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NATIONAL STATE OF THE ENVIRONMENT REPORT 2022

NEMA
ENSURING SUSTAINABLE DEVELOPMENT

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

The National State of the Environment Report 2022

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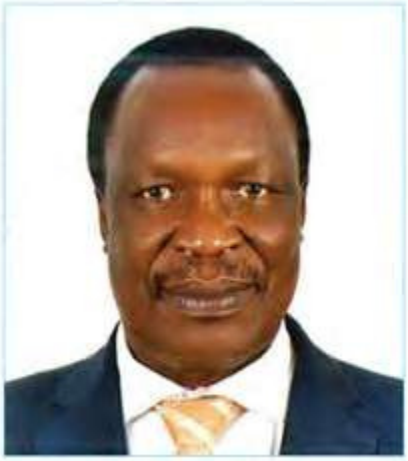
ACRONYMS

BMCA	Bwindi Mgahinga Conservation Area
CNOOC	China National Offshore Oil Corporation
CO	Carbon monoxide
DPSIR	Drivers, Pressures, State, Impact, and Response model of intervention
DRR	Disaster Risk Reduction
DWRM	Directorate of Water Resources Management
ED	Executive Director
ENR	Environment and Natural Resources
ESIA	Environment and Social Impact Assessment
EUR	Euros
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	GigaWatt
GWH	GigaWattHour
HP	Hydropower
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
MW	Megawatt
MWE	Ministry of Water and Environment
NAP	National Action Plan/National Agricultural Policy
NASA	National Aeronautics Space Administration
NDP	National Development Plan
NDPII	National Development Plan 2
NEMA	National Environment Management Authority
NFA	National Forestry Authority
NGO	Non-Governmental Organisation
NPA	National Planning Authority
NSOER	National State of the Environment Report
OECD	Organisation for Economic Cooperation and Development
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
SDG	Sustainable Development Goal
SDGS	Sustainable Development Goals
SO2	Sulphur Dioxide
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 Force
USAID	United States Agency for International Development
USD	United States Dollar
USDA	United States Department of Agriculture
UWA	Uganda Wildlife Authority
WCS	Wildlife Conservation Society
WHO	World Health Organisation
WWF	Worldwide Fund for Nature

FOREWORD

The National State of Environment Reports (NSOER) are prepared every two years as provided for by the National Environment Act No. 5 of 2019. The NSOER 2022 was prepared through wide stakeholder consultation including Government Ministries, Departments, and Agencies (MDAs), local governments, the academia, research institutions and NGOs.



Hon. Sam Cheptoris

Every citizen of Uganda has the responsibility to protect and enhance the quality of the environment. I am therefore pleased to present to the people of Uganda the National State of Environment Report 2022 that has proposed action needed to protect and conserve our environment. I call upon all stakeholders to implement the action in this report at national, district, community and individual levels.

FOR GOD AND MY COUNTRY.

Hon. Sam Cheptoris
MINISTER OF WATER AND ENVIRONMENT

MESSAGE FROM CHAIRPERSON NEMA BOARD

Prof. James Okot-Okumu

Uganda's natural resources is the foundation for the country's socio-economic development. To foster wealth creation, employment, and inclusive growth, Uganda needs to harness natural resources in sustainable. Presently, Uganda derives a substantial annual economic value of approximately 490 million US dollars from the ecosystem service of pollination for crop production. This constitutes a noteworthy percentage of the overall economic value of crop production, estimated at 116 billion US dollars, particularly benefiting cash crops like coffee, a major contributor to the country's economy.

However, there are number of challenges on environment management and these includes encroachment on wetlands, deforestation, poor waste management and pollution which are threats to biodiversity, climate stability, and land integrity. The NSOER 2022 has identified actions that needs to be taken to address these and other environmental challenges as detailed in the Report.

In line with the National Vision 2040 and national development frameworks, Uganda is progressing towards middle-income status and envisioned urbanization. This trajectory aims to establish an inclusive, low-emission economic growth path, emphasizing the efficient utilization of the nation's natural capital. The NSEOR 2022 serves as a critical assessment tool, identifying areas for enhancing environmental management to ensure the sustained provision of natural resources and ecosystems services it provides for both current and future generations.

FOR GOD AND MY COUNTRY.

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

MESSAGE FROM THE PERMANENT SECRETARY

Mr. Alfred Okot Okidi

The National State of the Environment Reports vividly presents the current environment landscape, pinpointing areas where Government intervention is crucial. Collaborative initiatives by the Ministry of Water and Environment, National Environment Management Authority, National Forest Authority, Local governments, the private sector, and other Lead Agencies have contributed to the restoration of the environment. The Presidential Directives have further reinforced protection measures for wetlands, forests, hilly areas, mountainous terrains, and rangelands.

Good governance and leadership is imperative for safeguarding and monitoring environment. Access to environmental information is another critical area to support environmental management and this includes web-based systems like the Water Information System. This system records critical data such as stream flow status, groundwater depths, and surface water elevations at key stations. The Natural Resource Information System aids the government in monitoring and obtaining real-time data on ecosystem management.

The Ministry of Water and Environment's 2020 national climate analysis and projections reveal anticipated mean annual temperature increases of 1 to 1.5°C in most parts of the country by 2031-2060, under various greenhouse gas concentration scenarios. This emphasizes the urgency for government to action outlined in the ten-year restoration plan for environmental and natural resource (2021-2031. Immediate and decisive action is crucial to tackle the pressing environmental challenges in Uganda

FOR GOD AND MY COUNTRY.

Mr. Alfred Okot Okidi
PERMANENT SECRETARY
MINISTRY OF WATER AND ENVIRONMENT

MESSAGE FROM THE EXECUTIVE DIRECTOR NEMA

In adherence to the National Environment Act No. 5 of 2019, the National Environment Management Authority (NEMA) is mandated to prepare the National State of the Environment Report (NSOER) every two years. Th e primary objective of the NSOER is to educate the public about the country's environmental status, emphasizing the significance of the environment and natural resources in development, their societal value, current trends, projections, key issues, challenges, and opportunities for enhancement.

Barirega Akankwasah, PhD

Functioning as a crucial communication tool, the NSOER employs contemporary scientific knowledge to facilitate evidence-based policies for sustainable environment management. The report caters for a diverse audience, including policymakers, decision-makers, the private sector, community leaders, academia, libraries, researchers, and the media.

NEMA expresses gratitude to the Government of Uganda, particularly the Ministry of Water and Environment for supporting in preparation of this Report. Significant contributions of information and data from various Ministries, Departments, Agencies, the Environment Information Networks, and district local governments have played a pivotal role in the NSOER's preparation. Collaborating institutions and partners participating in technical reviews are also acknowledged.

The findings and recommendations in this Report is meant to spur decision-makers at all levels to take prompt actions addressing anthropogenic activities causing environmental degradation. Additionally, institutions are encouraged to engage in environment planning to enhance environmental management in their areas of jurisdiction.

FOR GOD AND MY COUNTRY.

Barirega Akankwasah, PhD
EXECUTIVE DIRECTOR
NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

EXECUTIVE SUMMARY

The National State of the Environment Report (NSOER) for Uganda is a biennial publication by the National Environment Management Authority. The NSOER 2022 is a comprehensive report integrating data from various stakeholders using the Drivers, Pressures, State, Impact, and Response (DPSIR) framework to provide a thorough overview of Uganda's environmental landscape.

The key drivers of environmental change in Uganda include climate change, anthropogenic activities, rapid population growth, and economic development. Urbanization is a significant force, growing at a rate of 5% annually, with projections indicating a total urban population of 20 million by 2040. However, infrastructure development, especially in sectors like ICT, energy, roads, and oil and gas, is advancing rapidly but with uneven distribution. The surge in electronic waste due to technological advancements poses a growing concern. Agriculture, forestry, and fishing contribute to environmental shifts, leading to encroachment on fragile ecosystems such as wetlands.

Biodiversity's crucial role for human health and the environment is highlighted, with wetland coverage reaching 13.9% in 2021. Ongoing efforts on wetlands focus on demarcation, restoration, and rectifying erroneous land titles. While forest cover has increased, challenges persist due to illegal titles in forests and deforestation. Wildlife populations are generally on the increase especially in protected areas.

Urban areas, particularly cities, display evident air quality deterioration, exceeding WHO guidelines. The National Development Plan III identifies air quality as a national priority, aligning with climate change commitments. A temporary improvement during COVID-19 restrictions underscores the urgency to address this issue.

Climate change challenges are amplified by temperature increases and decreasing rainfall, with Uganda's vulnerability rooted in unsustainable practices, deforestation, wetland degradation, and a growing population. Soil degradation, linked to low fertility and climate change, is exacerbated by farmers abandoning conservation measures. Greenhouse gas emissions have risen, primarily from forestry and land use. Climate actions since 1993 include legislation, policies, strategies, and plans. New cities lack infrastructure and thus effective urban planning is crucial for mitigating climate change impacts.

The energy sector, growing at 10.9% annually, faces challenges in meeting rising demand, dominated by biomass consumption. The electricity sub-sector has expanded, and oil and gas exploration, with finalized investment decisions, necessitates robust environmental frameworks, including ESIA, monitoring, and waste management.

Cultural heritage sites, numbering around 650, face risks from rising lake levels and geo-thermal explorations.

The report emphasizes the urgent need for sensitization and restoration efforts in fragile ecosystems like hilly areas and wetlands. Harmonized planning around wetlands and incentivizing conservation are deemed crucial. Immediate implementation of the ten-year plan for environmental restoration is imperative. Revisiting fertilizer use and soil conservation strategies is recommended, alongside enhanced cultural heritage education. Climate-resilient infrastructure, early warning systems, and green initiatives are deemed essential for cities.

CHAPTER ONE

BACKGROUND AND INTRODUCTION

CHAPTER ONE

BACKGROUND AND INTRODUCTION

1.1 Context and Purpose of the Report

1.1.1 Context of the National State of the Environment Report 2022

The National State of Environment Report 2022 is the 14th edition of NSOERs. NSOER 2022 has laid emphasis on taking action to address identified environmental challenges in a number areas including water resources, forests, wetlands, minerals and energy, oil and gas, air quality, soils climate change and biodiversity.

1.1.2 The Purpose of the National State of Environment Report 2022

This state of environment report for Uganda is a compilation of the environment situation of the country, with the overall aim of keeping the country's environment situation under review. It is statutory and required of the National Environment Management Authority to prepare this report after every two years, highlighting the state of the environment, environmental challenges faced by the communities and regulators alike, emerging opportunities for communities to benefit from environmental resources and proposed intervention for all actors to protect the environment. The report is supposed to be geographically balanced, covering all exemplar issues of environmental concern across the country. It is also supposed to be prepared in a participatory manner, drawing input from all actors that manage any segment of the environment, and above all, make use of available evidence in state of environment reports prepared by lead agencies during the assessment period. This report is also expected to be accurate and scientifically credible, and presented in a manner that allows its use by all, including the public, scientists, and policymakers.

1.2.0 Drivers of Environment Change in Uganda

This section explains the driving forces behind environmental changes in Uganda from 2021 to 2022, distinguishing between direct and indirect drivers. Direct drivers exert a clear influence on ecosystem processes, while indirect drivers operate more diffusely. The intricate dynamics of environmental change in Uganda result from a myriad of interconnected drivers that collectively shape the complex ecological landscape.

The population growth in Uganda, steadily increasing at a rate of 3.32%, accentuates the demand for critical resources like land, water, and energy. This surge triggers cascading challenges, including deforestation, habitat loss, and the complexities of rapid urbanization. Climate change compounds these challenges, exposing Uganda to vulnerabilities arising from unpredictable weather patterns and extreme events.

Land use practices, marked by expansive agricultural activities and burgeoning urban development, contribute significantly to heightened environmental pressures. Agricultural expansion alters land use patterns, impacting ecosystems and biodiversity. Simultaneously, rapid urbanization exacerbates these challenges by placing stress on available resources and accelerating habitat degradation. Recent factors like rapid urbanization and technological innovation have further intensified these influences.

Key sectors, as indicated in the NEMA Annual Corporate Reports of 2019/20 and FY2020/21 (Figure 1,1), contribute to 91% of approved projects, reflecting the focus of the National Development Plan III on harnessing natural resources for sustainable socio-economic development (NDP III, 2021-2025). The developmental trends align with Uganda's Vision 2040 and NDP III, emphasizing industrialization and infrastructure projects.

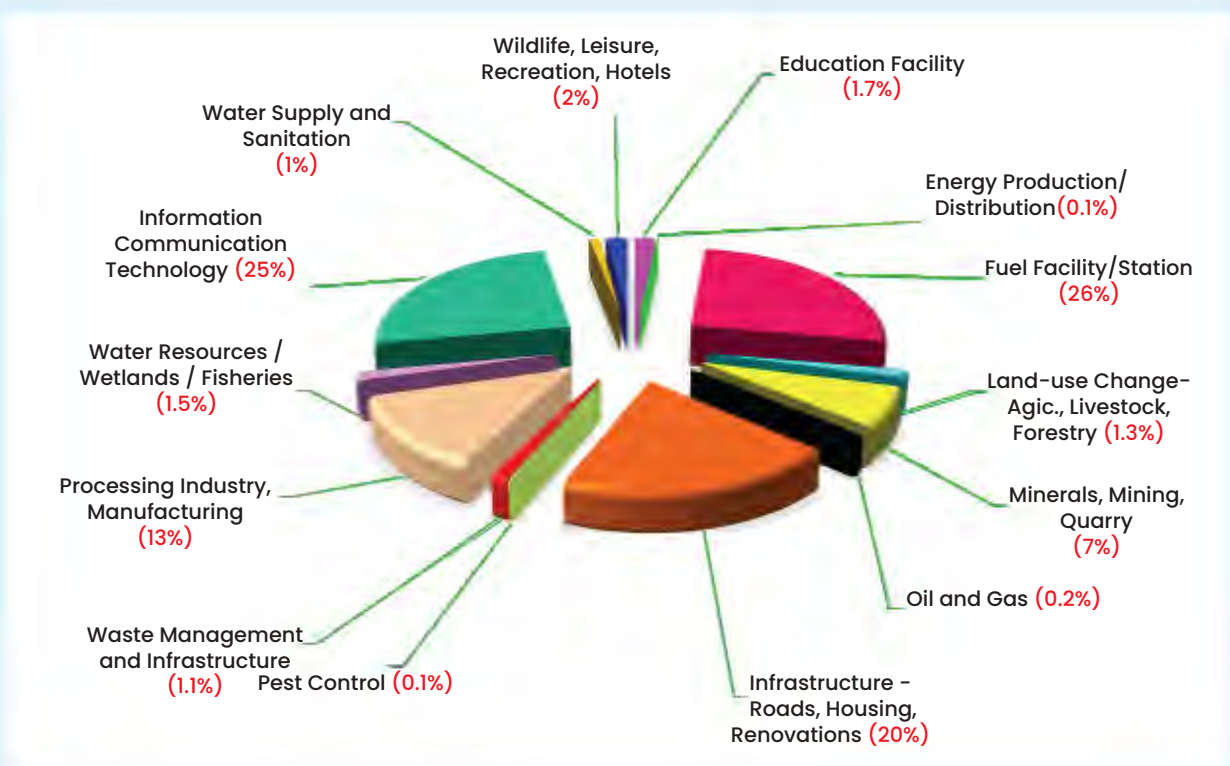


Figure 1.1. Percentage of projects approved per sector in FY 2019/20 to FY 2020/21

The industrial landscape in Uganda has undergone significant transformation, with the number of factories in sectors like food processing, iron and steel, ceramics, plastics, and batteries experiencing substantial growth. The proliferation of industrial parks across the country has played a pivotal role in this development. Furthermore, notable infrastructure projects have emerged, including the construction of key roadways such as the Entebbe Expressway and the Albertine region roads, as well as the establishment of hydro power plants like Isimba and Karuma, and the Kabaale International Airport. This surge in industrial and infrastructural initiatives underscores Uganda's commitment to economic growth and development. However, achieving a delicate equilibrium between sustainable development and environmental preservation becomes crucial for navigating the evolving environmental landscape. As Uganda experiences a complex interplay of direct and indirect drivers, the need for a mindful balance becomes increasingly apparent.

1.2.1 Population growth and demographics as a driver of Environmental Change

The burgeoning population in Uganda stands as a formidable driver of environmental change, exerting immense pressure on the ecosystem. With a consistent growth rate of 3.32%, the current population of 40 million, with 55% being youth, raises alarming concerns (World population prospects, 2019). The current scenario anticipates challenges such as swift urbanization, insufficient waste

management, elevated levels of poverty and unemployment, and environmental degradation resulting from the growing demand for land, water, and energy.

