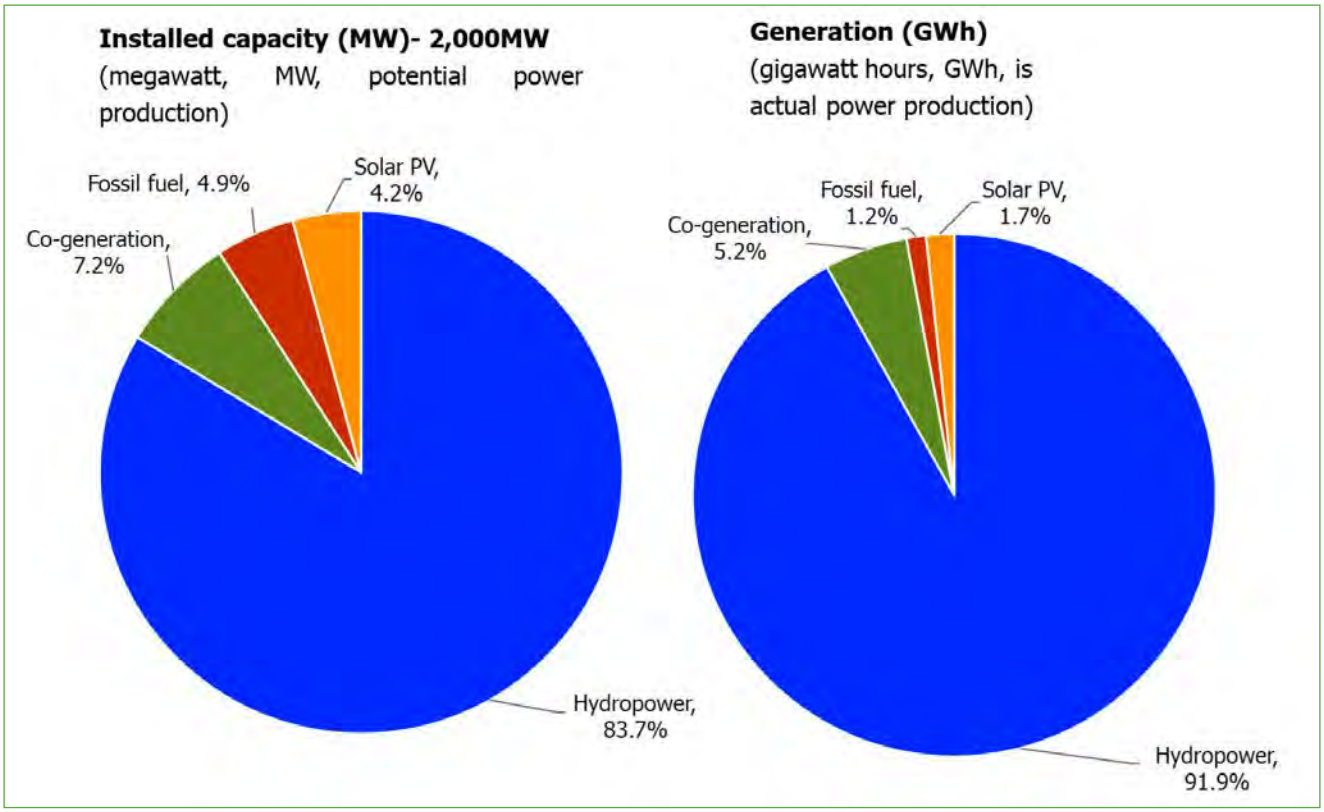


Figure 61: ***Electricity generation in Uganda as of 2023.***

Currently 380 MW developed at Nalubaale and Kiira and 250 MW under development at Bujagali, the unexploited potential is well over 1300 MW. Uganda has a total of 24 power plants that produce and supply electricity to the national grid (**Table 20** and **21**). These include 4 large hydropower plants and 11 small hydropower plants (1023.59 MW), 2 thermal or heavy fuel oil power plants (100 MW), 5 bagasse-based cogeneration power plants (63.9 MW), and 2 solar PV power plants (60 MW). The distribution of electricity in Uganda has expanded enormously in over two decades, with legally grid-connected customers rising from 180,000 in 2001 to 1,643,288 in 2020, including off-grid clients. However, the country has an electricity import capacity of 20.5 MW from two power plants in the neighboring countries (Bongomin and Nziu, 2022).

Table 20. ***Operational large hydropower plants***

S/N	Power stations	Community (district)	River	Capacity (MW)	Year completed
1	Nalubaale	Buikwe	Nile	180	1954
2	Kiira	Jinja	Nile	200	2000
3	Bujagali	Buikwe	Nile	250	2012
4	Mahoma	Kabarole	Mahoma	30	2018
5	Isimba	Kamuli	Nile	183	2019
6	Achwa 2	Gulu	Achwa	41	2019
7	Achwa 1	Gulu	Achwa	42	2021
	Total			926	

Source: Bongomin and Nziu, 2022.

In order for Uganda to meet its energy demand, many hydropower plants are under construction, and some are proposed.

Table 21. ***Large hydropower plants proposed and under construction in Uganda***

S/N	Power stations	Community (district)	River	Capacity (MW)	Year to be completed
1	Achwa 3	Pader	Achwa	135	2022
2	Karuma	Kiryandongo	Nile	600	2023
3	Ayago	Nwoya	Nile	880	2025
4	Agbinika	Yumbe	Tochi	20	2025
5	Nshungyezi	Isingiro	Kagera	39.0	2025
6	Kiiba	Kiryandongo and Nwoya	Nile	400	WIP
7	Oriang	Kiryandongo and Nwoya	Nile	392	WIP
8	Muzizi	Kibaale	Muzizi	48	WIP
	Total			2514	

Source: Bongomin and Nziu, 2022 (WIP, Work in Progress)

Uganda's current access rate to electricity is 28%, way below the sub-Saharan Africa average of 48%. Households are among the fastest growth markets for electrical connections, growing at annual rate of approximately 13%. Electricity is consumed by residential (55%), commercial (24%) and industrial (20%) sectors and for street lighting (1%). Half the urban households use electricity for lighting (using inefficient incandescent lamps). The tariffs are shown in **Figure 62**.

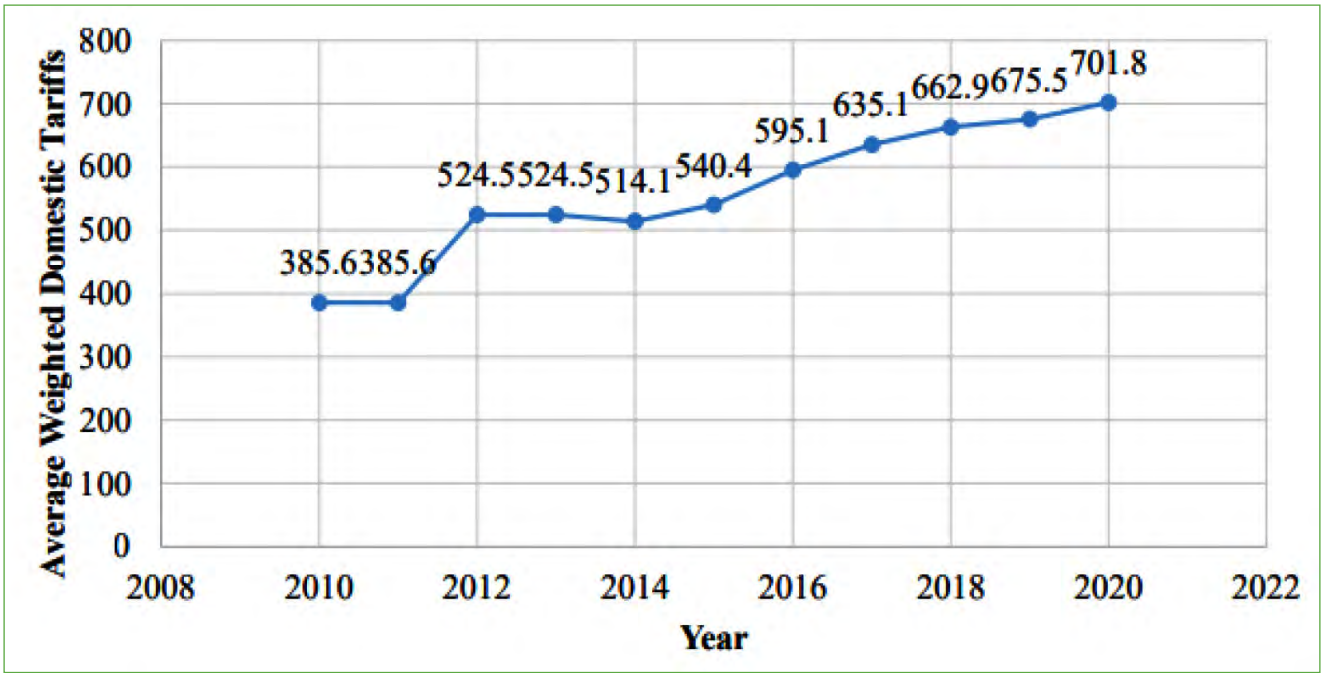


Figure 62: ***Trends in Average Domestic Unit Prices of Grid Hydroelectricity in Uganda (2010-2020).*** **Source:** ***Watundu et al., 2022***

This substantial increase in energy production underscores the country's commitment to enhancing its power production capabilities to meet the growing demand, and support its economic development. The expansion is a testament to the efforts made in infrastructure development and investment in the energy sector. The dams that have been built across the country to generate hydroelectricity include the Achwa 1 powerhouse, and Achwa 2 intake and headrace canal shortly downstream and the Isimba hydro power plant (**Figure 63**).