The demographic dynamic serves as the primary catalyst for global environmental change. This is evident in the increasing pressure to expand into additional areas, exploit more resources, enhance food production, escalate water consumption, contribute to higher levels of pollution, utilize more energy, and generate increased emissions of greenhouse gases (Bulege, 2013).

Projections from the World Population Prospects 2019 indicate that Uganda's population is expected to surpass 100 million by 2050, surpassing even Egypt, the second most populous country in Africa. Uganda's population increased by approximately 3.0 percent between 2002 and 2014 (Figure 1.2), and was projected to reach 41.6 million by mid-year 2020 (UBOS 2020). With an annual urban growth rate of 5.2 percent among the highest in the world, (World Bank Country Report) the urban population was projected at 10.6 million persons in the year 2020 (UBOS 2020). This rapid growth, reflected in a linear increase, accentuates the strain on essential services like education, water, and sanitation. The unregulated access and unsustainable use of natural resources further exacerbate the negative impact on the ecosystem.

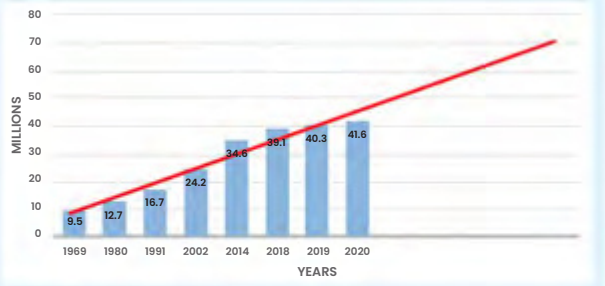


Figure 1.2. Census population, 1969 to 2014 and projected population 2018 and 2020 (Source: UBOS, 2020)

The consequences of population growth in Uganda are evident in a decline in ecosystem services, signaling environmental degradation across various fronts. This degradation is characterized by the accumulation of solid waste, encroachment, and depletion of wetlands, water pollution, and alterations in land use patterns. The surge in population amplifies the demand for resources, leading to increased waste generation that strains waste management systems. This buildup of solid waste adversely affects ecosystems and diminishes their ability to provide essential services.

Furthermore, the expanding population drives encroachment on and destruction of wetlands, critical ecosystems that play a pivotal role in water regulation, biodiversity conservation, and flood control. The consequences extend to water pollution, as heightened human activities contribute to the contamination of water bodies, impacting aquatic ecosystems and human health.

1.2.2 Land use and environmental change

The drivers of environmental change are multifaceted and are affected by various forms of land use. The different land use forms include (i) forests: either natural forest for leisure use or managed forest for lumber production and possible mixed use combined with leisure activities; (ii) undergrowth or scrub: considering natural areas for leisure or pastures with possible mixed use combined with leisure activities; (iii) agricultural areas: farmland producing annual crops, orchards, woods or mixed use; (iv) built areas: city, village, archaeological sites, industrial areas, second house developments, tourism development, commercial areas, transport or mixed use (Briassoulis 2000). These land-use forms have resulted in economic

development, implementation of new technologies in infrastructure projects and general urbanisation.

1.2.2.1. Economic development as a driver of environmental change

Economic development for a country is looked at in a broader sense and geared towards programmes, policies and activities that seek to improve the economic well-being and quality of life for a community. According to Sen (2011), economic development includes several aspects such as, social equity, poverty eradication, the meeting of basic human needs (access to health, education, and water and sanitation services, the provision of physical infrastructure (housing, energy, transport and communications), and the guarantee of essential political, economic and social freedoms.

Infrastructure development plays a key role in leading the country to a prosperous nation and increases its stock of land quality for strategic infrastructure to accelerate competitiveness. Infrastructure development is a trigger for other developments such as roads, power generation, ICT, and science and innovation as center points of unlocking the industrial evolution of Uganda (MFPED 2019).

As the need for information rises due to increasing urbanisation, so is the growing need to use information technologies in decision-making and knowledge management. In the last five (5) years (2016 to 2020), NEMA approved considerable amounts of ICT related facilities. Figure 1.3 shows that by FY 2019/20, 28 percent of ESIA approvals were allocated to ICT facilities but a drop on percentage approval to 25 percent in FY2020/21 was observed. This could be attributed to the limited activity caused by Covid-19 pandemic.

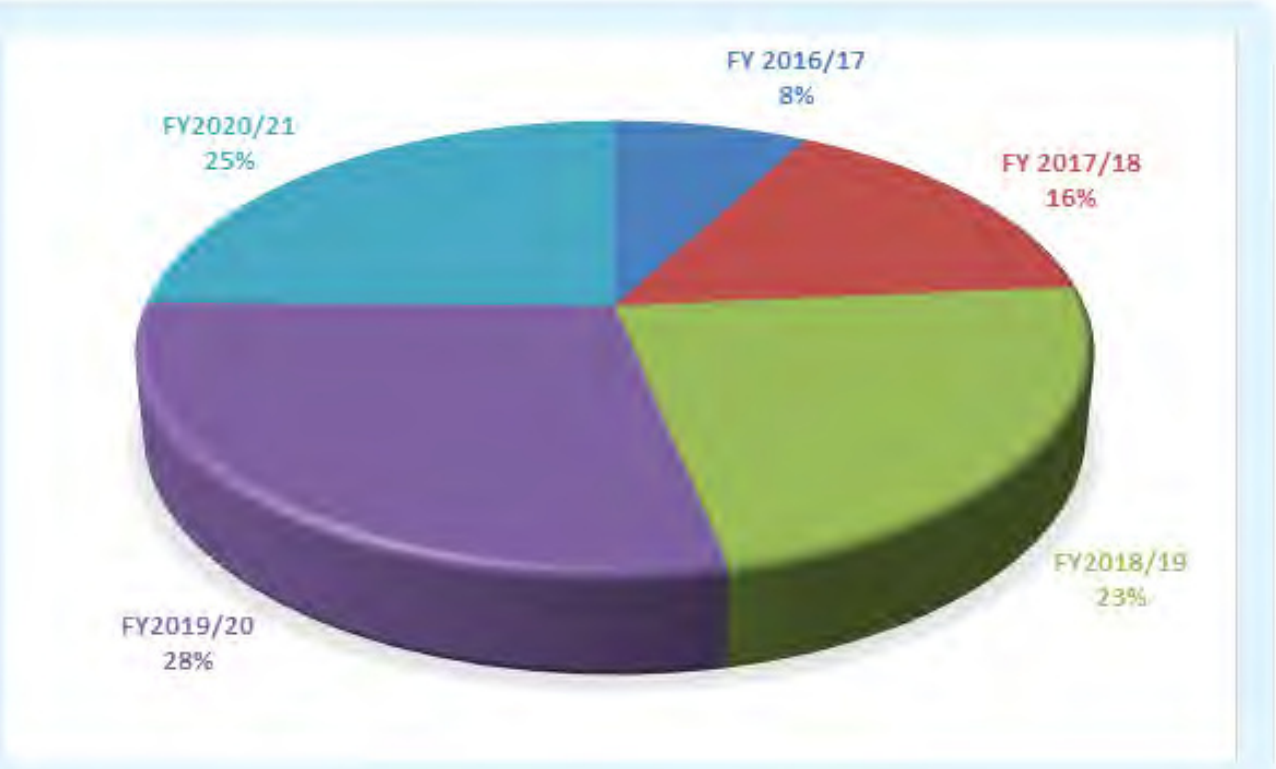


Figure 1.3. Percentage of ICT facilities approved by NEMA between 2016 and 2021

According to the Uganda Bureau of Statistics (UBOS, 2020), the mobile money registered customers increased by almost 9.1 percent from 24.5 million customers in 2018 to almost 26.7 million customers in 2019 to 28 million customers in 2020 as seen in Table 1.1. Digital technology's energy consumption increased by almost 70% between 2013 and 2020, and the benefits of having an informed society through improving access to information, using digital technology to exchange knowledge, and undertaking transformation of societal mindset are very important in transforming an economy.

Table 1.1. Mobile Money Transactions, 2016 - 2020

Subscribers	**2016**	**2017**	**2018**	**2019**	**2020**
Mobile money registered customers (number 0000)	21,585	23,363	24,466	26,691	28,045
Annual Percentage Change	**9.9**	**8.2**	**4.7**	**9.1**	**5.1**
Transactions('000)	974,747	1,206,845	1,878,736	2,840,934	
Annual Percentage Change	**40.5**	**23.8**	**55.7**	**51.2**	**25.0**
Transactions(Value in Shs)	43,831	63,093	71,100	73,091	92,977
Annual PercentageChange	**34.8**	**43.9**	**12.7**	**2.8**	**27.2**
Source: Uganda Communications Commission					

As we explore the benefits of using ICT to support communication and business transactions, knowledge about the causes of environmental ills require a number of options on how to handle the negative impacts and the development of collaborations and partnership aimed at harnessing the growing need for environmental protection (Braden et al., 2001). This is because digital activities have created their own carbon footprint and have accounted for nearly 3.7 percent of all greenhouse emissions, which is comparable to aviation industry emission levels (The Shift Project 2019). As a result, this calls for the implementation of policy measures to protect the environment, enhance energy conservation, and promote sustainable development. It also highlights the significance of effective management (Balabanova 2021).

The negative impacts of fast-growing ICT infrastructure for countries like Uganda, will be high turnover of electronic waste. It is estimated that 17 million kilotonnes of e-waste was generated in Uganda in 2018 with a projection of 4.5 million kilotonnes of e-waste to be generated annually from 2019 to 2022. Government owns the highest number of ICT equipment followed by Non-Governmental Organisations (NGOs) at 75 percent, large enterprises at 20 percent, Small and Medium Enterprises (SMEs) and others at 5 percent (E-waste Management Policy 2012). The e-waste management center was launched in 2021 to facilitate collection of all e-waste and transform it into other useful commodities, but also protect the environment from hazardous waste.

Uganda has heavily invested in hydro power mainly from the River Nile water. It has secured an appropriate share of the water resources from other basin states that have also invested in the use of the water in their territories (MFPED 2020). With the abundant energy resources, most especially renewable resources, Uganda is still exposed to widespread energy poverty (Tumwesigye 2011), with the majority of the rural communities still lacking access to clean cookstoves, and relying on charcoal and wood biomass.

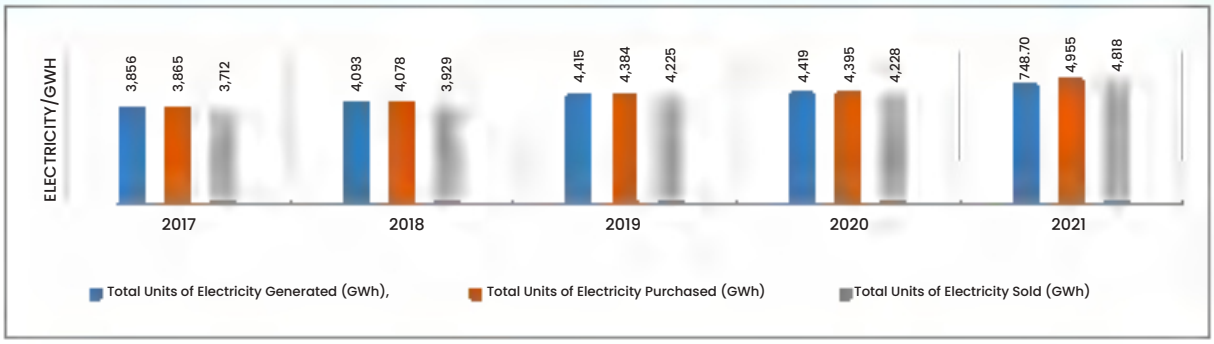
Most of the fuel wood is used for cooking, utilising the highly inefficient three stone cook stoves in the rural areas where most of the population lives (MWE 2019). Women are producers and consumers of energy in both urban and rural areas. However, Uganda's energy purchase increased by 7.5 percent from 4,078GWh in 2018 to 4384 GWh in 2019; and by 0.16 percent to 4,391GWh in 2020, while customers increased by 14.6 percent from 1,372,166 consumers in 2018 to 1,572,605 consumers in 2019; and by 3.7 percent to 1,630,769 consumers in 2020[5]. The total installed capacity of electricity power plants increased by 27.5 percent from 983.55MW in 2018 to 1254.007MW in 2019. Between 2020 and 2021, the installed capacity increased from 1289.6 MW to 1346.7 MW reflecting a percentage increment of 4.4% (UBOS 2022) (Table 1.2).

Table 1.2. Installed Capacity (MW), 2017 - 2021

Power source	2017	2018	2019	2020	2021	2020-2021 Additional	Pecentage Change
Renewable Sources	**800.8**	**881.1**	**115.1**	**1189.6**	**1246.6**	**57.0**	**99.9**
Hydro Electricity	706.8	744.0	1004.0	1015.9	1057.9	42.0	73.6
*Bagasse Electricity	76.4	96.2	96.2	111.7	111.7	0.0	0.0
Solar PV	17.6	40.8	50.8	60.8	60.8	0.0	0.0
Biomass		0.0	0.0	1.1	16.1	15.0	26.3
Non-Renewable Sources							
Thermal Electricity	136.1	101.7	101.1	100.0	100.1	0.1	0.1
Total Installed Capacity	**939.9**	**982.8**	**1252.2**	**1289.6**	**1346.7**	**57.1**	**100**
AnnualPercentage Change		**2.9**	**16.3**	**2.0**	**4.4**		

Source: Electricity Generating Authority

In addition, electricity generation grew by 7.86 percent from 4,093 GWh in 2018 to 4,415 GWh in 2019. as seen in Figure 1.4. In addition, the percentage increase from 2020 to 2021 is 7.4% from a generation capacity of 4419 GWh to 4748.7 GWh. It has been emphasised that the heavy reliance on biomass for home energy contributes to environmental deterioration and climate change, which worsens air pollution, deforestation, land degradation, and desertification.



Source: Uganda Electricity Transmission Company Limited

Figure 1.4. Electricity generation in from 2017 to 2021 (UBOS 2022)

According to the NEMA Annual Corporate Reports FY 2016/17 to FY 2020/21, ESIA certificates approved for fuel stations have significantly remained high over the 5-year period (Figure 1.5).

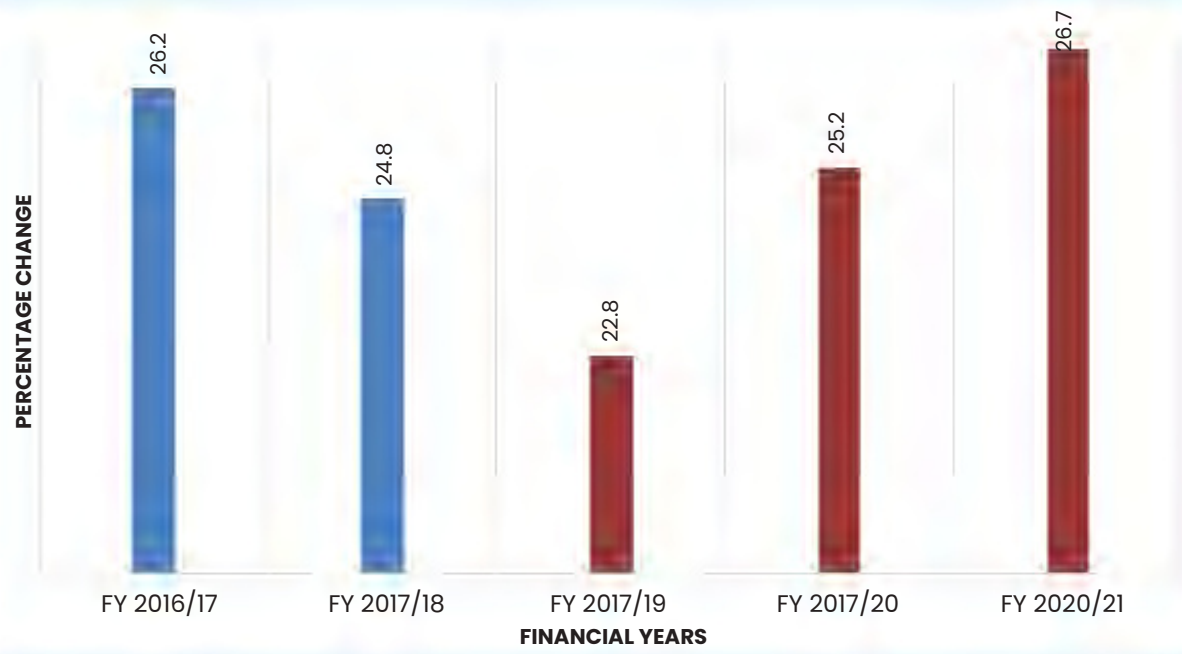


Figure 1.5. Percentage of ESIA approved for fuel station development from 2016 to 2021

The increasing number of fuel stations has been birthed by the high demand for fuel resulting from the rise in the number of newly registered motor vehicles and motorcycles, which grew from 145,132 in 2020 to 227,952 in 2021, increasing by 57 percent (UBOS 2021). There was also a notable rise in the number of vehicles with tourist transportation licences, which increased from 217 in 2020 to 1198 in 2021. This has also led to an increase in the pollution levels in the major cities such as Kampala.

Road infrastructure is one of the key sectors that will drive the economy to attain the much-desired goal in the NDP III. The road networks in Uganda are classified as national roads, district roads, urban roads and community access roads which are further subdivided into paved and unpaved roads. In the FY 2020/2021, the total national road network (paved and unpaved) was 21,021.4 compared to 21,016.18 in FY 2019/2020. Expansion of the country's road network will continue to influence the environment as substantial acres of land are gazetted for road works.

The Kabaale International Airport (KIA), which is being built in the Albertine Graben as part of Uganda's implementation of the Civil Aviation Master Plan Development (CAMPD) (2014 to 2033) is the country's second international airport. The projected oil refinery and other facilities connected to oil will benefit from the development of large, delicate, and heavy machinery made possible by the KIA. The construction of the KIA led to increased demand for building supplies such as stones and sand.

As the oil and gas industry draws close to the production phase, NEMA will need to make further compliance measures. Due to the large size of land needed for the new airport, many indigenous communities were displaced from their homes. Because indigenous peoples and local communities (IPLCSs) rely on nature for their subsistence, livelihood, culture, spirituality, and health, this has a negative impact on their quality of life. The impacts of these pressures from legal and illegal actors include increased conflict, and forced displacement of IPLCs from their ancestral lands.

Uganda's prospects of oil and gas have given way to the country's new investment portfolio which provides for more than 6.0 billion barrels with recoverable resources of 1.36 billion barrels in the Albertine Graben (MEMD 2020). Globally, governments have collectively projected an increase in global oil and gas production. Furthermore, by 2030, governments' production plans and projections would lead to around 240 percent more coal, 57 percent more oil, and 71 percent more gas.

The East Africa Crude Oil Pipeline (EACOP) and the Kingfisher Oil Development Project received historic clearance from Uganda in 2019, after baseline verification along the planned pipeline area covering 10 districts (from Kikuube to Rakai) and landscapes. To ensure there is little and restricted environmental harm, various rules, rigorous monitoring, and compliance were implemented. The majority of previously degraded sites had been successfully repaired or restored, and environmental recovery, including the restoration of wildlife and habitats, was ongoing. However, some social issues, such as land and compensation, are still unresolved due to the activities of the former international oil company.

The production phase will result in an increase in IPLC displacement, but communities under IPLC management must contend with expanding infrastructure for mining, transportation, and electricity, which has a variety of effects on local livelihoods and health. According to the Inter-Governmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) global assessment report 2019, indigenous peoples historically own, manage, use, or occupy 35 percent of all formally protected areas and 35 percent of all remaining terrestrial areas with low human intervention, underscoring the crucial role IPLCs play in biodiversity conservation.

In addition, the country continually relies on imported petroleum products. 2.298 billion Litres of petroleum products were imported into the country compared to 1.147 billion Litres in 2020. This represents an increment of 100.35% (MEMD 2021). The petroleum industry is the source of fuel that drives many sectors of the economy such as transport, chemical industries, and as well finds substantial usage in homes. The burning of the fuels releases toxins such as CO2, a dangerous greenhouse gas.

1.2.2.2. Technology and innovation as drivers of environmental change

Technology is an important driver of environmental change and its impacts are both positive and negative. The impact of science and technology on ecosystem services is more evident in the case of food production because increase in the agricultural output over the last 40 years has come from an increase in yields per hectare rather than expansion of area under cultivation (Agroindustrialisation Programme Annual Performance Report 2020/21). For freshwater ecosystem and their services, the most important direct drivers of change include modification of water regimes, invasive species, and pollution, particularly high levels of nutrient loading (IPBES, 2020).

Uganda being an agronomic country, agriculture remains the dominant source of livelihood. According to the NDP III, agro-industrialisation will offer great opportunity for transition into a modern industrial economy and the utilisation of natural resources provides for communities to harness raw materials such as food,

water, land and genetic materials among others. The sector is one of the three core components of the economy alongside industry and services (NDPIII 2020/21 - 2024/25). It requires land which causes changes in habitat ecosystem, physical modification and these exposes changes in the ecosystem.

1.2.2.3. Urbanisation as a driver of environmental change

Urbanisation is a distinct channel through which demographic trends affect environmental resources. urgency of actions required to protect the environment and ensure sustainable cities, arising from the establishment of 10 new cities in the financial year 2019/20, which increased urbanisation to 26.5% in 2021 (Uganda State of Urban Sector Report 2021-2022). This increase in urbanisation translates into a growth rate of 8.8% over a 7-year period, with notable expansion of the urban footprint as more rural land is taken up by the urban field (Uganda State of Urban Sector Report 2021-2022). This also comes with increased exploitation of environmental resources and transformation of areas everywhere to support livelihoods, trade and development, all to the detriment of the environment and associated resources, which are critical to achieving sustainable development within the scope of Agenda 2030.

Although the establishment of cities is advantageous in so far as creating job opportunities and improving infrastructure, it might hinder development if essential infrastructure is not planned and laws are not implemented (Mbabazi and Atukunda, 2020). Overall, it is important to support and operationalize the green growth principles, by embracing green cities models and green growth development everywhere, in the spirit of the Vision 2040 and the attendant Uganda Green Growth Development Strategy, which is aimed at creating an inclusive low-emission economic growth pathway that prioritises effective and efficient use of the nation's natural capital while ensuring natural resources continue to provide for the present and future generations (The Uganda Green Growth Development Strategy 2017/18-2030/31).

Urban areas are characterised by higher incomes and consumption, greater access to political power, higher rates of economic growth and higher per capita (UN Environment 2019). The rate of urban growth in Uganda is at 5.4% a year, and the country's total urban population could reach 20 million people by 2040 and 32 million people by 2050 (World Bank 2015). With the current growth rate of the population, urbanisation will be a required condition for Uganda to become a middle-income country. The present urban growth is driven by both natural growth rates and the ongoing immigration from rural areas. The urban growth rate will continue to exert pressure on the natural resources of the country.

The urban population dynamics in Figure 1.6 expose the challenges that drive environmental change. In 2021, the rate of urbanisation in Uganda (defined by the number of people in urban settlements in proportion to the total population) averaged 25.55%. The key drivers of urbanisation include demographic changes (net population change as well as rural-urban migration, immigration, and changing age structures), economic growth (GDP, investment in research and development, employment, and innovation and socio-economic factors (high-quality of life and service provision in cities).

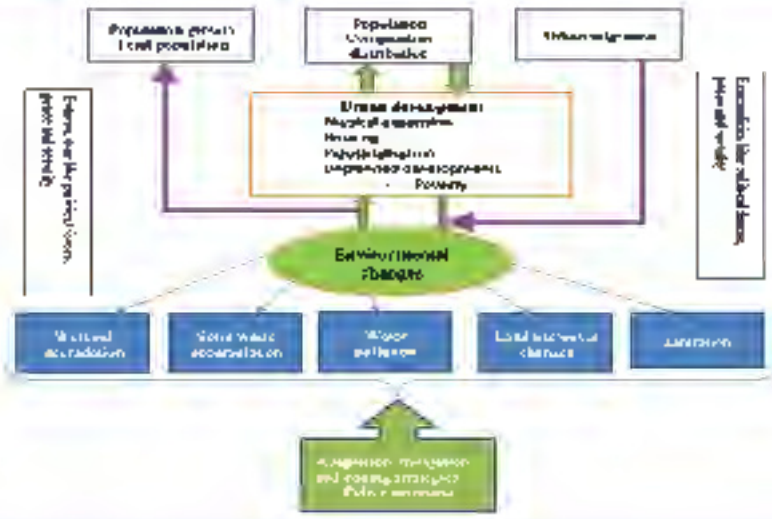


Figure 1.6. Urban population dynamics

UBOS (2020) reports the urbanisation growth of Uganda over the years from 2010 to 2020 as depicted in Figure 1.7 with an increasing trend from 19.38% in 2010 to 24.95% in 2020.

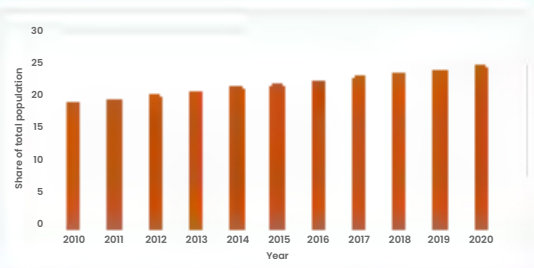


Figure 1.7. Uganda's urbanisation growth from 2010 to 2020 (UBOS, 2020)

With the continued rate of urbanisation, serious environmental problems such as air, water and soil pollution in the cities will be experienced. The high levels of flooding on the Kampala city roads and the collapse of various bridges across the country have continued to occur partly due to poorly planned infrastructures and encroachment on wetlands. Cities such as Kampala are regarded as one of the most significant sources of greenhouse emissions that ultimately cause climate change (Kennedy et al., 2009).

Besides, increased clear surface (paved walkways and parking spaces) caused by removing vegetation cover results in urban heat islands. Modification of landscapes and fragmentation, threaten biodiversity Besides, increased clear surface (paved walkways and parking spaces) caused by removing vegetation cover results in urban heat islands. In addition, modification of landscapes and fragmentation of natural cover threatens biodiversity, species dispersal, cycling of nutrients, and energy flow. This adversely affects ecosystem service value (Basu and Das, 2021).

1.2.3. Climate Change as a driver of Environmental Change

Climate change poses a critical threat with far-reaching consequences for both the environment and human well-being, setting off a chain reaction of impacts on various ecological processes. It is a global threat that has embarked on to put stress on various sectors (Abbass et al., 2022). Its most significant repercussions involve alterations in precipitation and temperature, presenting serious challenges for water resources, food security, natural resource management, and infrastructure (UN Environment,

2019). Globally, climate change has greatly impacted human health over the years (Lemery et al., 2021). Uganda has experienced a noteworthy 1.3°C increase in average annual temperature and a decline in rainfall since 1960, intensifying the impact of climate change. A study by Obubu et al., 2021 revealed an increase in the decadal relative rainfall anomaly from 85.6–105 in 1981–1990 to 92.0–120.9 in 2011–2020, while mean temperature anomaly rose from 0.2–0.6 °C to 1.0–1.6 °C in the same period. Rising temperatures induce shifts in weather patterns, profoundly affecting ecosystems and the availability of crucial resources like water, food, and energy.

A poignant example of this impact unfolded in 2019 and 2020 when rising water levels, attributed to a positive Indian Ocean Dipole (IOD) phase 5, 6, 7 caused by warmer sea temperatures in the western Indian Ocean region, led to significant flooding in the Lake Victoria basin. This environmental phenomenon rippled across Uganda, Kenya, and Tanzania, affecting areas adjacent to Lake Kyoga and Lake Albert. The escalating loss and rapid decline of riverbanks and lakeshores, crucial systems for the nation's productivity, diminish their ability to safeguard against flooding, landslides, and provide sustainable livelihoods.

The Kyoga basin, nestled at an elevation of 1,033 meters and spanning approximately 1,720 km^2, grapples with significant climate challenges. A 2021 study by Obubu et al. emphasized a heightened frequency of severe wet weather events within the Kyoga basin compared to dry events, signaling an upward trend in precipitation. Maximum, mean, and minimum temperatures have all escalated, leading to warmer nights.

The escalating frequency of extreme weather events, including droughts, and landslides over recent decades, underscores the urgency of addressing the complex and interconnected challenges posed by climate change in Uganda. The very high water levels of lakes including Lake Kyoga and Albert due to climate change have led to persistent expansion of lakeshore flooding in surrounding areas within the Murem Sub County in Kaberamaido and Nakasongola districts, including Mone and Kibuye landing sites affecting settlements and essential public infrastructures (Water and Environment Sector Performance Report 2020).
Flooding has caused significant crop losses, contributing to food poverty and the destruction of villages, disrupting livelihoods in Okile and Murem sub-counties. Concerns are heightened due to the expected influx of snakes and crocodiles. Sanitation facilities, including pit latrines and toilets, are failing, worsening fecal waste management.

In floodplains, flooding has both positive and negative effects on the ecosystem. While it can maintain biological diversity, it also leads to environmental deterioration. Riverbank erosion and sedimentation contribute to water contamination, carrying bacteria, pesticides, and harmful substances that impact water quality, spreading diseases like cholera and dysentery.

The consequences of flooding due to climate change extend to infrastructure damage, disrupting clean water and energy supplies, transportation, education, and healthcare. The high costs of relief and recovery hinder investments in infrastructure, impeding economic growth in flood-affected areas. Population displacement leads to long-term economic effects, loss of livelihoods, and potential city overpopulation.

Psychological and social impacts are profound, with victims experiencing lingering trauma. The loss of loved ones, especially among children, leaves

enduring scars. Regions prone to flooding may experience social inequality, unrest, and challenges to peace and stability, as the lack of development exacerbates economic disparities.

1.2.3.1. The locust invasion

Desert locust (Schistocerca gregaria) invasions are still a danger to the ecosystems (Salih et al., 2020). The unusual climatic condition, such as record-high temperatures in the Indian Ocean, was linked by scientists to the recent locust outbreak in Arabia and eastern Africa, primarily attributed to climate change. This outbreak had unprecedented impacts, with Uganda experiencing its most severe desert locust invasion in 60 years, Ethiopia and Somalia in 25 years, and Kenya in 70 years (FAO, 2020). The locust invasion affected 24 districts in Karamoja, Teso, Acholi, and Bugisu, resulting in food insecurity.

Figure 1.8. The invasion of Eastern Uganda by desert locusts, 2020 (Courtesy picture by NEMA)

The economic fallout was substantial, particularly for farmers who faced significant losses as their crops were destroyed. This economic strain extended to local communities, affecting income, employment, and overall economic stability. Environmental consequences were evident in the rapid consumption of vegetation by the locusts, contributing to imbalances in ecosystems. The loss of vegetation disrupted habitats for other species, upsetting the delicate ecological balance in the affected areas. Furthermore, the efforts to control the locust invasion necessitated the use of pesticides fenitrothion; phosphonothioate insecticide, a necessary but environmentally impactful measure which could have resulted in the killing of other non-targeted insects. This raised concerns about the potential negative effects on the environment and human health. Moreover, the social fabric of communities was disrupted as people grappled with the aftermath of the desert locust invasion. The challenges posed by displacement, loss of livelihoods, and increased competition for limited resources added further strain to the affected regions. Addressing these complex issues requires coordinated and sustainable strategies to mitigate the impacts and enhance the resilience of communities facing the challenges posed by desert locust invasions.

1.2.3.2. The Covid-19 pandemic

The worldwide spread of severe acute respiratory syndrome (SARS-CoV-2) has had a relevant impact on economies, societies, road traffic, tourism, human interaction, and the environment (Malagón-Rojas, 2020). The impacts of COVID-19 on the environment were myriad in Uganda. The pandemic led to various restrictions and changes in human activities, contributing to both positive and negative environmental outcomes. With lockdowns and travel restrictions in place, there was a temporary reduction in industrial activities, transportation, and overall human mobility. This resulted in lower levels of air pollution and reduced carbon emissions, offering a brief respite for the environment (Galiwango, 2022). The improvement in air quality during the lockdown year (2020-2021) due to Covid-19 in Kampala further confirms that most of the

air pollution is as a result of motor vehicles. However, the pandemic also brought about challenges for environmental conservation efforts. The diversion of resources to address the health crisis led to disruptions in conservation activities and a potential increase in illegal activities such as poaching and deforestation. Additionally, the surge in medical waste, including personal protective equipment (PPE) disposal, posed a new environmental concern (Benson et al., 2021).