Figure 63*: Hydroelectricity power plants. A. Achwa 1 powerhouse. B. Isimba Hydro power plant.*

The electricity transmission and distribution network in Uganda has also seen remarkable growth. For instance, the transmission segment, which forms the backbone of the country's electricity infrastructure, expanded from a circuit length of 1,165 km in 2003 to 4,519 km by 2023, nearly a fourfold increase (**Figure 64**).

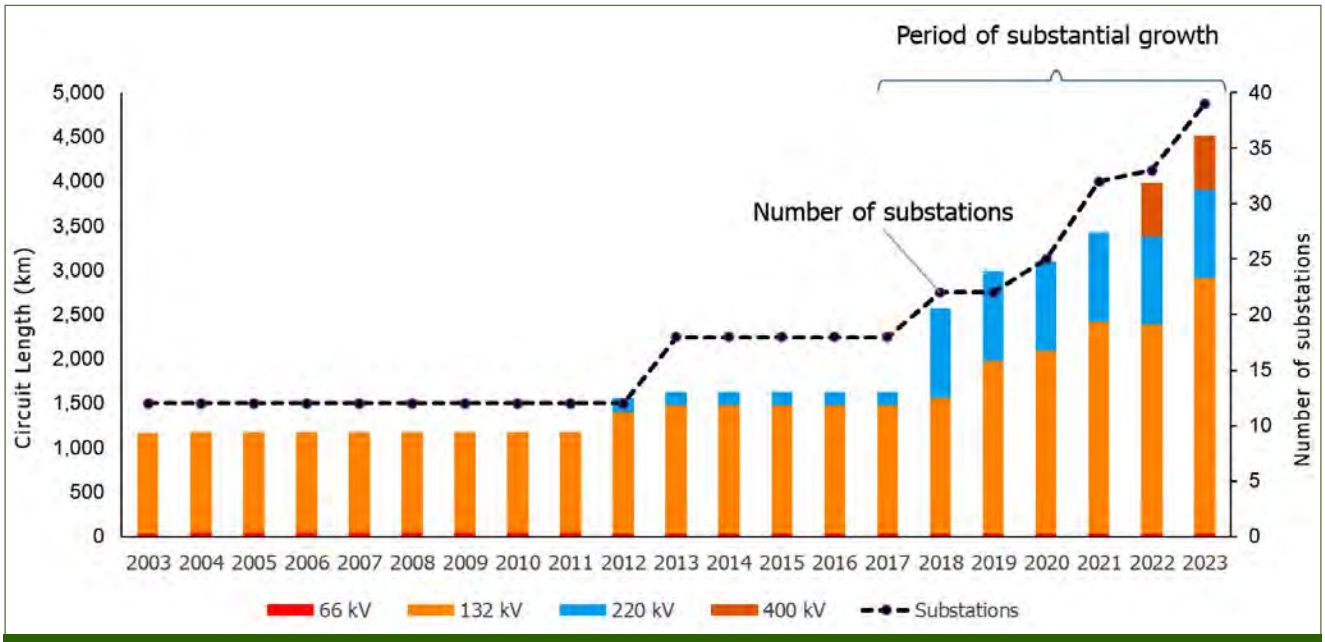


Figure 64*: Expansion of the circuit length and sub-stations across Uganda..*

Similarly, the distribution network expanded significantly, with its total length increasing by 41% from 45,086 km in 2018 to 63,373 km in 2023. These expansions have been crucial in improving electricity accessibility and reliability across the country (**Figure 65**).

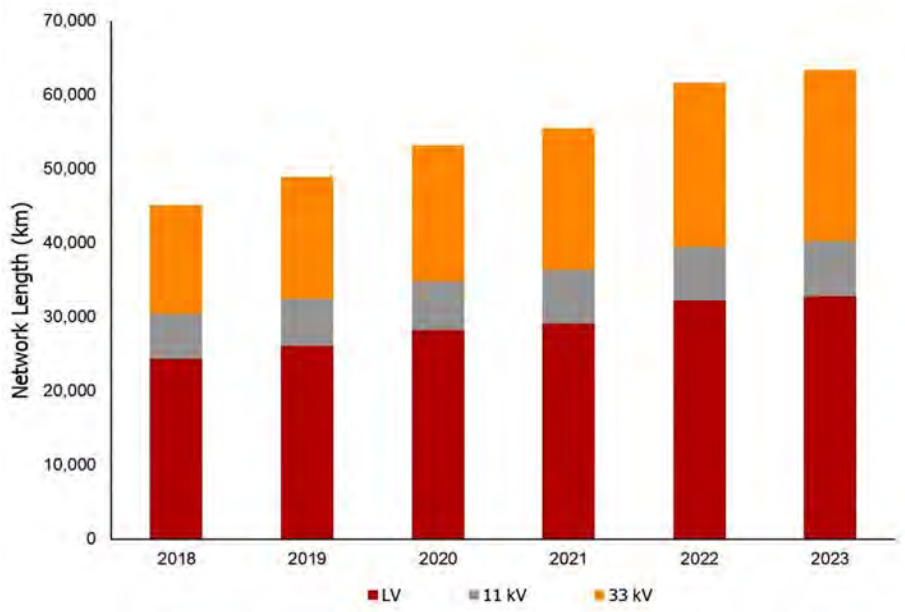


Figure 65*: The electricity distribution network across the Uganda.*

iii) Solar energy

The sun is a natural nuclear reactor that releases energy. Solar panels convert the sun's light into usable solar energy use (Avellino et al., 2018). Uganda presents a huge market potential for alternative technologies to provide electricity, such as solar energy and photovoltaic. Currently solar energy is underutilized in the country, although this is slowly changing. Though it started by donor-funded programmes, its use in rural areas in growing. Overall, the projected solar penetration in a different part of the country by the year 2021 was 6.1%, with the total annual energy estimated at 69.52 GWh. The average solar radiation is 5.1 kWh/m^2/day and existing solar data clearly indicate that the solar energy resource in Uganda is high throughout the year. Since 2014, two 10 MW solar power stations (Tororo Solar Power Station and Soroti Solar Power Station) in the east of Uganda were licensed by the ERA (**Figure 66**). In the rural areas, the electricity generated by the solar home PV systems is mainly used in household application such as cellphones, lighting, and radios.

Figure 66*: Solar plant in Tororo district. (***Photo Credit***: NEMA, 2024).*

iv) Wind energy

The wind is one of the notable atmospheric variables, and wind power has been one of the fastest-growing renewable energy technologies receiving much global attention of lately (Kisuule et al., 2023). Yet in Uganda, wind energy is not yet developed and is presently an unused resource in for electricity generation. Although wind speed distribution is an importance parameter for the assessment of wind energy potential, no wind measurements have been made at heights of over 10 m a requisite for wind turbine design in Uganda. Available wind measurements reveal that prospects, in Uganda are "low" for large-scale electricity generation, and much of the data collected by the Uganda National Meteorological Authority is for weather-related purposes.

Available data shows that wind speed in most areas of Uganda is moderate, with average wind speeds of about 3.7 m/s, rising to 6 m/s around Lake Victoria, the Karamoja region, and mountainous areas in the southwestern part towards the border with Rwanda (Kabale, Kisoro, Ntungamo) and in the area around Mt. Elgon (the average wind speed of 4 m/s). Wind speeds is also thought to be commercially viable in Tororo, Pader, and Nakapiripirit Districts with average speeds ranging from 7 to 9 m/s at the height of 80 m. In eastern Uganda, average wind speeds have been observed to be high from March to June (average 4m/s and 4.5m/s) with potential wind power of 46.7 Watts (Opejo, 2022). In Kabale, the highest average wind speed recorded was about 5.9 m/s where an energy of 127.3 Wh /m2 could be extracted (Muramuzi, 2022) .

Based on the available data, the wind energy resource in Uganda is only sufficient for small-scale electricity generation in mountainous areas and for special applications, such as water pumping, mainly in the Karamoja region (Bongomin and Nziu, 2022). The government installed 43 water pumping windmills in Karamoja and another Tororo Wind Power Station in Eastern Uganda. In addition, there is Uganda Veteran Wind Power Initiative that supplies between 1000 and 15,000 of wind power systems. Development of wind power farms requires a skilled workforce for wind resource assessment, infrastructure installation, operation, and maintenance, but the technologies used for wind power generation and supply are very expensive. For instance, an initial cost of investing in wind power is approximately 80% of the total project costs with additional costs for operation, maintenance, and insurance. It is estimated that a residential wind turbine can be rated in the range 5–15 kW with costs that ranges between $65,000 and $95,000, including installation.

v) Geothermal energy

Uganda still has no geothermal energy in operation. The exploration for geothermal resources in Uganda is still at the reconnaissance and exploration stage. Currently, more than 40 geothermal sites in Uganda have been studied for their prospect's parameters like temperature, chemistry of reservoir, natural heat transfer, and fluid characteristics to identify specific project areas and prioritize those for more detailed investigation. Temperature level that varies between 150 C° and 200 C° has been found to be sufficient for electricity generation and for direct use in industry and agriculture. Three major potential areas at Katwe-Kikorongo, Buranga and Kibiro for geothermal energy have been discovered in Uganda estimated at 450 MW. The rest of the geothermal areas of Uganda are at a preliminary level of investigation and results will soon be available as basis for their prioritization for detailed surface exploration.

There are 10 challenges that have been identified to hinder the geothermal development in Uganda. These are: 1) land access barriers and competition, 2) diversification of Uganda's energy mix, 3) large investment costs, 4) lack of awareness and information, 5) government policy, incentives and institutional challenges, 6) inadequate research and development, 7) inadequate human capacity and training, inadequate infrastructure to support geothermal energy development, 8) inadequate infrastructure to support geothermal energy development, (9) shortage of financial resources, and (10) sociocultural and environmental challenges.

vi) Nuclear energy

Nuclear energy is considered a valuable option for the decarbonization of power generation in Uganda, as it is produced from noncarbon resources. it plays a major role in meeting the future global energy needs and mitigating the threat of climate change. Preliminary findings indicate that 50000 km2 of estimated uranium can be found around Buyende, Nakasongola, Mubende, Kiruhura, Buhweju plateau, and Lamwo (Bongomin and Nziu, 2022). The unit cost of developing 1 MW of nuclear energy is estimated at $6 million. There are government efforts in Uganda to build a 1000 MW power plant in the medium term and 2000 MW in the long run and raise generation capacity to 3500 MW in the future. Currently, there are numerous challenges that are debarring atomic energy development in Uganda. These include perceived danger and the fear of nuclear energy, complex and specialized knowledge required. Nuclear energy: Promotion of nuclear energy technology across the country will contribute to poverty reduction through natives benefiting from employment opportunities, skills acquisition and development, investment opportunities and technology transfer (Mutumba, 2022).

c) Impacts

Biomass energy: Consequences of continued use of biomass fuels include deforestation. The high demand for fuel wood has resulted in the depletion of forests and exacerbates land degradation-associated with higher levels of indoor pollution, time allocations especially by women and children for its collection. Uganda suffers a degradation loss of USD 2.3 billion, of which 25% is wood fuels. About 2.6% of Uganda's forests are cut down annually for firewood, charcoal, agriculture, and to make way for population growth (Ogwok, 2022). Biomass can also pump out huge amounts of harmful air pollution, including dust, particulate matter, volatile organic compounds, and particularly toxic or hazardous air pollutants that can cause diseases like asthma and respiratory illnesses.

Hydrothermal energy: The environmental and social impacts of hydropower projects are significant. Habitat degradation and the conversion of land threaten both aquatic and terrestrial biodiversity. Sediment accumulation in reservoirs impacts aquatic life and reduces the efficiency of the reservoirs. Pollution from effluents affects water bodies, impacting ecosystems and human health. The creation of reservoirs also leads to the loss of land and displacement of communities, causing social disruptions. The pressures on water resources due to hydropower generation lead to reduced water availability downstream, changes in flow regimes, and competition with other water users, which can result in conflicts. Additionally, the impacts of climate change, such as flooding and reduced water flow, further exacerbate these issues, posing a threat to the reliability and sustainability of the electricity supply.

Solar energy: Although solar energy does not pollute air and water or cause greenhouse gases, it can have a negative, indirect effect on the environment. toxic materials and chemicals are used to make the photovoltaic (PV) cells that convert sunlight into electricity. Some solar thermal systems use potentially hazardous fluids to transfer heat. Leaks of these materials can harm the environment and cause health effects to human beings and animals. However, environmental effects from solar energy technologies are usually minor and can be minimized by appropriate mitigation measures.

Geothermal energy: Currently, there is no specific policy on geothermal energy development in Uganda. The government established geothermal resources department within in MEMD. There is a proposal to establish geothermal specialty training institutions in Uganda for developing specialized manpower in fields of Geosciences, Engineering (renewable energy, electrical, mechanical, mechatronics, chemical), material sciences, geophysics, geochemistry, energy management, social sciences. Currently, Makerere University created a program of renewable energy at post graduate and Makerere University Business School with Energy economics and governance.

Wind energy: The noise and vibration of construction and operation of the wind turbines can be damaging to fish and other marine species, and wildlife, most notably on birds and bats due deaths from collisions with wind turbines and due to changes in air pressure caused by the spinning turbines. Wind turbines may also increase fish populations by acting as artificial reefs. Sound and visual impact are also some of public health and community concerns associated with operating wind turbines.

d) Responses

Biomass energy

A number of policy measures have been suggested for the population to transition to modern biomass energy consumption. Bio energy could be used in powering vehicles like the recently unveiled Kira Motors' electric buses known as Kayoola buses in Uganda. The Kiira Vehicle Plant in Jinja, has an annual capacity of 2,500 vehicles. These buses use bio energy instead of fossil fuels.

The National Forestry Authority is enforcing the president's directive on charcoal products. President Museveni issued Executive Order No. 3 to ban the production of and trade in charcoal in Northern Uganda. This caused the prices of charcoal to double. Uganda is undertaking an energy subsidy transfer to use of modern bioenergy technologies (cleaner and more efficient source of energy). Improved biomass stoves are built to have higher efficiencies compared to the traditional counterpart. Energy-saving stoves are being promoted by the government (Okello et al., 2013). The role of the private sector in the dissemination of improved biomass stoves in Uganda is also becoming important. The use of an alternative energy source or processed wood fuels such as charcoal, briquettes, and other agricultural residues are very important for reducing overreliance on firewood. The government in Uganda has turned to promote liquefied petroleum gas (LPG) and electric cooking at household.

Hydrothermal energy: As a measure of increasing uptake of renewable energies, the Government of Uganda implemented power subsector reform program aimed at providing adequate, reliable, and least cost power to meet the country's demand, promoting efficiency in the power sub-sector, and scaling up of rural and peri-urban access. A Feed-in Tariff (FiT) structure as a policy tool was designed to stimulate investment in the renewable energy source. Constitution of Uganda, under Article XI, emphasizes promotion of energy policies to meet people's energy needs in an environment-friendly manner. There is the Atomic Energy Act, 2008 and the Electricity Act 1999 which specifically set out the legal framework for reforms in the power sub-sector, the Rural Electrification Strategy and Plan as well as the regulatory framework for power generation from small renewable energy sources. The government set the Electricity Regulatory Authority (ERA) to regulate the sector, established the Rural Electrification Fund (REF) to enhance rural access to electricity, and t Electricity Dispute Tribunal (EDT) to exercises powers to hear and determine electricity sector dispute.

The Energy Regulatory Authority (ERA), in collaboration with other agencies such as the National Environment Management Authority (NEMA), Directorate of Water Resources Management (DWRM), and Uganda Wildlife Authority (UWA), implements several regulatory measures to ensure sustainable energy development. ERA issues licenses for electricity activities, considering environmental impacts, and conducts periodic inspections to ensure compliance.

The establishment of an Environmental Flow Working Group, comprising various stakeholders, monitors compliance with environmental flow requirements and addresses issues such as illegal water abstraction. For critical projects, ERA conducts public hearings to gather stakeholder input before issuing licenses, ensuring transparency and accountability. To address the challenges and ensure sustainable energy development, several recommendations have been proposed including; strengthening the monitoring system for environmental flow and imposing heavy penalties for illegal water abstraction is crucial. There is also developing guidelines for sediment flushing and enhancing water quality monitoring systems

to help manage the environmental impacts of hydropower projects. It is also important to monitor the performance of effluent treatment plants at co-generation and other electricity projects to prevent pollution. Mapping and engaging with projects and water users along rivers can help minimize conflicts over water resources. Additionally, enhancing inter-agency collaboration and improving the conditions of surface water permits issued by the DWRM are essential for ensuring compliance and protecting water resources.

Geothermal energy: any construction of geothermal has direct impact on land scape and creates noise. It can also have impact of air and water quality. Air quality impact depend on chemical composition of the geothermal stream leading to acid rain and contribution to global warming. Hot water pumped from underground reservoirs often contains high levels of sulfur, salt, and other minerals. Hydrogen sulfide is the most notorious toxic gas from geothermal energy.

Wind energy: Government of Uganda priority in the renewable energy agenda for wind energy is mentioned in The Uganda Vision 2040 and the National Energy Policy 2002, and the Renewable Energy Policy 2007. Although support programs for wind energy development in Uganda are generally lacking, there are a few a responses to the water crisis in Karamoja sub-region for water pumping windmills and Tororo Wind Power Station in Eastern Uganda.

Solar energy: The Uganda government put in place a renewal energy policy but not policy to create public awareness on solar energy access and other efforts to promote clean renewable energy based on off-grid electrification. To increase the consumption of solar energy, the government has built two 10MW solar power plants, the largest in East Africa, in its eastern districts of Soroti and Tororo at a cost of USD 19 million and USD 19.6 million respectively that are estimated to connect electricity to around 75,838 (40,000 in Soroti and 35,838 in Tororo) residents. Rural Electrification Agency (REA) estimates that so far over 30,000 solar PV systems have already been installed to in rural areas in Uganda and still there are huge unexploited solar energy resources in the country (Avellino et al., 2018). The use of solar is currently being driven by private companies and non-profit organizations by offering financing options and educational resources to help households and businesses transition to solar power.