The economic impact of the pandemic affected various sectors, including tourism, which played a significant role in Uganda's economy. With travel restrictions, lockdowns, and global uncertainties, the tourism industry witnessed a significant reduction in the number of tourists visiting the country (Figure 1.9)

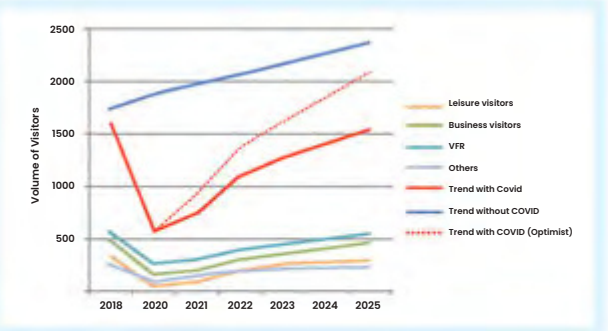


Figure 1.9. The impact of COVID-19 on the Uganda tourism sector (Ahebwa and English,

The decline in tourism during the COVID-19 pandemic has had both positive and negative effects on the environment. The decrease in tourist footfall led to reduced carbon emissions associated with transportation, as fewer planes, cars, and other modes of travel were in operation. This sudden decline in human activity provided a respite for popular tourist destinations including Queen Elizabeth National Park and Bwindi impenetrable forest, allowing ecosystems to recover and wildlife to thrive without the usual disruptions. However, the flip side of the tourist decline included the economic challenges for conservation efforts and local communities heavily dependent on tourism. Many conservation projects rely on tourism-generated revenue, and the sudden drop in visitors affected funding for wildlife protection and habitat preservation.

1.3 Structure of the Report

This report covers the status of the environment of Uganda over the years 2020 to 2022, highlighting the causes and effects of the changes over the reporting period while providing key policy actions to improve the environment. This report is divided into three chapters - Chapter 1: background and introduction; Chapter 2: Approach of Developing the National State of Environment Report for Uganda, 2022; and Chapter 3: State of Environment for Uganda.

Chapter 1 outlines the purpose of the report, conceptualizes and contextualizes the main drivers of environment change in Uganda, and includes the structure of the report, that is how the report is arranged. Chapter 2 describes the approach and process of preparing the report. Chapter 3 is the state of the environment in Uganda, itemized as follows: atmosphere, including air quality, weather and climate, noise; water, covering availability and quality; soil, including soil types and status of soil fertility and conservation, and management efforts; minerals and energy, covering the state of mining and all energy sources the country is exploiting and exploring, such as biomass, hydropower, solar, geothermal, oil and gas, and biodiversity as known at ecosystem, species, and genetic levels. Chapter 3 presents a highlight on the state of Uganda's population, although this is well covered by the abstracts produced by UBOS over the reporting period. Here, emphasis is on the linkage between the trends and socio-economic parameters of this population and the environment.

The chapter also discusses the state of Uganda's built environment and emerging issues in Uganda's urbanization process with an emphasis of the theme of the report. Finally, chapter 3 discusses research and innovations in Uganda in the context of environmental regulation and management.

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CHAPTER TWO

Approach of Developing the National State of Environment Report for Uganda, 2022

CHAPTER TWO

APPROACH OF DEVELOPING THE NATIONAL STATE OF ENVIRONMENT REPORT FOR UGANDA, 2022

2.1 Approach

Section 46 of the National Environment Act No. 5 of 2019 requires NEMA to prepare the national state of environment report every two years, highlighting environmental challenges, opportunities and proposed interventions to protect the environment. This report is expected to guide environmental planning at all levels. The reporting period is based on the calendar year and that lead agencies prepare environment reports, which then feed into the national report.

NEMA has so far produced thirteen versions of the state of the environment report, the first one published in 1996. Prior to its preparation, the Authority produced a guide to preparation of state of environment reports, outlining the rationale of these national environment assessments, an applicable analytical framework to support an integrated assessment taking into account the interlinkages between the environment and socio-economic systems, treatment of the state, and a generic structure of a typical report (NEMA 1996). The structure of this report in the guidelines has not been consistently followed. For some years, the outline of the state of the environment is focusing on the media, while in others, it is sectored.

The structure adopted in this report uses media for state but the issues are presented following analysis based upon the drivers-pressures-state-impact-response (DPSIR) approach (Figure 2.1). This allows some form of accounting of the state of the environment on pressure exerted on the environment by drivers of economic development. For example, the urbanization process demands resources to support development, hence affecting the environment, which impacts ecosystem health and human wellbeing, triggering responses, which include a set of interventions undertaken to remedy the situation. These responses directly or indirectly influence the state of the environment (Figure 2.1).

The discussion under the state of the environment chapter was made following the afore-mentioned analytical framework. Where this was not done, such as for minerals and energy, the intention was two-fold, namely to illustrate the environmental effects of exploiting these resources and the potential of some of these resources to contribute to a carbon neutral economy. The lessons from the latter are especially useful in orienting policies to achieve sustainable development.

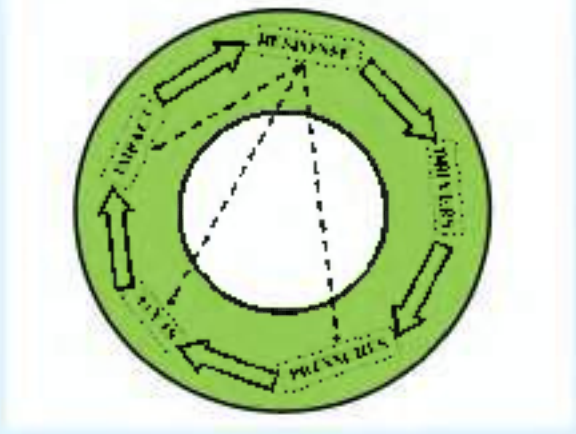

Figure 2.1. The DPSIR approach is used to analyze the interrelationships between environment and socio-economic systems.

2.2 Preparation of the report

This report was prepared by a team drawn from lead agencies in the ENR sector and specialized CSOs, institutions, academia and researchers whose work is allied to the sector and/or are members of the Environment Information Network. This was favored because of the expectation that data archived by entities where the authors were drawn would readily be accessed and made use of in the process of preparing the report. Moreover, this provided the members of the author team with the opportunity to build capacity in preparing assessment reports.

The report was written over a period of two years and involved the following stages: (i) planning; (ii) thematic desk reviews for background information; (iii) field work; (iv) content and context analysis; (v) drafting; (vi) validation and editing the report; and (vii) publication and dissemination of the report. The first planning meetings were at the secretariat in NEMA. They gave rise to the theme and the proposed structure of the report, which were approved by Management. Subsequently this fed into the first meetings with the author team and guided on the kind of data required and the analytics. The authors were also assigned chapters to prepare. They reviewed literature, as guided by the theme and analytical framework, and supplemented this with field data, all of which were analyzed following the flow shown in Figure 2.1, above. Drafting of the report was done individually, but the team would occasionally assemble to present draft chapters before they were finally consolidated into a single document. Several validations meetings were held before the report was presented to management. Thereon, the report was presented to the Board for approval before publication and dissemination.

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CHAPTER THREE

STATE OF THE ENVIRONMENT

CHAPTER THREE

STATE OF THE ENVIRONMENT

3.1 Atmosphere (Air, noise and noxious smells)

Developing countries in the global south, including Africa, are prone to higher exposure to air pollution as a result of the limited capacity for effective emissions management. Statistics from WHO (2023) report that 6.7 million premature deaths result from the combined effects of ambient air pollution and household air pollution.

The socio-economic costs of poor air quality in Africa are estimated to be higher than malnutrition and unsafe sanitation (Roy, 2016; WHO, 2018), in addition to HIV/AIDs. Air quality deterioration continues to be evident in fast-growing areas, including Uganda, where air pollution attributed mortality is estimated at more than 30,000 people annually. Children under five in low and middle-income countries such as Uganda are especially burdened with respiratory illnesses, with a 90.8 percent risk factor, which makes it the second driver of death as per the Global Burden of Disease Study 2019 of air pollution.

There are no known safe levels for air pollution exposure but air pollution interventions are targeted to address air pollutants with adverse health impacts on human health and the environment. These include both Particulate Matter ($PM_{2.5}$ and PM_{10}) and gas phase pollutants (NO_2, CO, SO_2, etc.), collectively referred to as classical pollutants or criteria pollutants. Uniquely, Particulate Matter is the most common pollutant, emanating from multiple-sources including gaseous pollutants at specific atmospheric conditions. Common sources include natural processes such as volcanic activities, bush fires, domestic burning, exhaust and non-exhaust vehicle emissions, wear and tear from machinery, suspended particles from loose surfaces, industrial processes among others.

Universal pollutant-based scientific health guidelines are available for classical pollutants, for exposure levels beyond which adverse health impacts start to occur (WHO, 2021). Whilst it is ideal to report extensively on the pollution levels based on all classical pollutants, existing monitoring infrastructure is limited to continuous data on Particulate Matter.

3.1.1 Air quality in monitored urban areas

Longitudinal trend analysis for the years 2020-2021 for all monitored urban centers in Uganda is presented using spatio-temporal analytics. Because air quality varies considerably over time and space, monitored locations are clustered according to cities with further categorisation of land use i.e., urban, urban background and commercial centers, as varying landscapes influence unequal distribution of pollution levels.

Data presented are based on the size characterisation concentration of particulate matter, $PM_{2.5}$ defined as the mass concentration of particles with aerodynamic diameter less than 2.5, although measurements for $PM_{1.0}$ and $PM_{5.0}$ are widely carried out in air pollution measurements. In general, coarse particles (>2.5 µm) are formed by mechanical

processes while fine particles (<2.5µm) and ultrafine particles (<0.1µm) are emitted directly after formation through chemical reactions from gaseous precursors (Massey et al., 2012). The current WHO guidelines restrict exposures to $PM_{2.5}$ with concentration limits not exceeding 5 µg/m^3.

Figure 3.1 illustrates the concentration of particulate matter ($PM_{2.5}$) for the years 2020 and 2021. It is evident that all designated urban centers recorded annual particulate matter concentrations surpassing the WHO's recommended 2021 annual health guideline of 5 µg/m3. Furthermore, the air quality levels for both years exhibited similarities, suggesting consistent pollution drivers across various regions in Uganda.

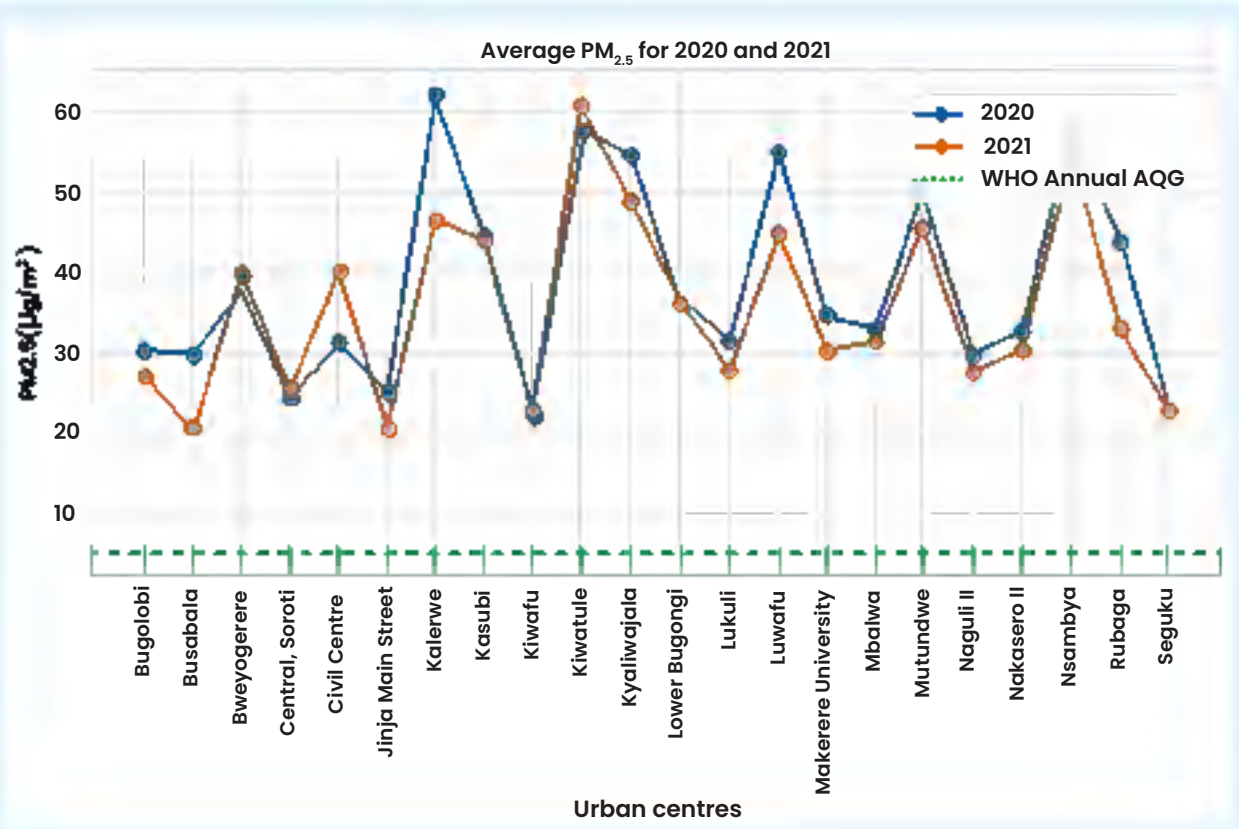

Figure 3.1. Air quality (PM2.5) in designated urban centers in Uganda

3.1.2. Lessons from Covid-19 response

The Covid-19 imposed restrictions disrupted human activities and led to temporary but unprecedented air quality improvements in many cities around the world (Venter et al., 2020; Tobias et al., 2020; Green et al., 2022). Likewise, targeted analysis during the Covid-19 lockdown period (2020-2021) in Greater Kampala shows that air quality improved by up to 50% and 60% for $PM_{2.5}$ and NO_2 respectively (Figure 3.2). According to Green et al. (2022) publication on the impact of Covid-19 lockdown restrictions on air quality, densely populated areas near major roads experienced the greatest air quality improvements; which correlated well with reduction in traffic (80% traffic reduction) and commercial activities.

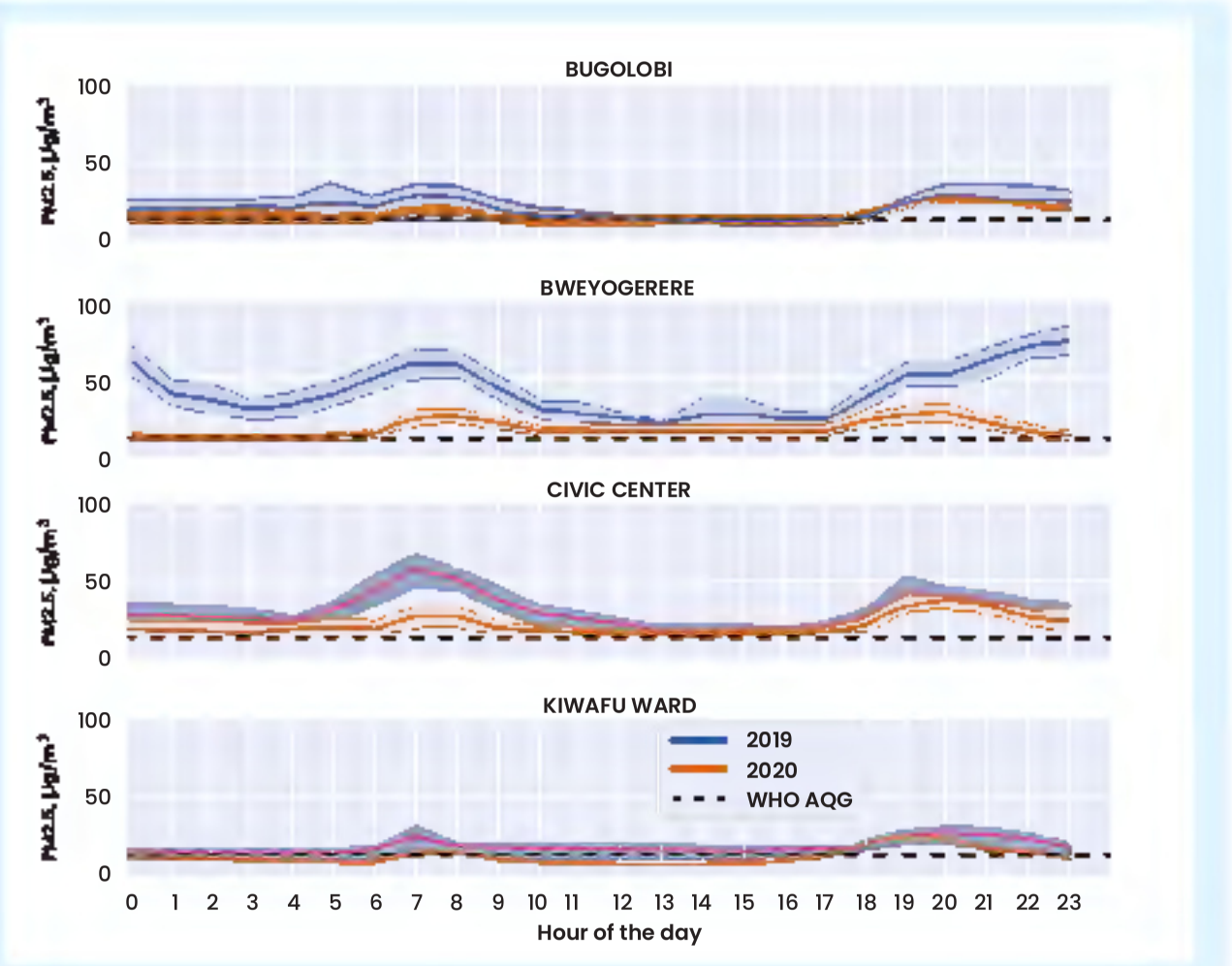

Figure 3.2. Changes in air pollution levels during Covid-19 lockdown in Greater Kampala

The improvement in air quality during the lock-down year (2020-2021) due to Covid-19 in Kampala further confirms that most of the air pollution is as a result of motor vehicles. Air quality improved when movement of vehicles was restricted during the lock-down period.

3.1.3. Spatio-temporal variations of air quality

Pollution varies distinctly over the course of the day (24-hour period), often exhibiting consistent patterns determined by the pollutant property and prevailing environmental conditions. For the 2-year period 2020-2021 (Figure 3.3), peak pollution episodes were experienced during morning hours (07:00 am to 11:00 am), and evening hours (03:00 pm to 11:00 pm). These trends are a consequence of heightened human activities as well as the meteorological and atmospheric conditions that distinctly influence pollution dispersion during the course of the day. This pollution profile is replicated in other parts of the country and other geographical landscapes with similar contexts (Okure et al., 2022), although the 5-year trend focuses on Kampala. The definitive pattern provides explicit avenues for developing targeted interventions such as promoting non-motorised transport during peak pollution hours, other traffic and vehicle regulations initiatives, public health messaging that encourages outdoor physical activities during the least polluted hours of the day.

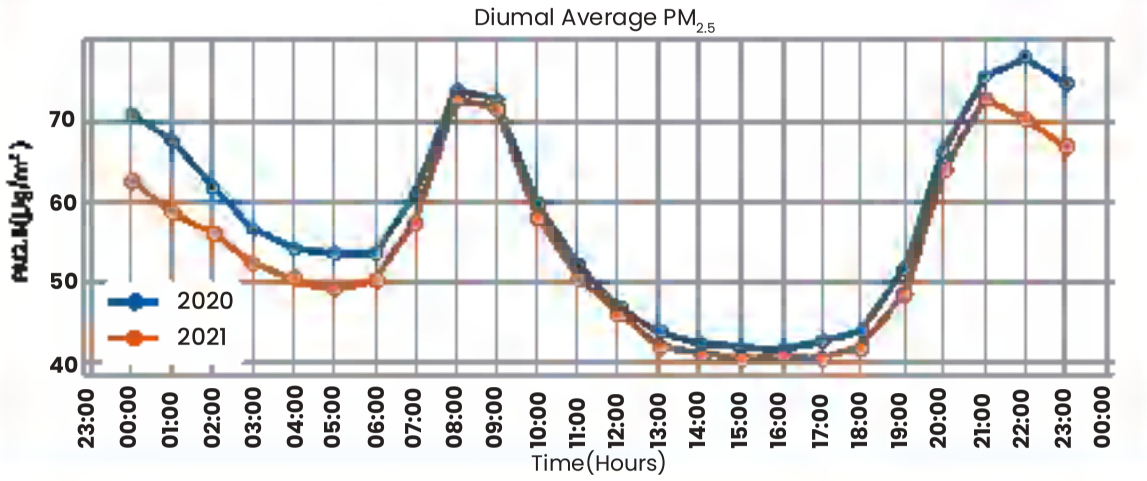

Figure 3.3. $PM_{2.5}$ variations over a 24-hour period for the 5-year period (Diurnal variations)

Seasonal changes affect air quality through pollutant transportation, dilution, suppression and catalyzing chemical reactions. Uganda experiences two rainfall seasons from March to May, and September to November, and two dry seasons from December to February, and June to August. Aggregated datasets for all monitored urban centers (Figure 3.4) show that the rainfall months consistently experience the least pollution levels while the dry seasons experience the highest pollution. Precipitation and stormy conditions particularly lead to increased suppression and dilution of pollution; and the strong inverse correlation with rainfall, typical of particulate matter, is replicated across the monitoring locations. This is also consistent with the earlier published monitoring results by Okure et al. (2022).

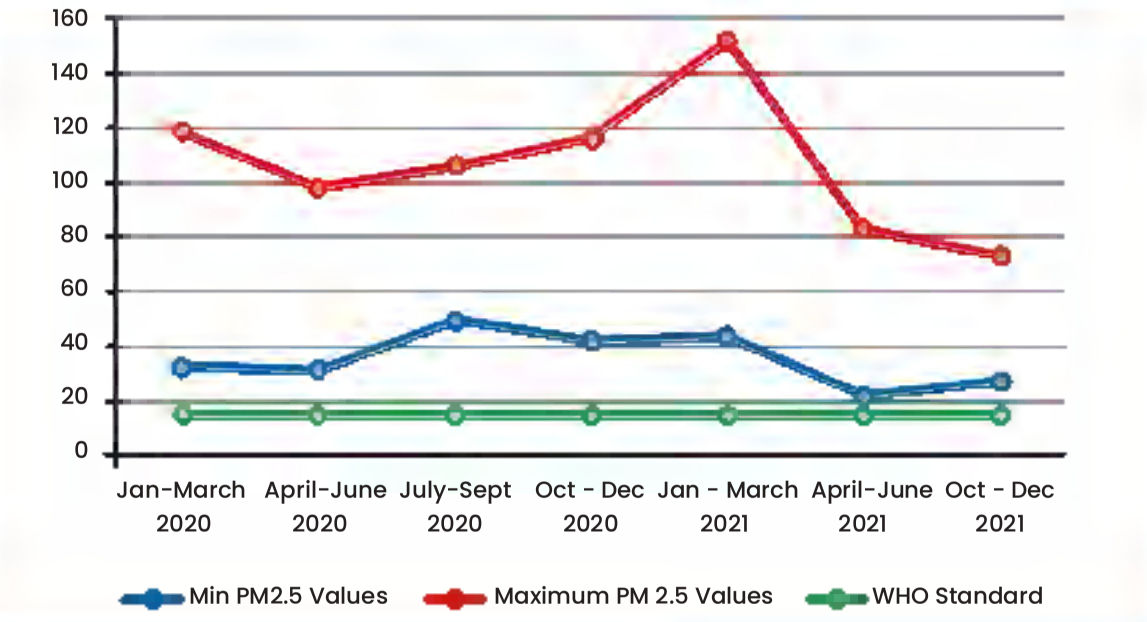

Figure 3.4. Trends of PM2.5 concentrations (maximum and minimum values) in Kampala city. (data obtained from Ninsiima et al., 2022)

3.1.4. Pressures and impacts

3.1.4.1. Existing drivers

Ambient air pollution profile in many of Uganda's urban centers is predominated by diffuse sources which lead to more localized effects, and fundamentally require holistic intervention mechanisms along with complex policy scenarios. In essence, the key sectors where pollution emerges include; transport, energy & waste, and industry although precise quantification of sectoral contributions in Uganda is hindered by limited data on pollution sources and inventory. The key drivers of air pollution include: (i) Domestic energy uses that rely heavily on solid biomass; (ii) Exhaust and non-exhaust emissions from the transportation sector (a function of fleet age and technology, operations, and road infrastructure); (iii) Poor waste management in urban areas; (iv) Diffuse industrial processes and activities; and (v) Wildfires in rural areas.

3.1.4.2. Emerging air pollution issues

Oil and gas sector

Although environmental safeguards have been identified at the environmental impact assessment stage, the air quality landscape will significantly be affected as the oil and gas industry enters the production phase.

Urban development

The government of Uganda has designated nine new cities to stimulate socio-economic development towards achieving Vision 2040 and the UN SDGs. Pollution levels under the business as usual scenario will be compounded by these major socio-economic drivers, that will result in disproportionate increase in anthropogenic activities and consequently higher pollution.

Inevitably, commensurate and deliberate mitigation measures will be required to tackle the pollution and congestion effects of rapid urbanisation coupled with industrial activities for the emerging sectors.

3.1.5. Impacts of Air pollution

Air pollution is a global challenge in this 21st century and severely impacts human health, ecosystems, plant and animal life. The impacts of air pollution will continue to be felt because of the continual interaction of humans with the environment.

Exposure to air pollution increases cancer risk, damages the immune system and causes neurological, reproductive, developmental, respiratory and other health problems (Wolf & Sommer, 2004). In their study conducted in rural and urban areas of Uganda, Siddharthan et al. (2018) found that one in every five adults had a chronic respiratory condition. About 40% of all those that had asthma lived in urban residences which are the most polluted.

3.1.6. Efforts towards tackling air pollution in Uganda

Uganda's Vision 2040 implemented through the 5-year National Development Plans (NDP) in many ways prescribes the strategic response towards the management of environmental and climate health challenges. The NDP III explicitly highlights tackling air quality as a national priority, also consistent with the national commitment to tackle air pollution in the country's Nationally Determined Contributions (NDC) submitted to the United Nations Framework Conventions on Climate Change (UNFCCC).

The existing interventions can be framed in different broad categories including institutions and regulations, awareness and advocacy, infrastructure, research

and innovation. The proposed interventions are presented in Table 3.1.

Table 3.1. On-going interventions and opportunities for targeted actions

Existing interventions	Opportunities and recommendations
Institutions and regulations	
• NDC, an international obligation submitted to UNFCCC. Uganda has committed to enhancing institutional capacity to tackle air pollution as one of the areas during the NDC implementation. • NDP III explicitly highlights tackling air pollution as an important priority for the country. • Regular reporting through the National State of the Environment Report. • The national air quality regulations are in advanced stages of development. Transport sector interventions including progressive policies for Non-Motorised Transport (NMT) and mass transport.	• Consolidating synergistic and nexus issues through regular meetings to harmonise institutional approaches to tackling air pollution. • There is a need to further trickle down policy commitments to lower administrative levels in urban centers in the form of localised ordinances and air quality action plans. • Institutional capacity enhancement programmes to facilitate air quality management in Uganda. • Formulate a transport policy that promotes mass transport services.
Infrastructure	
• Progressive infrastructure for air quality monitoring in different urban areas comprising over 150 low-cost monitors. Todate, high resolution monitoring has been deployed in Kampala, Jinja and Fort Portal cities, Makindye-Ssabagabo, Kira and Kabale municipalities. • Vehicle inspection facilities established in different parts of the country. • Gradual improvement in the road infrastructure including NMT infrastructure. • Energy pricing initiatives to increase access to cleaner energy alternatives for domestic use.	• Need for increased monitoring infrastructure in different major urban areas in Uganda beyond Kampala, Kira, Jinja, Fort Portal and Kabale. • Investment in increasing scope of air quality monitoring to include gas phase pollutants, and source quantification. • Prioritisation of green mobility initiatives within the transport sector. • Exploring market opportunities for cleaner energy alternatives to increase household energy access. • Promote use of energy efficient technologies to minimize pollution from fossil fuels.

Awareness and advocacy	
• Institutionalised air quality awareness campaigns in the form of annual air quality awareness week during the first week of May, a test case of sustained collaboration synergies involving government, development partners, academia and the general public. • Effectively leveraging a wide range of available media platforms for dissemination (social media, print media, websites, radios and TVs).	• There is need for more rigorous public awareness on the dangers of poor air quality to promote participatory and community-driven actions. • Regular and institutional reporting on air quality.
Research and innovation	
• Enhanced capacity for local air quality research and dissemination covering different facets of air quality including health, monitoring, policy, community engagement and citizen science. This can be measured by the amount of air quality focused research publications, air quality convening, research and student placements, etc. in the last two years. • There has been progressive increase in research and policy collaborations, in many ways developing a template for other African countries. • Data infrastructure-role of digital innovations. • Local capacity has been built in partnership with Makerere University, AirQo initiative, to develop low-cost tools for continuous air quality monitoring.	• Scaling up air quality research to different institutions of learning to improve research collaborations. • Increased direct support for local research and innovation in the form of enhanced mechanisms for research translation into policy. • Improved research financing for new innovations. • Targeted research on health implications of air pollution.

3.2. Weather and Climate Change

Uganda predominantly features a tropical climate, covering three-quarters of its land within the tropical belt. This results in a warm tropical climate, characterized by average temperatures ranging from 25–29°C. The annual near-surface temperature averages around 21°C, and the total annual rainfall varies between 500mm and 2800mm.

The tropical belt experiences two distinct rainy seasons annually, occurring from March to May and September to December. In contrast, the northern region, comprising one quarter of the country, lies outside the tropical belt and encounters a single rainy season from March to October. The diverse topography, prevailing winds, and the presence of lakes and rivers contribute to significant variations in rainfall patterns across the country.

Uganda's geographical location in the tropics, straddling the equator, exposes it to climatic influences from the Indian Ocean Dipole (IOD), the extensive Indian Monsoon, the Congo air mass, and the Inter Tropical Convergence Zone (ITCZ) systems. Additionally, the country experiences the El Nino Southern Oscillation (ENSO) phenomena, which are pivotal factors influencing both intra-annual and inter-annual variability in rainfall patterns.

3.2.1 Status and trends

Uganda's mean temperature has undergone a noteworthy change at a rate of 0.030C per decade, demonstrating significance levels of 99.8% for the period 1951 to 2020, 99.9% for the period 1971 to 2020, and 87.6% for the period 1991 to 2020. The minimum temperature has similarly shown an increase at a rate of 0.030C for the periods of 1951 to 2020 and 1971 to 2020, and 0.020C for the period of 1991 to 2020. Concurrently, the maximum temperature has experienced an increase at a rate of 0.030C for the same periods, with a significance level exceeding 85%.

Contrastingly, the annual rainfall totals have exhibited a decreasing trend at a rate of -10.3mm per decade for the periods 1951 to 2020 and 1971 to 2020, both demonstrating a significant level of over 95%. Additionally, there was a decrease of -3.58mm for the period 1971 to 2020, although not statistically significant. Spatially, the mean annual rainfall has displayed significant increasing trends at a 95% confidence level over the majority of the eastern, north-eastern, and certain areas of the south-western regions of Uganda. Conversely, decreasing trends have been observed over the north-western, central west, and western parts of the country. The areas experiencing decreasing trends, such as Mubende, Mpigi, and Sembabule, have shown particular significance according to the Uganda National Meteorological Authority (UNMA) in 2020.

3.2.2 Projected temperature and rainfall (2031 – 2060)

The Intergovernmental Panel on Climate Change's (IPCC, 2021) sixth Assessment Report asserts with high confidence that at 1.5°C global warming, heavy precipitation and associated flooding are expected to intensify and become more frequent across most African regions. At 2°C, the likely impacts involve heightened hydrological and meteorological droughts in many parts of Africa. Climate projections specific to Uganda indicate that monthly temperature changes are anticipated to rise by 1.8°C in the 2050s and by 3.7°C in the 2090s under a high-emission scenario, as reported by the World Bank in 2020.
The 2020 national climate analysis and projections conducted by the Ministry of Water and Environment (MWE) aligning with the country's Vision 2040 reveal that mean annual temperature projections for the climate level (2031–2060) anticipate temperature increases of 1 to 1.5°C under low, moderate, and high greenhouse gas (GHG) concentration scenarios (RCP 2.6 and RCP 4.5) across most parts of Uganda (Figure 3.5). The RCP 8.5 scenario projects a temperature increase of 1.5 to 3oC relative to the 1981-2010 average for the majority of the country.