Nuclear energy: Governments of Uganda is examining technical offers from vendors pursuing their own business interests in nuclear energy for advice and knowledge. There are plans to establish and develop nuclear training programmes in the country.

3.8.2 EXTRACTIVES

The extractives sector, which includes activities such as mining, oil and gas exploration, and quarrying plays a significant role in Uganda's economy. However, these activities have notable environmental impacts, including land degradation, deforestation, water pollution, biodiversity loss and greenhouse gas emissions. In Uganda mineral exports contributed 30% of foreign exchange earnings at the peak of sector performance during the 1960s to 1970 according to the Ministry of Energy and Minerals Development. However, political and economic instability experienced in the country in the 1970s led to the decline of the sector to its present level of contributing only 1% of the Gross Domestic Product (GDP).

The country's rich and diverse mineral resources are of High Value Minerals and precious metals that were looked at include gold, tin, wolfram, and iron ore. The Low Value Minerals and Materials include salt, sand, dimension stones and construction materials (granite, shale and quartzite), pozzolana, limestone and marble.

Minerals are categorized into two; metallic minerals and non-metallic minerals. Metallic minerals are those that contain metals in their chemical composition and are a potential source of metal while nonmetallic minerals are those that do not contain any extractable metals in their chemical composition.

3.8.2.1 Mineral production by quantity

During CY2022, the production of Pozollana and Kaolin experienced a percentage decrease of 49.3 percent and 96.7 percent respectively. Positive production was realized in the production of Limestone, Vermiculite, Wolfram, Syenitic Aggregate, Iron Ore, Beryllium (1%), Volcanic Ash and Feldspar at 20.4, 44.9, 94.7, 809.2, 925, 12.6, 526.5 and 1360.5 % respectively.

Non-Metallic Minerals

The production of non-metallic minerals saw mixed trends between 2019 to 2020 and 2021 to 2022. Limestone experienced a notable decrease in production by 237,396 tons in 2019 to 2020 then increased by 94,505.33 tons in 2021 to 2022, reflecting improved mining activity. However, Pozzolana production increased by 169,438 tons in 2019 to 2020 then reduced 475,847.81 tons. Vermiculite showed steady growth, rising by 4,496 tons in 2019 to 20202 and rose steadily by 7,109.40 tons, while Kaolin, reduced by 10,125 tons and furtherly reduced by 6,659.00 tons. Marble and diatomite experienced positive changes, with marble production increasing from zero to 4,173 tons, and diatomite rising from zero to 21 tons. Granite production, reduced by 98 and further declined by 141 tons, while dimension stone showed a positive shift, growing from zero to 112 tons.

Metallic Minerals

In the periods between 2019 to 2020 and 2021 to 2022, the metallic minerals sector displayed a combination of recovery and decline in production. Wolfram reduced by 168 tons between 2029 to 2020 then rose by 38.81 tons between 2021 to 2022. Syenitic Aggregate reduced by 61,288 tons then rose by 43,746.49 tons. Iron ore production surged significantly, reaching 92,500 tonnes between 2021 to 2022, while Coltan production increased by 166 tons then reduced by 404 tons. Tin's production increased to 3 tons between 2021 to 2023. Beryllium experienced a decline, falling by 171 tons and by 59.5 tons. Volcanic ash production experienced a dramatic rise, from zero to 159,225.78 tons, while lithium and feldspar both saw increases by 81 tons and 1,292.5 tons, respectively between 2021 to 2022, reflecting growing demand in industries such as electric vehicles and ceramics.

3.8.2.2 Oil resources

The Petroleum Authority of Uganda (PAU) estimates Uganda's petroleum resources at 6.5 billion barrels, of which 1.2 billion are considered recoverable under current market conditions, with an additional 0.4 billion barrels of contingent resources.

1. PMS (Premium Motor Spirit, commonly gasoline)

The import volumes for PMS show a general increase over the years, with some fluctuations. It started at 930.54 million in 2018 and reached 1,121.34 million in 2022, indicating growing demand. This growth likely reflects increased usage of motor vehicles, population growth, and urbanization, which drive gasoline consumption.

2. BIK (Bitumen for Industrial Use)

BIK imports started at 57.66 million in 2018, peaked at 53.46 million in 2019, and dropped to 48.97 million in 2022. The variations in BIK imports might be linked to the level of infrastructure projects in a given year, as bitumen is primarily used in road construction and other industrial applications. The decline post-2020 may suggest a slowdown or completion of large-scale infrastructure projects.

3. AGO (Automotive Gas Oil, commonly diesel)

AGO imports have remained relatively consistent, starting at 982.22 million in 2018 and peaking at 1,067.94 million in 2021 before slightly declining to 985.44 million in 2022. The steady demand for diesel is likely driven by industrial machinery, heavy-duty vehicles, and generators. The slight drop in 2022 may reflect improved energy efficiency or changes in energy sourcing.

4. JET (Jet Fuel)

Jet fuel imports fluctuated significantly, starting at 133.52 million in 2018, peaking at 131.10 million in 2019, then sharply dropping to 69.61 million in 2020, before recovering partially to 95.89 million in 2022. The sharp decline in 2020 reflects reduced aviation activity due to the COVID-19 pandemic, which grounded flights globally. The

subsequent recovery in 2021 and 2022 aligns with the resumption of air travel.

3.8.2.3 Monitoring and inspection of environment aspects of oil, gas and minerals in Uganda

Recognizing that Uganda is endowed with a wide range of extractives resources in the form of Oil, Gas, minerals as well as Geothermal Resources, Uganda's vision 2040 and the National Development Plan III aim at building a strong mining (including Oil & Gas) industry that will contribute to the country's economic and social development.

The regulation of environmental aspects of oil and gas activities in Uganda is essential for promoting sustainable development, protecting public health and safety, ensuring fair socio-economic benefits, and upholding legal and ethical responsibilities. These regulations help balance the exploitation of natural resources with the need to preserve the environment and improve the quality of life for current and future generations. Specifically, during the Financial Year, the Authority played its assigned role of supporting the extractives sector through, environment assessment and compliance monitoring and inspections, i.e. review of ESIA reports and Environmental Audit (EA), and development of critical regulatory tools.

3.8.2.4 Oil and gas

The development phase of the country's Oil and Gas sector is now fully under implementation in line with the third National Development Plan (NDP III) which lists several development strategies for the period 2020/21-2024/25 and prioritized the fast-tracking of interventions aimed at facilitating the production and processing of oil/gas as well as mining and mineral beneficiation. With the country targeting first oil in 2025, there has been an exponential increase in the level of activity in the Albertine Graben. Accordingly, a lot of work is ongoing with the Tilenga Project (Buliisa and Nwoya), Kingfisher Project (Kikuube & Hoima) and the construction of the 1,443km East African Crude Oil Pipeline (EACOP) from Buliisa to Tanga in Tanzania is underway. However, this has serious implications on the environmental (and social) resources. NEMA together with partner instituitons have developed mechanisms to mitigate any negative impacts on the environment including the development of the Albertine Graben Sensitivity Atlas.

3.8.2.5. Mining and geothermal developments

Uganda's mining and geothermal sector is steadily growing, a lot of exploration and mining is taking place. With the opening of the tin processing plant in western Uganda, there has been an increase in ESIA reports in exploration and mining of tin especially in the areas of Ntungamo and Mitooma where most deposits are. Iron ore and critical minerals like lithium, Rare Earths and graphite are also taking shape. Sand mining and other extractives like marrum and stone quarries have also continued to come in. Sand mining is mainly in the areas of Rwampara and Mpigi, Marrum in Buliisa and Wakiso districts and stone quarries in Mukono district.

Artisanal and Small Scale Miners continue to exist though largely not regulated. These are mainly in stone quarries, gold and tin mining, there are no ASMs in critical minerals probably due to their location and the technology requirements to mine such minerals. The Ministry of Energy and Mineral Development is now focusing on sensitization of the ASMs to mainly form associations and submit requests for mining licenses under the new Mining and Minerals Act of 2022 and other regulations under this act like the Artisanal and Small Scale Mining Regulations of 2024. NEMA has sensitized these groups in environment management to attract them to carry out ESIA studies.

Geothermal development is still in the exploration development, the advanced one being in Panyimur which is at Deep Exploration Wells Development. Other potential areas like Kibiro and Buranga are still at Thermal Gradient Wells development, however, their ESIAs are still pending due to many factors including stakeholder consultation and the sensitivity of the proposed areas. Geothermal potential has also been established at Kibiro in Hoima District, Panyimur in Pakwach District, Buranga in Bundibugyo District, and Katwe-Kikorongo in Kasese.

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CHAPTER 4 LINKAGES OF RELEVANT ENVIRONMENTAL POLICIES AND LAWS

4.1 Environmental policies

The environmental policies in Uganda as highlighted in **Table 22** collectively establish a comprehensive framework aimed at conserving natural resources and promoting sustainable development. Strengths across these policies include robust regulatory frameworks, institutional support for environmental management, and integration of sustainable practices into national development plans. These policies emphasize the protection of biodiversity, sustainable land, water use and management, climate resilience, and disaster preparedness, aligning with international standards and promoting public participation.