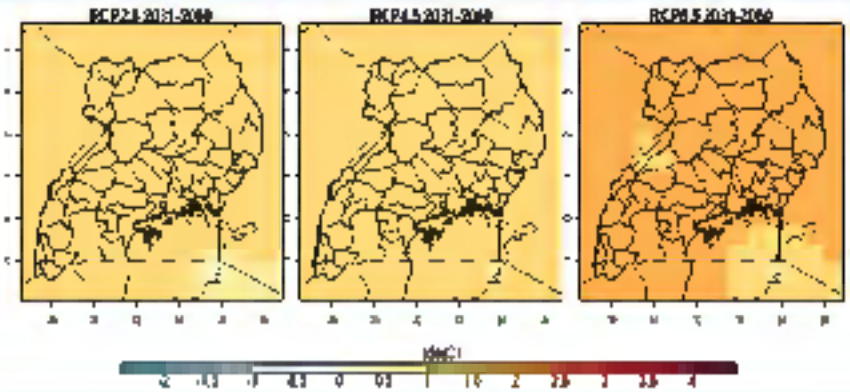

Figure 3.5. Projected temperature changes for the 2031-2060 climate period in relation to the 1981-2010 average

The mean total annual rainfall, in contrast to temperature, exhibits diverse patterns across the country. In some regions, rainfall is projected to increase, while in others, it is expected to decrease (Figure 3.6). Under RCP2.6, much of the country's rainfall is anticipated to remain relatively unchanged in the climate period 2031–2060 compared to the 1981–2010 average. However, the Masindi, Hoima area, and Karamoja regions may experience a decrease in rainfall by 5 to 10% relative to the baseline. Similarly, under RCP 4.5, no significant changes are projected across the country, with only the South Western highlands expected to see a rainfall increase of 5 to 10% relative to the baseline. Under RCP 8.5, mean annual rainfall in the 2031–2060 period is predicted to decrease by 5 to 15% in most parts of central Uganda, while south-western Uganda may experience an increase of 5 to 10%.

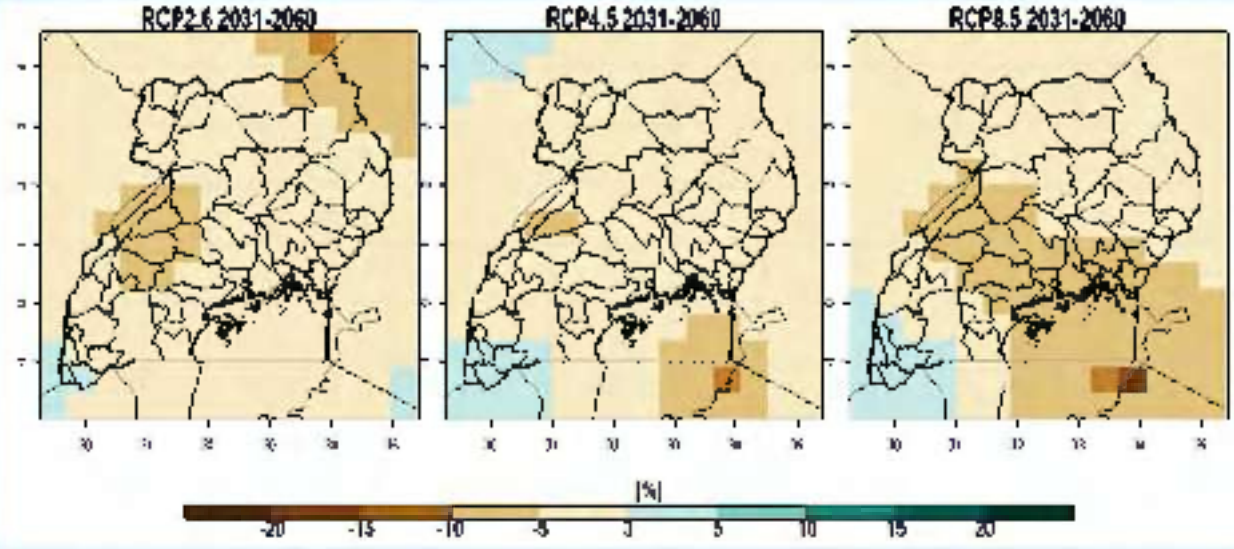

Figure 3.6. Projected Rainfall for the 2031-2060 climate period in relation to the 1981-2010 average

3.2.3 Pressures and impacts

Uganda's climate vulnerability is high, and features a high degree of exposure, high sensitivity, and a low adaptive capacity. The National Risk and Vulnerability Atlas of Uganda 2019 reports floods, landslides, mudslides, prolonged droughts, lightning, hailstorms, windstorms, and earthquakes as the common climate-induced hazards (Office of the Prime Minister, 2019). The country experiences both flash floods and slow-onset floods, which are prominent in urban areas, low-lying areas, areas along riverbanks, and wetlands.

Modelled flood risks for Uganda show that floods are expected to affect nearly 50,000 people and cause an estimated USD 62 million in losses each year (World Bank Group and GFDRR, 2019). The floods normally result from variabilities in the rainfall received. Heavy rains result in destruction and damage to crops, livestock, human settlements, and infrastructure such as housing, water, roads, and electricity infrastructure among others.

Prolonged droughts affect mostly agriculture, causing a poor ability to plan for farm activities, particularly in the cattle corridor areas of the country. Farmers are not sure of when to plant, and droughts lead to crop failures and animal deaths, resulting in farmers' economic loss, food insecurity, and famine. In some cases, prolonged droughts have led to the emergence of new pests and diseases that affect crops and animals.

A study on the impact of short-term drought on the economy of Uganda estimated that climate change could cause declines in employment by 5.1%, household consumption by 4.6%, and exports by 5.2% (Kilimani et al., 2015).

Landslides are mostly experienced in the mountain areas of Elgon, Kigezi, and Rwenzori. Heavy rains and water concentration on base rock result in mudslides and landslides that cause human life losses, property losses, infrastructure destruction, increases in waterborne diseases, and food insecurity among others.

Uganda's vulnerability to climate change risks and impacts is due to unsustainable practices such as deforestation, charcoal production, and increased wetland degradation (OPM 2019), as well as high levels of poverty, a rapidly growing population, strong economic dependence on climate-sensitive sectors such as agriculture, and ongoing environmental degradation (World Bank 2021 & Echeverría, et.al, 2016). Other factors that increase vulnerability include uncertain land tenure arrangements, low diversity of incomes and livelihoods, weak institutions, inadequate infrastructure, weak enforcement, underdeveloped irrigation schemes, and the near absence of disaster preparedness at the community level (Hepworth and Goulden, 2008).

In accordance to Notre Dame Global Adaptation Initiative 2021, Uganda is ranked as the 10th country in terms of vulnerability and 35th in terms of preparedness, this calls for both for need to enhance climate investment and innovations to improve readiness and urgency for action to build resilience.

The sectors most vulnerable to climate change risks in Uganda according to the national risk and vulnerability assessment for the Updated NDC and LTS are water, environment, agriculture, forestry, fisheries, energy, health, urban transport, and the built environment. These have been identified as priority sectors for adaptation in the Uganda's updated Nationally Determined Contribution (NDC) (MWE, 2021). In addition, disaster risk reduction is a significant cross-cutting issue for all sectors and has been identified as a priority area for adaptation in the updated NDC.

The first step toward adaptation to future climate change is reducing vulnerability and exposure to present climate variability (Oppenheimer et al., 2014), which makes assessing and understanding climate risks and vulnerability a critical step in adaptation planning.

3.2.4 Responses

Uganda has an overall objective enshrined in the country's NDP III which aims to promote inclusive and climate-resilient development across sectors at all levels. As indicated in the updated NDC, the priority adaptation sectors in the current cities that are most affected by climate change include water and sanitation, energy, transport, cities and built environment, education, health, and disaster risk reduction.

The country has undertaken a range of climate actions since its ratification of the UNFCCC in 1993. These actions include: creating an enabling environment (laws, policies, strategies and plans) and enhancing institutional capacities to coordinate national climate change responses

Since the ratification to the UNFCCC, Uganda has made progress in instituting policies and actions to address climate change such as the National climate change policy of 2015, National climate change Act 2021, Strategic Programme for Climate Resilience (SPCR, 2017), the updated NDC 2021 contains Adaption component, the Long Term climate Strategy LTS consists of adaptation pillars, the National Adaptation Plan for the Agriculture Sector (NAP-Ag) and currently on the roadmap to relaunch the National Adaptation Plan (NAP) for the country.

The key action for climate change adaptation are aligned for various sectors responding to climate risks and vulnerabilities.

3.3. Water

Water flows are affected by both climate and land use dynamics. Variations in surface water are influenced by sub-surface flows through recharge and discharge of groundwater systems. The fluctuations impact aquatic environments leading to different changes, for example, extended periods of flooding affect breeding sites and lead to rotting of crops and prolonged drought leads to movement of livestock into wetlands which affects water quality and increases land conflicts. The impacts directly and indirectly affect development in different ways, for example, due to floods access roads and bridges are damaged which hinders produce from reaching the markets, and children from attending school. On the other hand, specifically, children and women pay the price during drought since they have to move long distances in search of water.

In order to safeguard Uganda's water resources, government monitors the status (quality and quantity) of all water bodies (both on the surface and underground). It also regulates the use of water resources through a permitting and enforcement system and is actively engaged with other River Nile riparian states to ensure that Uganda's interests are considered.

3.3.1 Status and trends

The Directorate of Water Resources Management (DWRM) operates hydrological monitoring networks for surface water elevation, river flow, groundwater depth, water quality and compliance. There are more than 120 hydrological monitoring sites across the country. The stations employ different technologies for measuring and reporting water levels ranging from manual (where readings are captured by station observers twice a day) to telemetric stations (where readings are captured and transmitted in real time to the directorate's servers). In the same way, government operates 63 groundwater monitoring stations most of which are automated and should transmit data in real time. The operational status of all the stations was about 40% following the flooding in 2019 and 2020 which damaged a considerable number of them.

3.3.2 Water availability and trends

The year 2020 was unprecedented in the hydrology of Uganda. It was characterised by high water levels in all the major lakes including Lake Victoria, Kyoga and Albert (Figure 3.7).

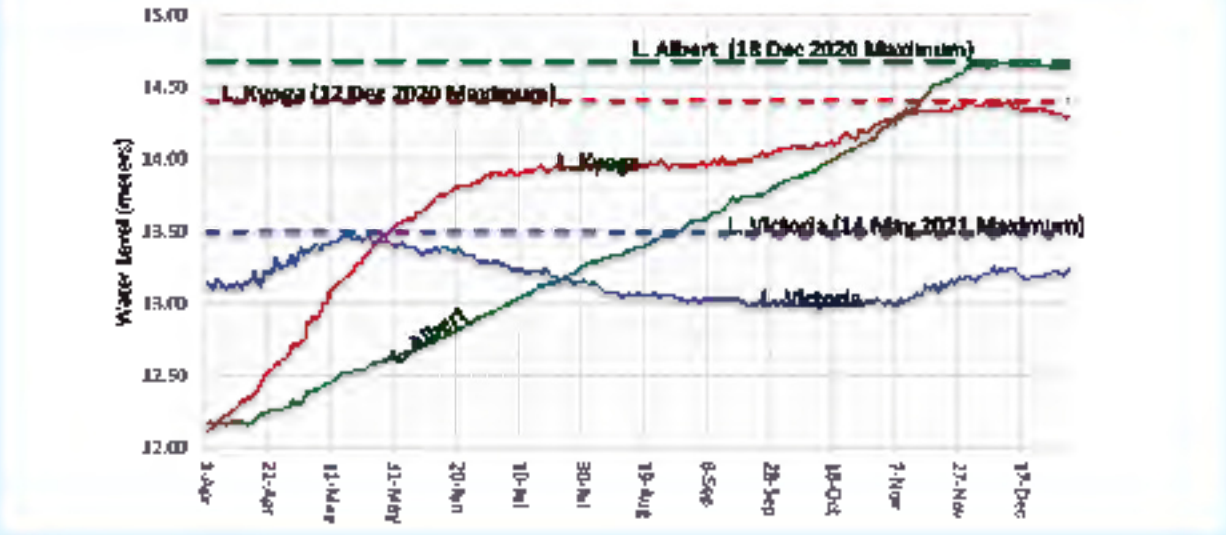

Figure 3.7. Hydrograph of Lake Victoria (blue), Lake Kyoga (red) and Lake Albert (green) (April 2019 – December 2020)

The water level for Lake Victoria rose steeply by approximately 1.4 metres from the 22nd September, 2019 to 27th May, 2020. Similarly, Lake Kyoga level rose sharply from 19th May, 2020 to 6th July, 2020. On the other hand, Lake Albert experienced the steepest rise in water level of approximately 2.5m around 17th December, 2020.

Similarly, the flow of rivers increased significantly and a number of them overflowed their banks including River Kagera, River Kafu and River Nile (Figure 3.8).

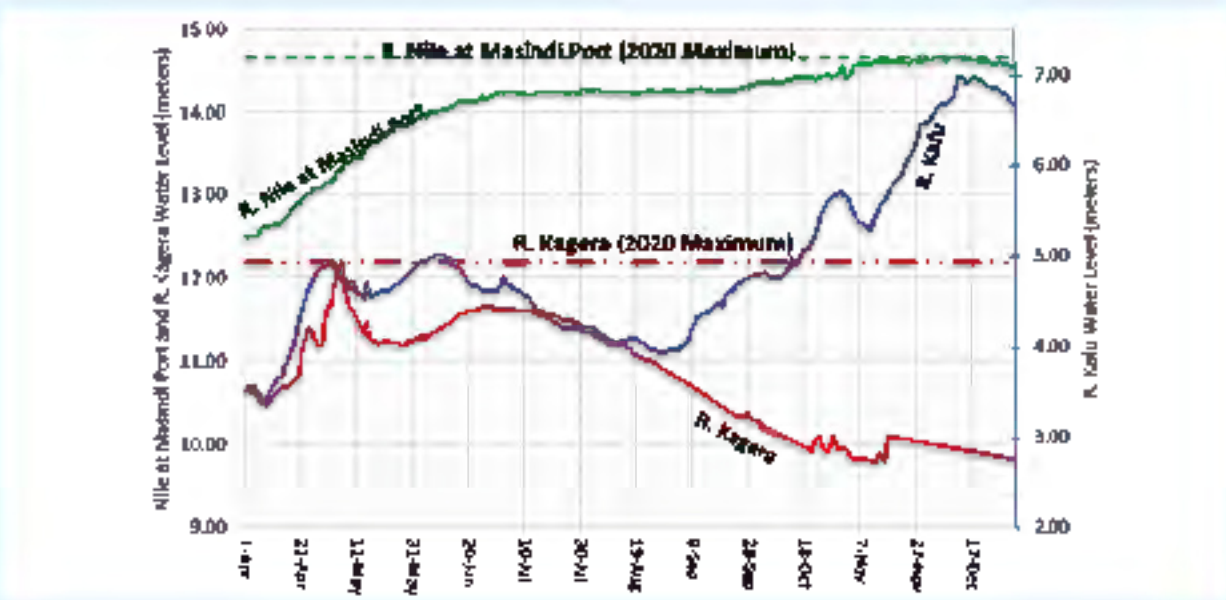

Figure 3.8. Hydrograph of River Kagera, (red), River Kafu (blue) and River Nile (green) (April 2019 – December 2020).

3.3.3 Pressures and impacts

3.3.3.1 Floods and high-water level along major lake shores and rivers in Uganda

The year 2020 was unprecedented in the hydrology of Uganda, it was characterized by high water levels in all the major lakes in the country, namely: Victoria, Kyoga and Albert.

The high-water levels led to flooding in the lake shores/areas. Flooding was first reported around Lake Victoria in January 2020. It was later reported around the shores of Lake Kyoga in May 2020 that led to destruction of crops (Figure 3.9A). The flooding of Lake Albert in June 2020 led to destruction of buildings among others (Figure 3.9B).

Figure 3.9. Flooding caused by outburst of the lakes. A: Dried maize crop in the background as a result of high-water level along the shores of Lake Kyoga in Kayunga District. B: Flooded houses along the shores of Lake Albert.

3.3.3.2 The major effects of the floods

(i) Destruction of crops which led to food insecurity in areas that were cut off

(ii) Displacement of communities and disruption of livelihood as many communities had to migrate from the shoreline and river banks

(iii) Destruction of government infrastructure such as port/ferry docking sites and water monitoring points in Masindi, Namasale, Kachung – agwata water monitoring site in Lira, among others

(iv) Loss of key flora and fauna. Some key biodiversity species such as medicinal plants that indigenous peoples and local communities used were lost. Some wildlife habitats like fish breeding sites were disrupted due high level of water.