Table 22: ***The environmental policies in Uganda***

S/No	Policy Name	Environmental Linkage	Lead Agency
1	National Environment Management Policy, 2014	➢ Provides a framework for conserving natural resources and promoting sustainable practices ➢ Integrates environmental concerns into development to ensure sustainable use of natural resources	NEMA
2	National Policy for Disaster Preparedness and Management, 2011	➢ Integrates environmental considerations into disaster risk reduction ➢ Promotes sustainable practices for mitigation, preparedness, and resilience against environmental hazards	Office of the Prime Minister
3	National Land Policy, 2013	➢ Provides guidelines for sustainable land management and use of land resources ➢ Promotes equitable land access, resolves land tenure issues, and incorporates environmental considerations in land use planning	Ministry of Lands, Housing and Urban Development
4	National Climate Change Policy, 2018	➢ Guides efforts in climate change mitigation and adaptation ➢ Focuses on reducing emissions, enhancing resilience, and promoting sustainable practices	MWE
5	National Oil and Gas Policy, 2008	➢ Ensures environmentally sustainable exploration and exploitation of oil and gas resources	Ministry of Energy and Mineral Development
		➢ Sets guidelines for minimizing ecological impacts and promoting social responsibility among oil and gas companies ➢ Mandates environmental assessments and protects ecosystems and communities from the adverse effects of oil and gas activities	

6	National Wetlands Policy, 1995	➢ Aims to conserve and sustainably utilize wetland ecosystems ➢ Supports biodiversity conservation, restoration, and sustainable use for agriculture, fisheries, and tourism	MWE
7	National Forest Policy (NFA, 2022)	➢ Emphasizes forest conservation and sustainable management ➢ Promotes reforestation, afforestation, and community participation in forest management	MWE
8	National Water Policy (NWP, 2021)	➢ Ensures sustainable and equitable use of water resources ➢ Focuses on water supply, sanitation, and addressing water scarcity and pollution	MWE
9	National Fisheries and Aquaculture Policy, 2019	➢ Establishes a framework for sustainable fisheries and aquaculture ➢ Protects aquatic biodiversity, prevents overfishing, and empowers community stewardship	MAAIF
10	National Urban Policy and Habitant, 2017	➢ Provides a framework for sustainable urban development ➢ Addresses environmental challenges of urbanization, such as unplanned settlements and urban sprawl ➢ Emphasizes the periodic reviews to adapt to emerging environmental challenges	Ministry of Lands, Housing and Urban Development

Several policies are aimed at driving rural and urban development that impact on the environment. These include the National Agriculture Policy (2013), and the National Urban Policy (2017). The National Agriculture Policy (2013) aims to facilitate commercialization of the smallholder agriculture by providing access to financial services such as loans. It also aims to improve the quality and safety of agricultural products, and promote trade in agricultural products. Thus, government policies and international aid programs aimed at boosting agricultural productivity and sustainability play a crucial role in driving the sector forward, but some of them may adversely affect the environment.

The National Urban Policy (NUP), 2017 guides urban development. The goal is to promote livable urban areas that are organized, inclusive, productive and sustainable. The Local Government Act, 1997 decentralizes social services, including education to village levels thus promoting development. Uganda National Local Economic Development (LED) Policy, 2014 provides a collaborative framework for partners in local development to promote economic opportunities, eradicate poverty and ensure inclusive, sustainable and equitable economic growth at local level.

However, notable challenges need addressing to realize these policies' potential fully. Common weaknesses include limited financial and technical resources, implementation and enforcement challenges, inadequate public awareness and engagement, and coordination issues among various agencies.

4.2 Environmental laws in the framework law on the environment: The linkages

Uganda has several environmental laws in place, creating a cohesive legal framework that addresses multiple dimensions of environmental management, ensuring that policies and actions are harmonized and mutually reinforcing. The linkages between these laws lie in their shared objectives

of protecting natural resources, conserving biodiversity, promoting sustainable resource use, and mitigating environmental impacts. They also complement each other by addressing different sectors and aspects of environmental management, ensuring a holistic approach to environmental protection and sustainable development in Uganda. Together, these laws create a cohesive legal framework that aims to balance economic development with environmental conservation, safeguarding Uganda's natural heritage for present and future generations.

a) The National Environment Act, Cap. 181

The National Environment Act, 2019 Cap. 181, which serves as the cornerstone of the country's environmental legislation. This Act provides a comprehensive legal framework for environmental management in Uganda to provide for the management of the environment for sustainable development; to continue the National Environment Management Authority as a coordinating, monitoring, regulatory and supervisory body for all activities relating to environment; to provide for emerging environmental issues including climate change, the management of hazardous chemicals and biodiversity offsets; to provide for strategic environmental assessment; to address environmental concerns arising out of petroleum activities and midstream operations, to provide for the management of plastics and plastic products; to establish the Environmental Protection Force; to provide for enhanced penalties for offenses under the Act; to provide for procedural and administrative matters; and for related matters. It addresses pollution control, conservation of biological diversity, sustainable use of natural resources, environment and social impact assessment, environmental audits and enforcement mechanisms.

b) The Water Act, 1997; Cap 152

The Water Act 1997, Cap. 152 ensures the sustainable management and use of water resources in Uganda. Its key provisions regulate the use and management of water resources, establish water quality standards and mechanisms for controlling water pollution, and provide for the issuance of water permits and the establishment of water user associations.

c) The Forestry and Tree Planting Act, 2003

The Forestry and Tree Planting Act, 2003, promotes the conservation, sustainable management, and development of forest resources. It establishes the National Forestry Authority (NFA) to oversee forest management, encourages reforestation and afforestation efforts, and regulates the harvesting of forest products and the protection of forest reserves.

d) The Wildlife Act, 2019

The Wildlife Act 2019, Cap. 200 provides for the conservation and sustainable management of wildlife in Uganda. It established the Uganda Wildlife Authority (UWA) to manage wildlife conservation areas, regulate hunting, poaching, and trade in wildlife products, and promote community participation in wildlife conservation. The Wildlife Act works in conjunction with the National Environment Act, Cap. 181 to protect biodiversity, ensuring the conservation of wildlife and their habitats.

e) The National Climate Change Act, 2021

The National Climate Change Act, 2021 Cap. 182 enhances the objectives of the National Environment Act, Cap. 181 by addressing climate change, a cross-cutting issue that affects water resources, forestry, and wildlife.

f) The Fisheries and aquaculture Act, 2022

The Fisheries and Aquaculture Act, 2022 Cap. 197 is aimed at consolidating and reforming the law relating to fisheries and fish products; to provide for the conservation, sustainable management, utilization and developments of the fisheries sub sector; to provide for the integrated management of the fisheries sub sector in order to facilitate the achievement of sustainable increases in the economic, social and environmental benefits from fisheries; to provide for conservation, capture, farming, rearing, processing and marketing of fish; top provide for licensing, control and regulation of fisheries and fish regulation of fisheries and aquaculture production activities and practices, the methods of fishing and fishing gear; to enhance and strengthen and strengthen

the Directorate of Fisheries Resources; to provide an enabling environment for equitable sharing of increased benefits for the fisheries subsector; to provide for the establishment and regulation of the lake management organizations and gazetting of landing sites; to allow for fisheries mechanization; to provide for fish breeding and breeding areas; to provide for the regulation of fish feeds; to provide for private sector engagement in fisheries sub sector; to repeal the Fish Act, Cap 197 and the Trout Protection Act, Cap. 199; and related matters in the environmental sector.

g) Land Amendment Act, 2010

The Land Amendment Act 2010, Cap. 227 of Uganda is aimed at amending the Land Act to enhance the security of occupancy of lawful and bona fide occupants on registered land per Article 237 of the Constitution, and for related matters.

h) The building control Act, 2013

The Building Control Act, 2013 of Uganda consolidates, harmonizes, and amends the law relating to the erection of buildings; provides for building standards; establishes a National Building Review Board and Building Committees; to promote and ensure planned, decent, and safe building structures that are developed in harmony with the environment; and for other related matters.

i) Mining Act, 2003

The Mining Act of 2003, Cap. 248 significantly influences Uganda's environmental landscape, as it regulates mineral exploration, development, and production, directly impacting environmental sustainability. Mandating environmental impact assessments (EIAs) ensures early identification and mitigation of mining-related environmental risks. Additionally, the Act facilitates provisions for community participation, land acquisition, and compensation that prioritize addressing social and environmental concerns, promoting sustainable practices and social responsibility in the mining sector.

4.3. Effectiveness of the environment legal frameworks

Uganda's environmental policies and laws have made significant strides in addressing various environmental challenges. The National Environment Act, Cap. 181, has provided a comprehensive framework for environmental management, facilitating better coordination and regulatory oversight. Environmental Impact Assessments (EIAs) have become a standard requirement for development projects, ensuring that potential environmental impacts are considered and mitigated. Policies targeting specific areas, such as the Forestry and Tree Planting Act and the Water Act, have contributed to more focused management and conservation efforts. However, the effectiveness of these policies and laws varies across different sectors and regions. While there have been notable successes, challenges such as inadequate funding, limited technical capacity, and enforcement issues persist. Deforestation rates, for instance, remain high despite the Forestry and Tree Planting Act, indicating gaps in implementation and enforcement. Similarly, water pollution from industrial and agricultural sources continues to be a significant problem, pointing to the need for more stringent enforcement of the Water Act.

The National Forestry Authority (NFA) has undertaken several reforestation projects, involving the planting of millions of trees in degraded areas and distributing free tree seedlings. These initiatives have not only helped in restoring forest cover but also in enhancing biodiversity, combating soil erosion, and improving water catchment areas. Community involvement in these projects has also provided livelihoods and increased environmental awareness.

Under the Water Act, Uganda has implemented Integrated Water Resources Management (IWRM) programs that promote sustainable water use and management through stakeholder participation, private public partnerships, water user associations, and catchment management plans. These programs have led to improved water quality, distribution and availability, reduced conflicts over water resources, and enhanced resilience to climate change impacts.

The Uganda Wildlife Authority (UWA) has

successfully implemented anti-poaching operations, wildlife monitoring, and community conservation programs. These efforts have resulted in the stabilization and growth of key wildlife populations, increased tourism revenue, and greater community support for wildlife conservation.

The Climate Change Department has spearheaded several adaptation projects, including promoting climate-resilient agricultural practices and constructing flood defenses. These projects have enhanced the resilience of vulnerable communities to climate change impacts, improved food security, and reduced disaster risk.

The Fisheries Directorate has mainly made emphasis on the increasing production and productivity, conservation and restoration of the aquatic biodiversity in the Capture fisheries and also production and improved seeds and feeds in the aquaculture sector. In addition to that advocacy of the fish habitat thus the pollution level reduction and controls in the aquatic ecosystem.

The Land Act provides the best utilization and management of Land and the surrounding environment of the seating tenant in accordance with the constitution of Uganda as provided in article 237.

The National Urban Policy, 2017 is essential for guiding sustainable urban development, fostering coordination among stakeholders, protecting the environment, promoting economic growth, ensuring social inclusion, and enhancing resilience to hazards and climate change in urban areas.
Implementation of some of the government programmes may have unintended negative impacts on the environment. Urban expansion through reclassification of land use from rural to urban-Spatial expansion during creation of Cities and Municipalities, for example, involved demarcation of the boundaries of selected urban areas and annexing adjacent townships and rural areas (MoLHUD, 2022). Administrative reclassifications-beyond pure spatial expansion, administrative reclassifications have influenced the pace and magnitude of urbanization. For purposes of achieving the required minimum area, the upgrading of some urban councils has led to annexing rural areas which compromises on food security and constrains provision of services. These new district headquarters are automatically gazetted as Town Councils reclassifying the population as urban irrespective of the level of development (MoLHUD, 2022). Growth in sectors such as manufacturing and construction increases demand for resources and leading to overexploitation of resources.

Despite comprehensive legal frameworks, enforcement remains weak. There are inconsistencies in the application of laws and a lack of sufficient resources and capacity to enforce regulations effectively. Environmental policies often operate in silos, with limited coordination and integration across sectors such as agriculture, industry, road construction and urban planning. To address these gaps, it is essential to strengthen enforcement mechanisms by increasing funding for regulatory bodies, enhancing technical and operational capacity, and ensuring consistent application of laws. Promoting cross-sectoral coordination and integrated planning approaches is crucial to ensure that environmental considerations are mainstreamed into all development activities. Enhancing enforcement mechanisms by providing adequate resources and support for monitoring and regulation, and promoting community-led conservation initiatives and supporting sustainable livelihoods to reduce pressure on forest resources, are necessary measures. Water pollution from industrial and agricultural sources continues to be a significant problem, pointing to the need for more stringent enforcement of the Water Act. Implementing stricter regulations and more effective monitoring to control industrial and agricultural pollution, and increasing investment in water treatment infrastructure and promoting sustainable agricultural practices to reduce water pollution, are recommended actions.

Current policies may not fully address emerging environmental challenges and hence regular reviewing and updating environmental policies to adapt to new challenges and ensuring they remain relevant and effective in addressing

contemporary issues is vital. Integrating climate change adaptation measures into national and local development plans, focusing on building resilience in vulnerable communities and ecosystems, is also essential. While there are policies promoting community involvement, enhancing community engagement through education programs, participatory planning processes, and support for community-led conservation initiatives is recommended.

Effective environmental management is hindered by inadequate monitoring and data management systems. Investing in robust monitoring systems and data management infrastructure to ensure timely and accurate information for decision-making and policy evaluation is necessary. There are limited incentives for private sector engagement in sustainable practices. Community engagements in addition to developing and implementing incentive schemes such as tax breaks, grants, and recognition programs to encourage businesses and individuals to adopt environmentally sustainable practices is advised.

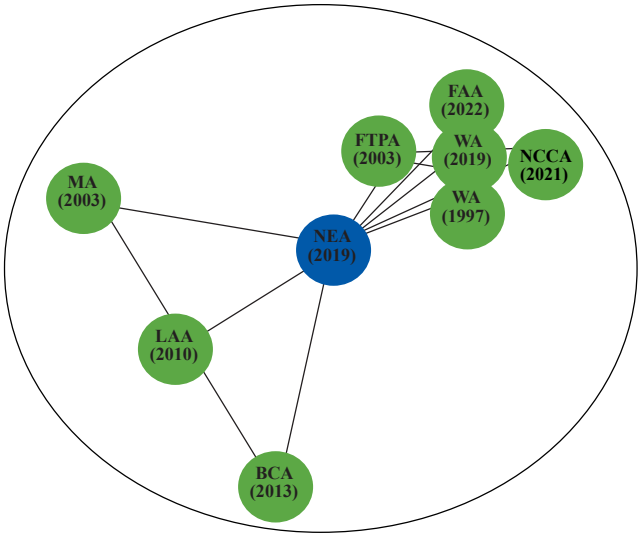

Figure 67: ***Linkages of various laws of Uganda to the National Environmental Act (NEA)***

NEA Cap 181 is the core framework, coordinating efforts across sectors and integrating environmental management principles (**Figure 67**). The Water Act (WA) works closely with NEA to ensure water resource management aligns with environmental goals. The Forestry and Tree Planting Act (FTPA) promotes sustainable forestry practices, directly supporting biodiversity conservation and carbon sequestration goals under the NEA. The Wildlife Act complements FTPA and NEA by protecting ecosystems and biodiversity. National Climate Change Act (NCCA) addresses climate change impacts, linking water, forestry, and biodiversity laws for holistic climate resilience. Fisheries and Aquaculture Act (FAA) regulates aquatic ecosystems in harmony with NEA and NCCA for sustainable fisheries management. Land Amendment Act (LAA) ensures land-use policies protect environmental resources in line with NEA. Building Control Act (BCA) promotes environmentally friendly infrastructure development aligned with NEA principles. Mining Act (MA): Requires Environmental Impact Assessments to align mining activities with NEA standards. Each law plays a specific role, but together, they form a comprehensive legal framework for environmental sustainability in Uganda.

4.4. Adherence to environmental statutes – Environmental policing

Enforcement of environmental laws and policies in Uganda is a multifaceted process involving several agencies. NEMA is at the forefront, tasked with monitoring compliance with environmental regulations, conducting environmental audits, and taking enforcement actions against violators. The Environment Protection Force (EPF), a specialized unit within NEMA, assists in enforcing environmental laws and responding to environmental crimes. With efforts of the EPF, as of March 2024, 250 criminal cases had been handled compared to 69 and 112 criminal cases handled in FYs 2021/22 and 2022/23 respectively. Most of the criminal cases were related to the encroachment and abuse/degradation of wetlands, noise pollution, and commencement of projects without Environment Social Impact Assessment (ESIA). The Legal and Corporate Affairs Division continues to support the Authority in legal and technical advisory functions through drafting correspondences, restoration orders, compliance agreements, and providing legal advice among others.

To ensure compliance, regular inspections, ESIA, and audits are conducted. In FY2020/2021, out of 1,478 ESIA documents processed, 893 were

inspected, for FY2021/2022, 829 were inspected out of the 2,600 processed. In addition, in FY2023/24, out of 1,000 project that were targeted to be inspected, 920 were inspected as illustrated in **Figure 68**. NEMA has prioritized compliance assistance inspections, focusing on helping developers implement cleaner production and green economy interventions. Non-compliance can result in penalties, fines, and legal action. Additionally, community-based monitoring initiatives and partnerships with civil society organizations assist in tracking and reporting environmental violations.

In the FY2023/24, the Authority registered a higher number of projects conducting environment compliance audits i.e. compliance audit reports were received from 3,348 projects/ developers, out of which 2,163 report were reviewed accounting for 64.6% churn out of audits received for review. Out of the 2,163 audit reports reviewed, 1,795 were approved representing 83% compliance of facilities to ESIA conditions. In contrast, few projects carried out compliance audits in FY2020/21, that is, the Authority received only 855 audit reports. However, 1,350 reports were processed that included backlogs from the previous years. The analysis in figure 4 below show audit reports submitted to NEMA compared to the report processed in the past four years. in (**Figure 68**)

.

Figure 68*: ESIA submissions and processing.*

NEMA has registered a significant increase in the number of developers conducting ESIA for projects. This is evidenced by the number of ESIA submissions that increased from 1,618 to 4,761 submissions in FY 2018/19 and FY 2022/2023 respectively, a percentage increase of 66%. Similarly, the review and processing of documents also improved significantly. The document processing rate in FY 2018/2019 was 69%. In FY 2022/2023, the rate increased to over 100% due to the processing of backlog documents from previous fiscal years. As of the end of March 2024 (Q3), there has been a good progress in performance in FY 2023/2024. A total of 2,938 documents (1,730 ESIA reports and 1,208 ESIA TORs) were submitted. Out of these documents, 1,172 ESIA reports and 932 ESIA TORs were processed and concluded, representing processing rates of 68% and 77% respectively. Since July 2021, NEMA has issued 6,147 ESIA certificates (**Figure 69**).