(v) Increase in reptile attacks such as crocodiles and snakes in Okile and Murem sub counties in Kaberamaido District

(vi) Ponding/flooding around protected water sources which led to contamination of water

(vii) Collapsed in sanitation facilities such as pit latrines/toilets which led to poor feacal waste management, and hence a potential outbreak of diseases such as cholera, dysentery, bilharzia etc.

(viii) Flooded roads which has led to inaccessibility of key social services like health centers, markets and other social needs that may be required by communities. This was observed on Kayunga Road in Kayunga District that was flooded. Communities were cut off, and UNRA deployed a boat to ferry people across the newly formed water body.

3.3.3.3 Analysis of water level increment

The USDA/NASA G-REALM program consistently monitors height variations of lakes and reservoirs globally, utilizing radar altimetry data over inland water bodies. In East Africa, satellite passes cover lakes Victoria, Kyoga, and Kwania. Figure 3.10 depicts the height variations of Lake Victoria and Lake Kyoga from January 2019 to May 2021. The data was retrieved from the USDA/NASA website to observe changes in water levels across these water bodies.

Figure 3.10. Shows trends in height variation for Lake Victoria and Lake Kyoga (January 2019 – May 2021). (Source: USDA/NASAG-REALM).

Lake Victoria

A steep rise of approximately 1.4 metres is observed from the 22nd September 2019 to 27th May, 2020. The level dropped slightly by 0.36 metres before rising again. It should be noted that the levels are still high.

Lake Kyoga

Similarly, Lake Kyoga level rose sharply from 19th May, 2020 to 6th July, 2020. The water level has been fluctuating within 0.4 metres to date.

Flood extent

Sentinel images were downloaded to assess the flooded areas around Lake Kyoga (Figure 3.11).

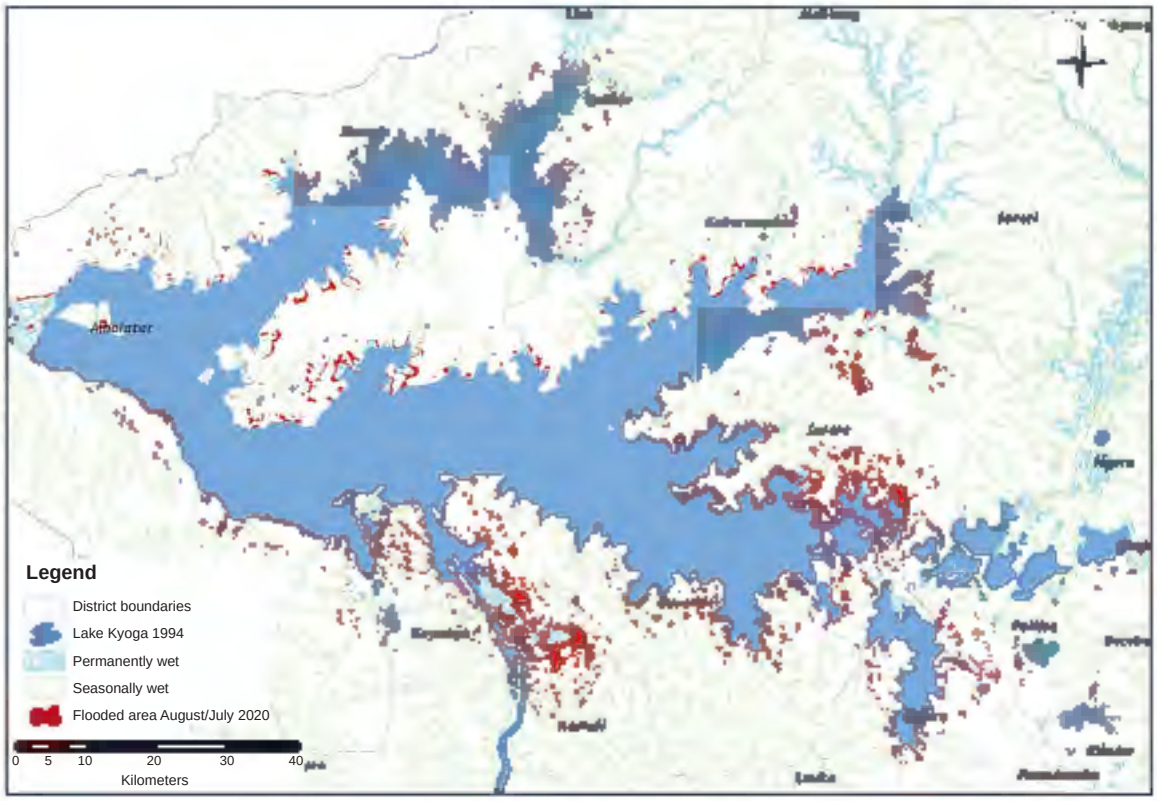

Figure 3.11. Map showing the flooded areas of Lake Kyoga

Flooding was more severe on the southern and eastern shores of the lake. Flooding in Kamuli District may be attributed to backflow as the Victoria Nile pours into Lake Kyoga. In most of the affected areas, the floods extended beyond the seasonal wetlands. Since other land uses had taken over such areas, the impacts were severely felt.

3.3.3.4 Cause of high-water levels and floods

The high-water levels resulted from above average rainfall experienced in the Lake Victoria basin in the September, October, November, December (SOND) season of 2019 (NBI, 2020). Figure 3.12 shows the distribution of monthly rainfall compared with monthly average from May 2019 to May 2020. The rain extended further into January and February of 2020 which is supposed to be a dry season (Wainright et al., 2020) attribute the increased rainfall to a number of factors:

(i) Strongly positive Indian Ocean Dipole (IOD). Positive IOD events lead to enhanced rainfall over East Africa.
(ii) Active Madden – Julian Oscillation which enhances convective activity over Africa and the Indian Ocean
(iii) Presence of tropical cyclones in the Western Indian Ocean

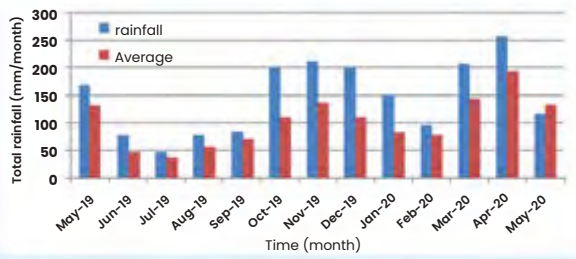

Figure 3..12. Lake Victoria sub-basin rainfall compared to the average (May 2019 to May 2020). (Source: NBI, 2020).

3.3.3.5 Challenges

Challenges for water resources management

i. Prolonged floods and high-water levels along the major water bodies in Uganda. Due to the floods, a number of stations could not be accessed while others were washed away or damaged. This led to loss of data and gaps.
ii. Inadequate funding for the maintenance of an optimal monitoring network
iii. Late release of funds for monitoring. Once the data is not picked in time, the station observers become lax in collecting data which compromises its quality.
iv. Vandalism of station equipment that creates financial loss to government and reduced quality of data
v. The impacts of climate change call for intense monitoring in order to inform early warning systems. However, the objective of the current monitoring network is to inform water resources management. The stations are not optimally located to inform flood monitoring. There is need to establish flood and drought early warning systems which can improve the resilience of communities.

3.3.4. Responses

3.3.4.1 Water information system

The current challenges call for increased water resources monitoring. This has forced the ministry to improve water resources monitoring through upgrading hydro meteorological monitoring stations. Some of the manual stations have recently been upgraded to telemetric so that data can be transmitted in real time in order to facilitate timely analysis and decision making through the water information system (WIS). The WIS is a web-based information system that covers collection of water related data. The system is made of several components including a hydrological information system that captures data from the field (water bodies), database management system, and a knowledge base management system through which basic data analysis is conducted before the information is published on a public-facing portal. The system captures stream flow status, groundwater depths, and surface water elevations for critical stations. The portal is also used to report the status of the platinum indicators for programmes under MWE.

3.3.4.2 Catchment based water resources management

Since the introduction of catchment based integrated water resources management (CBIWRM) in 2013, the ministry has developed catchment management plans for the 15 catchments. During 2019 – 2020, CMPs were prepared for rivers Mitano, Nyamwamba, Nkusi, Muzizi and Semliki. Through the preparation of CMPs, the critical issues, threats and opportunities to water resources management were identified. Priority actions were set by

stakeholders. The implementation of the plans contributes to the reversal of catchment degradation and improve water resources availability and use in these areas.

3.3.4.3 Water Source Protection Plans

The sector promotes the use of water source protection guidelines during the development of water related projects. This is done in order to secure the availability of water resources.

3.3.4.4 Recommendations

(i) Flood Management Strategy: Development of a National Flood Management Strategy in order to address issues related to floods
(ii) Management of land use practices along the fringing zones of water bodies
(iii) Working with partner states to develop joint water hydro-meteorological monitoring protocols for shared water bodies

3.4. Soils

3.4.1 Soils of Uganda

The soils of Uganda are characterized in the original regional soil survey reports by Harrop (1960), Olier and Harrop (1959), Olier (1959), Radwanski (1960), and Wilson (1959), focusing on the Western Province, Eastern Province, Northern Uganda (excluding Karamoja), Buganda, and Karamoja, respectively. Figure 3.13 presents a map of soil types derived from these surveys, with ongoing improvements over the years. The distributional aspects of soil types have remained consistent, as they change over extended geological timescales. While individual soil parameters couldn't be replicated for the period under review due to data limitations, elemental and some physical parameters are known to exhibit variation over short distances and time steps, influenced by factors such as land management practices. For further details on soil health and degradation, please refer to the discussion in the national state of the environment report for Uganda, 2018/19.

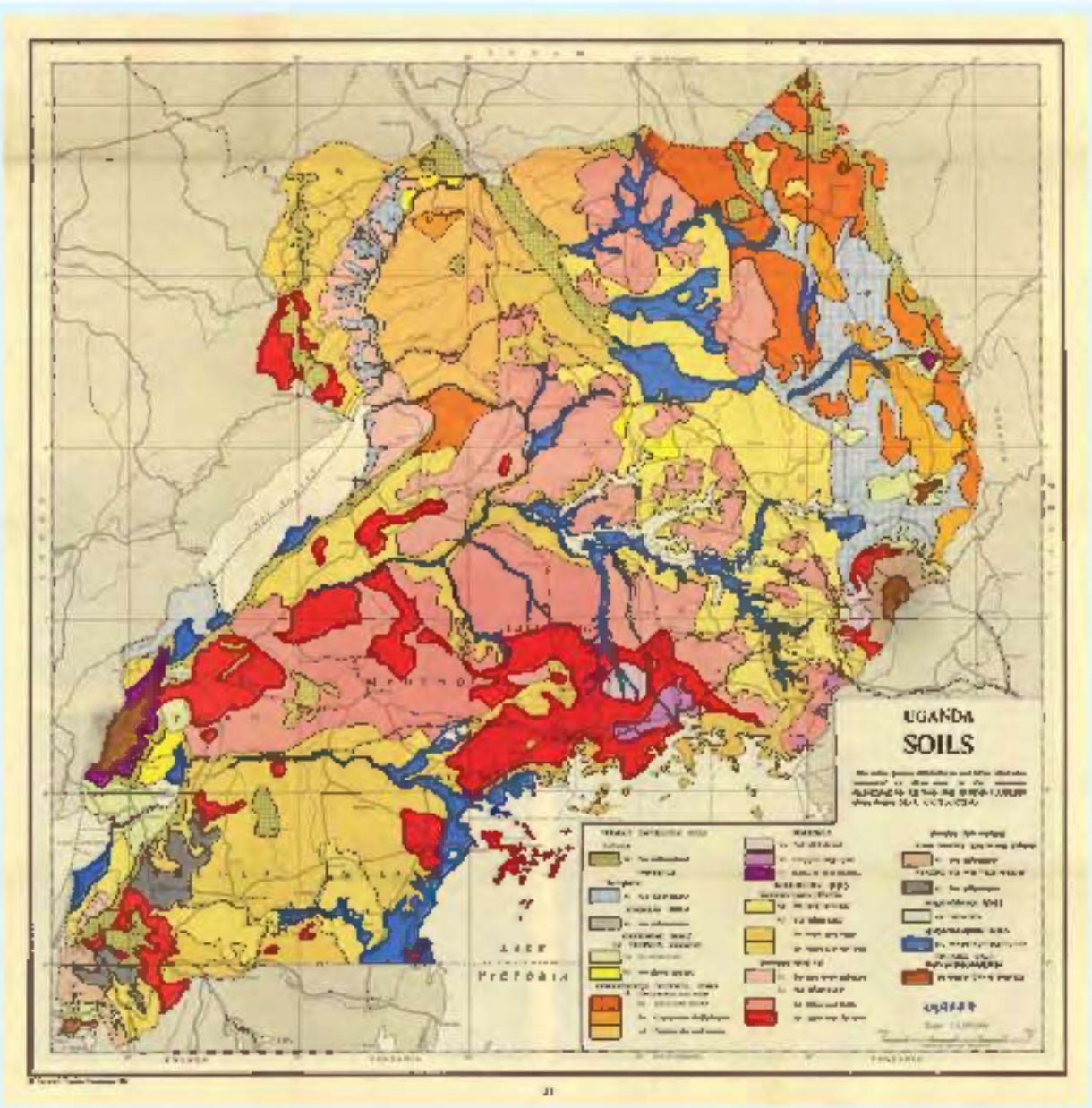

Figure 3.13. Soil types of Uganda[1]

3.4.2 Status and trends

3.4.2.1 Soil degradation through nutrient mining

There is continued soil degradation in the country through nutrient mining as soil nutrients are lost through crop harvest, in addition to other pathways, namely runoff and soil erosion (Kaizzi et al., 2017). Losses could be compensated by application of organic and inorganic fertilizers, but this is not so in Uganda, where fertilizer use is the lowest in the region - just about 1 kg ha-1(Chianu, Chianu and Mairura, 2012). Figure 3.14 illustrates the quantities of nutrients removed as constituents of harvested produce for selected crops, for the period 2019 to 2020, and is based on a similar analysis done in the national state of environment report for Uganda, 2018/2019, under soil health and soil degradation. Generally, 2020 saw an increase in mining of nutrients and trace elements from the soil (Figure 3.15), and the trend is expected to have been maintained in 2021.

1 https://esdac.jrc.ec.europa.eu/content/uganda-soils

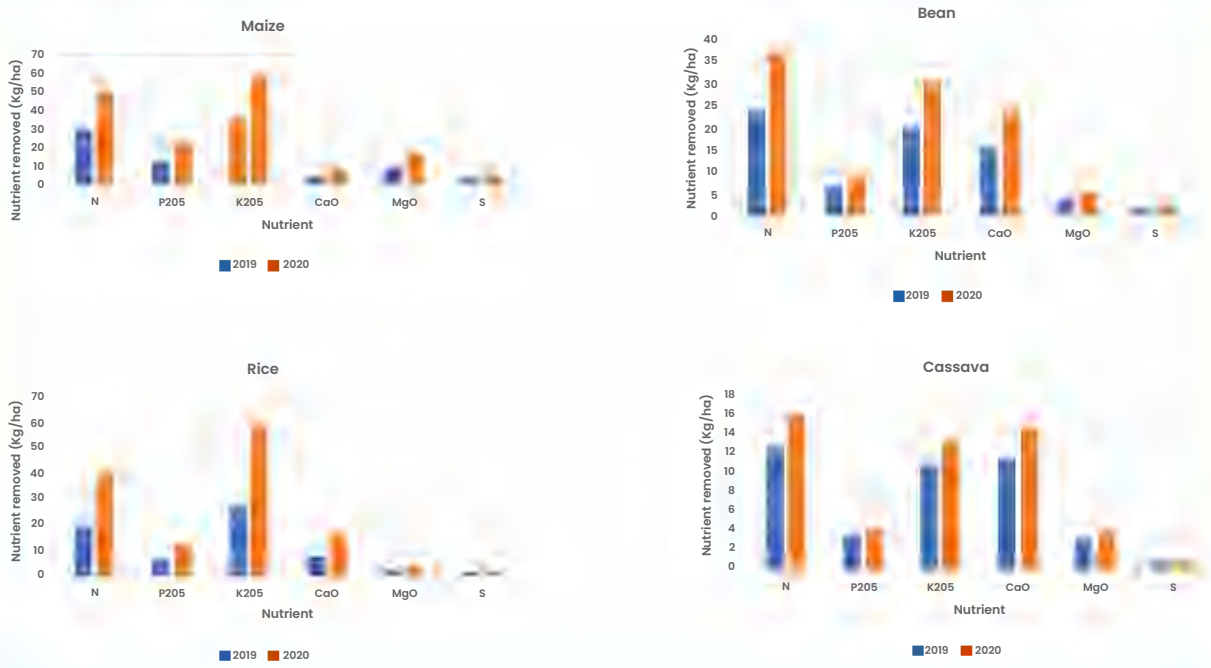

Figure 3.14. Major and secondary nutrients removed as constituents of harvested crop produce during 2019 and 2020 (Source: UBOS Statistical Abstracts of 2020 and 2021).