Figure 69*: Trend of compliance audit submissions to NEMA.*

Public participation is a cornerstone of environmental governance in Uganda, recognizing that community engagement is essential for effective environmental management. Various mechanisms facilitate public involvement, including public hearings, consultations during the Environmental Social Impact Assessment (ESIA) process, and community-based natural resource management initiatives. NEMA and other agencies actively involve communities in decision-making processes, ensuring their views and concerns are considered in environmental planning and policy development. Civil society organizations (CSOs) and non-governmental organizations (NGOs) play a significant role in mobilizing community participation, raising awareness, and advocating for environmental justice. Public awareness campaigns, educational programs, and capacity building workshops further empower communities to engage in environmental conservation activities. By fostering a participatory approach, Uganda aims to ensure that environmental governance is inclusive, transparent, and responsive to the needs and aspirations of its people.

NEMA in collaboration with key stakeholders has formulated and continues to formulate regulations that enhance compliance to environmental protection and management in the country. The regulations that have been gazetted in the last three FYs include The National Environment (Management of Hazardous Chemicals and Products Containing Hazardous Chemicals) Regulations, 2024, The National Environment (Air Quality Standards) Regulations 2024, and the Environment Police Force regulation, 2024. Similarly, those under formulation are: The Noise and Vibrations regulations, The environment practitioners' regulations, the Access to Benefits Sharing regulations and policy, the express penalty, administrative fine and coercive fine regulations, and the Extended Producer Responsibility and Product Stewardship regulations. Relatedly, in FY 2023/2024, NEMA developed an instrument for the gazettement of Environmental Inspectors from various institutions/sectors to support the functions of the Authority.

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CHAPTER 5 OUTLOOK AND PATHWAYS FOR SUSTAINABLE ENVIRONMENT MANAGEMENT

5.1. Vision and Objectives

5.1.1. Vision

The vision of the National State of the Environment Report is a clean, healthy, resilient, and flourishing environment supporting the well-being and prosperity of its people and ecosystems for generations. The vision is in line with the Uganda Vision 2040 that seeks to achieve a green and clean environment with no pollution of water and air while conserving the flora and fauna, restoring and adding value to the ecosystems.

5.1.2 Objectives

The long-term objectives are to:

i. build resilience to climate change and climate variability impacts;
ii. promote the sustainable management of natural resources, including forests, water, and land;
iii. minimize pollution and the associated environmental degradation;
iv. promote the transition towards a green and circular economy;
v. empower local communities and indigenous peoples to actively participate in environmental decision-making, conservation efforts, and enhancing sustainable livelihoods;
vi. enhance the capacity of government ministries, departments and agencies, local governments, civil society organizations, and other stakeholders to effectively implement environmental policies and regulations.

5.2. Possible pathways

5.2.1. Policy reform scenario

The Policy Reform scenario envisions a future where there is a significant shift towards the enforcement of existing environmental laws and the introduction of new policies designed to promote sustainable development practices. Key changes should include the strict implementation of regulations on land use, pollution prevention and control, and natural resource management. This scenario also emphasizes community participation and green growth initiatives. The anticipated outcomes are improved environmental conditions, enhanced resilience to climate change, and sustainable economic growth driven by innovation and responsible resource management. This should lead to healthier ecosystems and a more balanced relationship between economic development and environmental preservation.

5.2.2. Technology-driven scenario

In the Technology-Driven scenario, innovative technologies and sustainable practices are embraced to address environmental challenges. There is substantial investment in research and development of clean technologies, renewable energy, and eco-friendly infrastructure. Digital solutions for environmental monitoring and management are promoted extensively. This scenario aims to achieve a reduced environmental footprint, increased efficiency in resource utilization, and the emergence of a knowledge-based green economy. Outcomes include a significant reduction in pollution levels, optimized resource use, and the creation of new economic opportunities rooted in sustainable practices and technological advancements.

5.2.3 Approaches and technologies for sustainable environmental management

a) Renewable energy

The expansion of renewable energy sources, such as solar, wind, and hydroelectric power, will reduce reliance on fossil fuels and mitigate the impacts of climate change and climate variability. These energy sources provide cleaner alternatives that

contribute to reducing greenhouse gas emissions and promoting energy security.

b) Smart Agriculture

Smart Agriculture involves the adoption of precision farming techniques, agroforestry, and climate-resilient crop varieties. These practices will enhance agricultural productivity while minimizing environmental impact, ensuring food security, and promoting sustainable land use.

c) Circular economy

Implementation of the circular economy principles will promote resource efficiency, waste reduction, and sustainable consumption and production patterns. By designing systems that reuse, recycle, and regenerate resources, the circular economy will minimize waste, create economic opportunities and reduce the demand for new raw materials.

d) Nature-based solutions

Integrating nature-based solutions, such as afforestation, wetland restoration, and green infrastructure will address climate change and climate variability, reduce biodiversity loss, and alleviate water scarcity. These approaches will leverage on the power of natural processes to enhance ecosystem resilience and provide essential services to communities.

e) Green infrastructure

The development of sustainable urban infrastructure, including green buildings, public transportation systems, and wastewater treatment facilities will enhance urban resilience and reduce the environmental footprint. Green infrastructure solutions promote sustainable urban living and improve the quality of life in cities.

f) Payment for Ecosystem Services (PES)

Payment for Ecosystem Services (PES) is a viable strategy for reconciling human well-being with environment conservation. By providing financial incentives to landowners and managers, PES encourages sustainable land-use, biodiversity conservation, and ecosystem service delivery. PES programs can reduce deforestation, improve water quality, and promote carbon sequestration. By aligning economic benefits with environmental stewardship, PES fosters a win-win situation for ecosystem service providers and beneficiaries. Effective PES implementation requires careful design and targeting. Conditional payments, monitoring, and community engagement are crucial elements. PES can support sustainable agriculture and climate change mitigation. To maximize impact, policymakers should integrate PES with broader environmental policies and development.

g) National Biodiversity Strategy and Action Plan (NBSAP)

The NBSAP offers a robust framework for implementing and complying with national, regional, and international environment related agreements. This strategy provides guidance for tackling pressing environmental challenges, including emerging biodiversity threats, climate change, and environmental degradation. Through NBSAP, Uganda has achieved notable progress in environmental management, including habitat restoration, species conservation, and protected area expansion. The plan integrates biodiversity programs into national and international development agendas, ensuring policy coherence and effective implementation. By leveraging NBSAP, Uganda will achieve inclusive and sustainable environmental resource utilization, fostering sustainable development, climate resilience, and ecosystem conservation.

h) Biodiversity offsets

Enhancing the implementation and monitoring of biodiversity offsets through the 'mitigation hierarchy' - which includes Avoiding, Minimizing, Restoring, and Offsetting environmental impacts - ensures that development projects systematically reduce their ecological footprint. By promoting the principle of "No Net Loss" (NNL) of biodiversity (and ideally a Net gain), developers can balance economic growth with ecosystem preservation, which is vital for the sustainable management of natural resources.

5.2.4 Specific policy recommendations for achieving the long-term vision

a) Strengthening the regulatory framework

Enhancing the enforcement of existing environmental laws and regulations is crucial, with more strict penalties on non-compliance and illegal activities. This will ensure that environmental standards are upheld and that there is accountability for environmental harm.

b) Promoting sustainable land use

Implementing land use planning strategies that prioritize conservation, sustainable agriculture, and responsible land development practices is essential. This will contribute towards the Kunming-Montreal Global Biodiversity Framework (KMGBF) Target 2 (restoring 30% of all degraded ecosystems) and Target 3 (conserving at least 30% of the land). These strategies will help balance the need for development with the preservation of natural resources and ecosystems.

c) Investing in green technologies

Providing incentives and support for the adoption of clean technologies, renewable energy, and eco-friendly production methods across sectors fosters innovations and drives the transition to a sustainable economy. Investment in green technologies will reduce environmental impacts and create economic opportunities. The waste management issue is at the forefront considering the innovative ways that involve the generation of energy from waste.

d) Enhancing community participation

Fostering community engagement in environmental decision-making processes empowers local stakeholders to contribute to conservation efforts and sustainable development initiatives. Engaging communities will ensure that solutions are locally relevant, supported and adopted. Moreover, environmental protection should be a duty for everyone.

e) Mainstreaming climate change mitigation and adaptation

Integrating climate change mitigation and adaptation measures into national and local development plans focuses on building resilience in vulnerable communities and ecosystems. Mainstreaming adaptation will help societies prepare for and mitigate the impacts of climate change.

f) Fostering Public-Private Partnerships

Facilitating collaboration between government, the private sector, civil society, and academia leverages resources, expertise, and innovations for sustainable environmental management. Public-private partnerships can drive large-scale environmental initiatives and bring diverse perspectives to problem-solving.

g) Enhancing education and awareness

Promoting environmental education and awareness campaigns empowers citizens with knowledge and skills for sustainable living and environmental stewardship. Education initiatives will raise awareness of environmental issues and encourage proactive behaviors to protect the environment. The NSOER should be widely disseminated in the country, including institutions of learning.

h) Reduction of incentives that are harmful to biodiversity

In line with Target 18 of the Kunming-Montreal Global Biodiversity Framework, reduce incentives that are harmful to biodiversity and scale up the positive Incentives. Some of these incentives are in the agriculture, energy and mining sectors.

CHAPTER 6 RESOURCE NEEDS

6.1 Data and knowledge

6.1.1 Data required for environmental management

High-quality environmental data is essential not only for fulfilling reporting obligations but also for enabling effective environmental management. Reliable and diverse data types provide a foundation for assessing and managing ecosystems. Such data is critical for evaluating the health and resilience of ecosystems and guiding informed decision-making.

Accurate data is fundamental for sustainable environmental management, as it facilitates the tracking of extraction, consumption, and depletion of critical natural resources such as water, forests, and minerals. Understanding usage trends through such data serves as the foundation for implementing strategies that promote sustainability and environmental conservation. Integral to this approach is pollution data, which encompasses emissions, effluents, and waste from industrial, agricultural, and urban activities. Insights into the origins and scale of pollution further support efforts to mitigate adverse effects on ecosystems and public health.

Climate data, which includes meteorological records on temperature, precipitation, and extreme weather events, remains indispensable for monitoring climate trends and evaluating vulnerabilities to climate change impacts. This information allows governments and stakeholders to effectively assess risks and develop strategies to enhance climate resilience and adaptation. Land use and land cover data add another layer of understanding by revealing ecosystem transformations caused by deforestation, urbanization, and habitat loss. Capturing these changes is essential for making informed land management decisions that preserve ecosystems and ensure responsible land use.
Biodiversity data, which tracks species diversity, genetic variation, and ecosystem dynamics, plays a critical role in understanding extinction patterns, the emergence of new species, and overall biodiversity shifts. This information directly informs conservation efforts, helping to maintain ecological balance and protect the planet's biological heritage. Social and economic data, covering aspects such as population trends, livelihoods, and economic activities, further enriches the understanding of human-environment interactions. It highlights vulnerable communities and guides targeted interventions to promote sustainable development and equitable resource distribution. Incorporating data from these interconnected domains strengthens environmental management efforts and is vital for evidence-based decision-making.

6.1.2 Data collection methods

Environmental data in Uganda is generated through diverse efforts by government Ministries, Departments, and Agencies (MDAs), alongside contributions from non-state actors, including national and international organizations. These data are essential for informed decision-making and sustainable environmental management, leveraging a variety of advanced collection and management methods.

Remote sensing, utilizing satellite imagery and aerial surveys, is a critical tool for monitoring changes in land cover, deforestation, and habitat fragmentation over time. Ground-based monitoring, through strategically installed stations, provides real-time measurements of air and water quality, soil moisture, and biodiversity indicators, forming a backbone for environmental assessment.

Field surveys, encompassing ecological assessments and biodiversity studies, yield valuable primary data on species populations and habitat conditions. Complementing this, environmental sampling focuses on analyzing soil, water, and other environmental media to assess pollution levels and ecosystem health. Data

modeling, employing Geographic Information Systems (GIS) and mathematical tools, enables robust analysis, scenario simulations, and trend forecasting to support policy and planning.

Citizen science initiatives have emerged as transformative approaches, engaging communities in participatory monitoring and crowd-sourced data collection. These efforts not only expand the scope of environmental data collection but also foster public awareness and involvement in environmental stewardship. These methodologies generate data that are vital for assessing ecosystem health, managing natural resources, and addressing emerging environmental challenges.

6.1.3 Data sharing and dissemination

Sharing knowledge and best practices among different stakeholders involved in environmental management is important for advancing environmental management. Stakeholder workshops and conferences are organized to facilitate knowledge exchange, networking, and collaboration. Online platforms and portals are developed to provide web-based access to data, reports, case studies, and best practices in environmental management. Networking and partnerships among government agencies, NGOs, research institutions, and communities help share expertise, resources, and lessons learned. Capacity-building programs, including training sessions and technical assistance, enhance stakeholders' skills and knowledge in environmental management. Policy dialogues and forums, such as media engagements, roundtable discussions, and multi-stakeholder meetings, provide venues for discussing emerging issues, exchanging ideas, and developing consensus on priority actions. Additionally, knowledge exchange events, including study tours, field visits, and showcases of successful projects and innovative approaches, highlight best practices in environmental management.

6.2 Funding

The effective implementation of environmental policies and programs demands substantial financial resources across various domains. Key areas requiring investment include capacity building, technical support, and infrastructure development. Training programs, workshops, and robust data collection systems are vital to equipping stakeholders with the skills needed for efficient environmental management. Infrastructure, such as monitoring stations, wastewater treatment plants, and renewable energy facilities, plays a key role in pollution control and ecosystem monitoring, necessitating significant funding.

Innovations and research are central to addressing complex environmental challenges. Financial support for pilot projects, research initiatives, and cutting-edge technologies is crucial for developing sustainable solutions. Additionally, conservation and restoration efforts, including biodiversity preservation and ecosystem management, require dedicated funding to safeguard natural resources. Climate change mitigation and adaptation further amplify the demand for resources, emphasizing renewable energy promotion and greenhouse gas reduction strategies.

A diversified funding approach is essential to bridge financing gaps. Government budgets form the backbone of environmental funding, while international aid, grants, and multilateral agreements provide critical supplementary support. Public-private partnerships (PPPs) leverage private sector expertise and investments, and mechanisms like environmental taxes, carbon markets, and corporate social responsibility (CSR) initiatives generate additional revenue streams. Innovative financing tools, such as green bonds, crowdfunding, and payment for ecosystem services (PES), offer transformative opportunities to mobilize resources. Strategic partnerships with donors, NGOs, and communities, alongside strengthened financial management, ensure accountability and effective utilization of funds. Sustainable, long-term financial planning is indispensable to meet the growing challenges of environmental protection.

6.3 Human resource

Environment and natural resources management requires a robust understanding of various technical disciplines and skills. Professionals must possess technical knowledge, including a thorough understanding of environmental science principles such as ecology, hydrology, climatology, and pollution control. This knowledge is crucial for

assessing environmental issues and developing appropriate solutions. Additionally, analyzing environmental policies, regulations, and legislation is essential, as is the skill to create strategies for their implementation and enforcement. Proficiency in data analysis techniques, statistical methods, and Geographic Information Systems (GIS) is necessary for interpreting environmental data and conducting spatial analysis.

Competence in project management is also vital, encompassing project planning, implementation, monitoring, and evaluation to manage environmental projects and initiatives effectively. Lastly, the capability to conduct environmental risk assessments, identify potential hazards, and develop risk management plans is essential for mitigating adverse impacts on human health and the environment.

Professionals need to be equipped with the necessary skills and knowledge, and various programs and initiatives. Formal education programs, such as undergraduate and graduate degree programs in environmental science, environmental management, ecology, and related fields offered by universities and colleges, form the foundation. Professional development workshops and courses provide short-term training on specific topics like environmental law, environmental impact assessment, and sustainable development. On-the-job training opportunities, including internships, apprenticeships, and roles within government agencies, NGOs, research institutions, and private sector organizations, are crucial for practical experience.

Online learning platforms offer flexibility, providing access to webinars, e-learning courses, and certification programs focused on environmental management. Field-based training programs and experiential learning opportunities, such as field trips and hands-on training, are invaluable for gaining practical experience in environmental monitoring, data collection, and field research. To attract, retain, and develop skilled environmental professionals, organizations need to implement effective strategies. Offering competitive salaries and benefits, including performance-based bonuses and professional development opportunities, is essential to attract top talent. Establishing clear career pathways and advancement opportunities, such as promotions, mentorship programs, and leadership training, helps retain professionals by providing a vision for their future within the organization.

6.4 Research technologies

Effective environmental management requires a blend of advanced technologies and robust research support. Remote sensing technologies, including high-resolution satellite imagery, aerial photography, and drones, are critical for ecosystem monitoring, land cover mapping, and large-scale environmental assessments. Geographic Information Systems (GIS) further enable spatial analysis and visualization, aiding decision-making and resource management. Environmental sensors measure air and water quality, soil moisture, and temperature, offering real-time data essential for monitoring. Complementing these are data management platforms and simulation tools, which analyze trends and predict environmental changes, facilitating informed interventions.

Emerging technologies hold immense potential to revolutionize environmental management. Artificial Intelligence (AI) and machine learning analyze large datasets, identify patterns, and model predictions. Blockchain enhances transparency in environmental transactions like carbon credits, while advanced remote sensing methods such as LiDAR and hyperspectral imaging enable detailed environmental monitoring. IoT-enabled sensor networks ensure real-time data collection, supporting timely responses to environmental challenges. Genomic technologies aid in biodiversity assessment and ecosystem health monitoring, and bioengineering innovations contribute to restoring polluted sites.

Research and development (R&D) play a pivotal role in driving innovation. Government funding, industry partnerships, and international collaborations foster joint R&D efforts and technology commercialization. Establishing research hubs and innovation centers promotes interdisciplinary knowledge exchange. Additionally, capacity-building programs are essential for equipping researchers and practitioners with cutting-edge skills. Together, these efforts ensure sustainable environmental management, resilience to climate change, and a healthier planet for future generations.

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