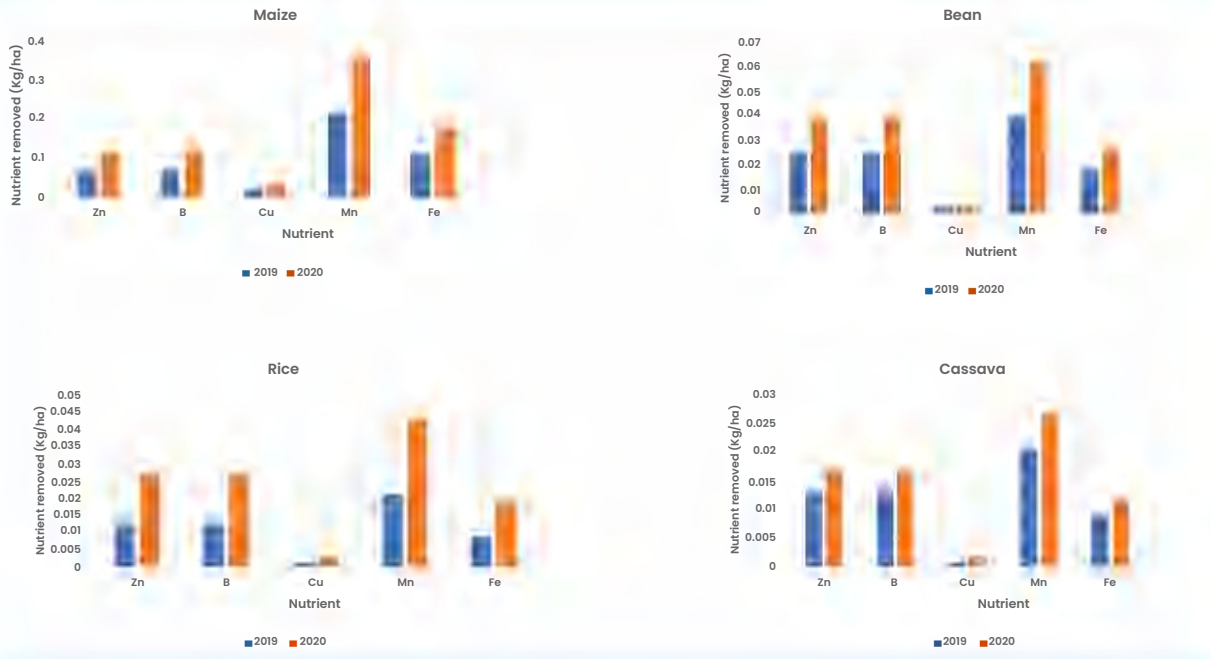

Figure 3.15. Trace elements removed as constituents of harvested crop produce during 2019 and 2020 (Source: UBOS Statistical Abstracts of 2020 and 2021).

Replenishing nutrients removed in harvested produce is important for sustainable soil fertility and high crop production. The quantity of fertilizer required to replenish the nutrients are calculated based on the nutrient content in the different fertilizers, the nutrients in the harvested produce and the target yield for different crops. It is observed that the quantities of fertilizers required are relatively low because of low crop yield. However, with higher yield, more fertilizer will be required as observed for 2019 and 2020, and certainly

going forward. The quantity of fertilizers required after taking into consideration the low fertilizer use efficiency approximated at 40%. Tremendously large amounts of fertilizer are required, yet a significant amount is not taken up by the plants. This stresses the need for farmers to use recommended agronomic practices and follow the 4Rs nutrient steward approach, where these are: right type, right amount, right time and right application method.

3.4.2.2 Expansion of agricultural land

The increasing rate of mining of soil nutrients is notable in the preceding section. This is attributed to a growing population and demand for food, with two major effects. First, farming is mostly intensive, with limited fallowing, and second, more land is opened up for agriculture (Figure 3.16), where land under cassava, beans and plantain increased between 2019 and 2020. Unfortunately, expansion is also happening into environmentally sensitive areas, such as the increasing cultivation and hence acreage of rice in wetlands, pitting farmers against the Government as the latter enforces environmental laws to rid these areas of encroachers.

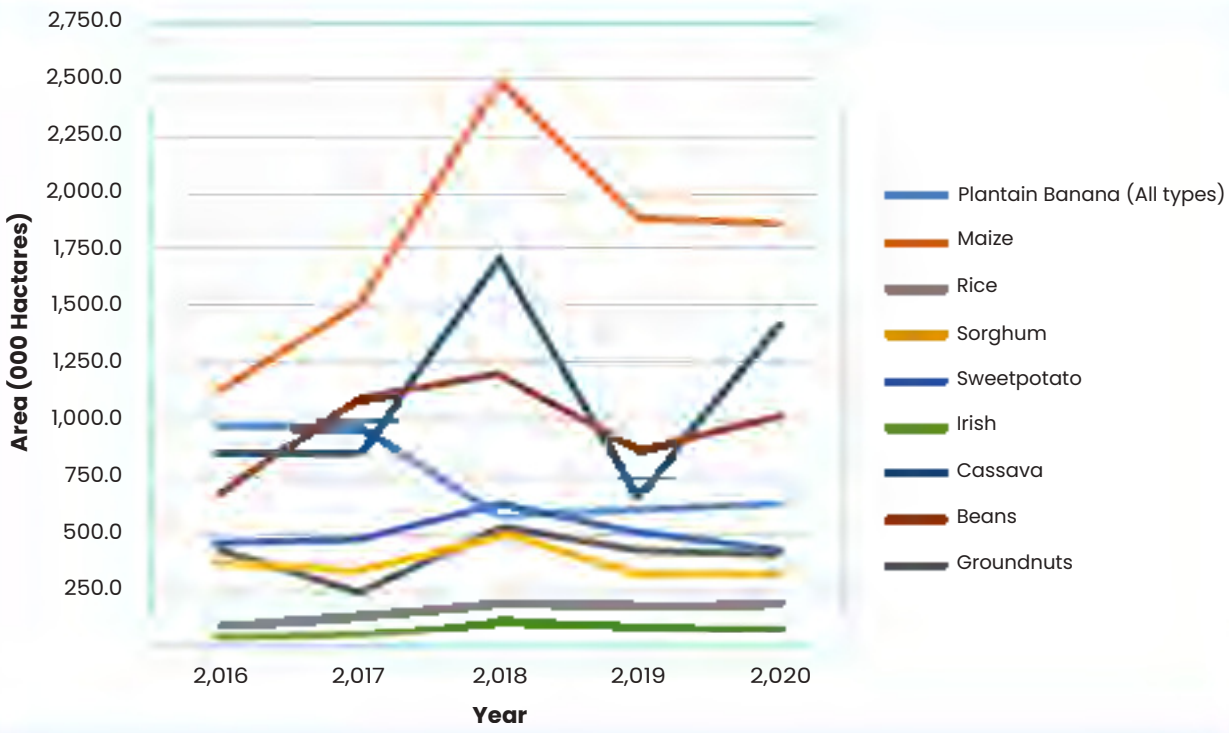

Figure 3.16. Acreage of land under selected crops for the period 2016 to 2020 (Source: UBOS, Agriculture Statistics 2020 and 2021).

3.4.2.3 Soil erosion

Soils erosion continues to be a serious cause of land degradation on most farmlands in Uganda. Unfortunately, there is no recent representative data on the problem, but it is common knowledge that soil erosion has persisted in the highlands and cattle corridor, owing to intensive cultivation and overstocking of livestock, which have to do with a growing population and the demands it imposes on nature. Given that soil erosion affects

the topsoil, it also impacts fertility, because soil fertility largely depends on soil organic matter, mainly in the top 0-30 cm (Foster, 1981). For emphasis, a decrease in soil organic matter affects crop yields because soil organic matter is a major source of nutrients, it improves soil physical properties, acts as a substrate for soil biological activities and maintains ecosystem services.

3.4.3 Implications

Although yields for major crops appear to have increased in 2020 relative to 2019 (Figure 3.17), agricultural production and productivity are low (NDP III). This is partly attributed to low and declining soil fertility, accounting for the persistent low crop yield per unit area of production. This has negative consequences, including food, nutrition and income insecurity, for a significant percentage of the 4.3 million farming households. As such, and on account of the demand, farmers respond by opening up more land for production in areas where this is still possible, or use land continuously without resting it, hence violating the recommended fallow period of three years. In other cases, they have opted using short-term legume fallows, which has its own challenges. Use of herbaceous green manure with no immediate monetary or food value is a constraint because farmers cannot sacrifice land for future soil fertility benefits. As a result, nutrients are generally never returned to the soil to replenish those lost with harvest. But even then, agricultural productivity has remained low (Agro Industrialization Programme Annual Performance Report 2020/21), and at this level, it is not possible to achieve government development objectives in the NDPIII.

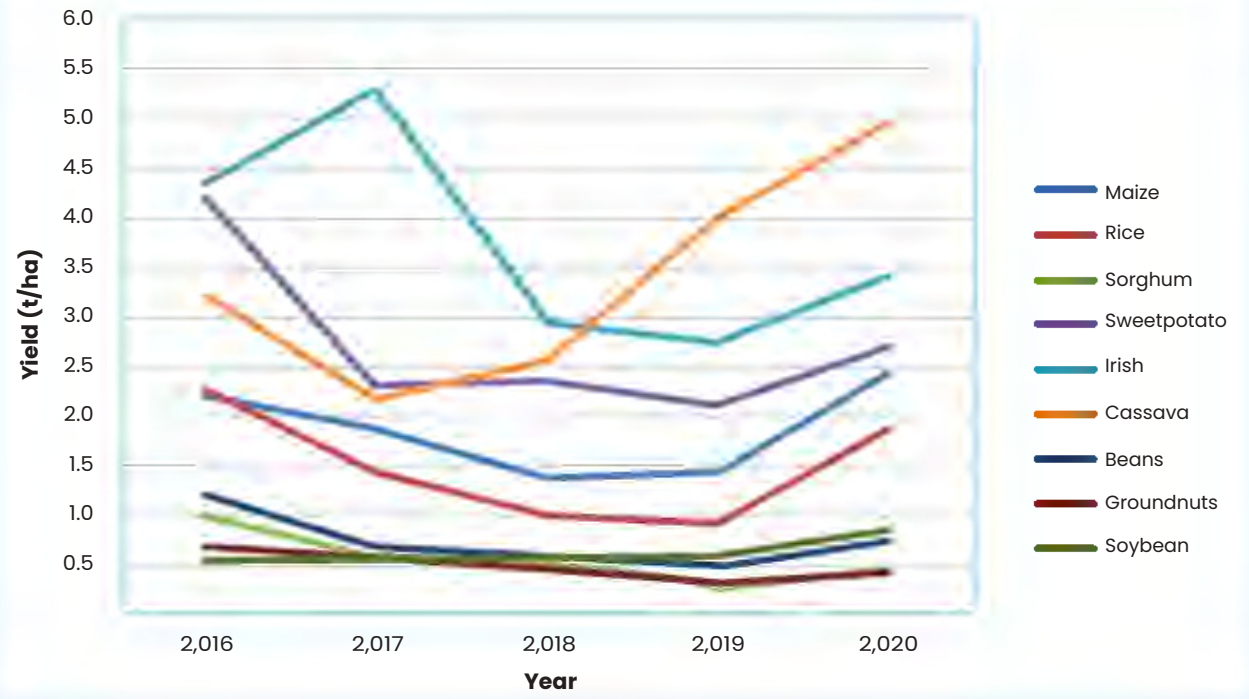

Figure 3.17. Yield of selected crops per unit area over the period 2016 to 2020 (Source: UBOS, Agricultural Statistics 2020 and 2021).

The financial ramifications of mining nutrients are significant, as depicted in Figure 3.18, illustrating the costs of purchasing inorganic fertilizers for selected major crops over two years, with increased production in 2020. Generally, the expense of replenishing nutrients rises with crop yield, correlating with the loss of nutrients during harvest. In contexts where fertilizer use efficiency is low, as observed in Uganda (ranging between 20% to 40%), due to factors like farmer knowledge, the costs become notably high. Figure 3.19 delves into the financial implications of buying inorganic fertilizers per hectare for urea, TSP, MOP, and gypsum, considering a 40% fertilizer use efficiency scenario. A comparison between Figure 3.19 and Figure 3.18 highlights that the expenditure on fertilizers increases with a decrease in fertilizer use efficiency.

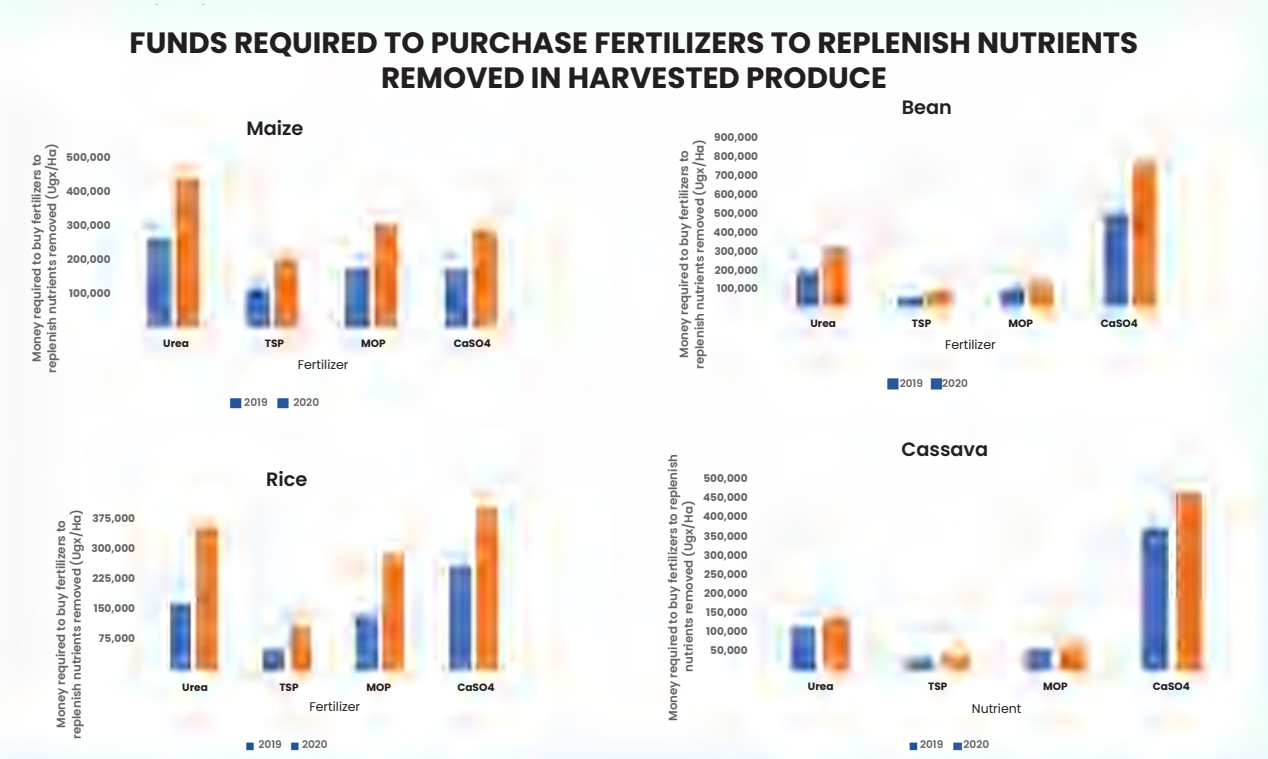

Figure 3.18. The cost of replenishing nutrients removed from the soil with harvested products. (Source of data: Price of 50kg bag of urea and TSP is Uganda shilling 200,000; and MOP is 149,000 and CaSO4 is 370,000 as Quoted from Crop Care – Uganda, and Grainpulse LTD).

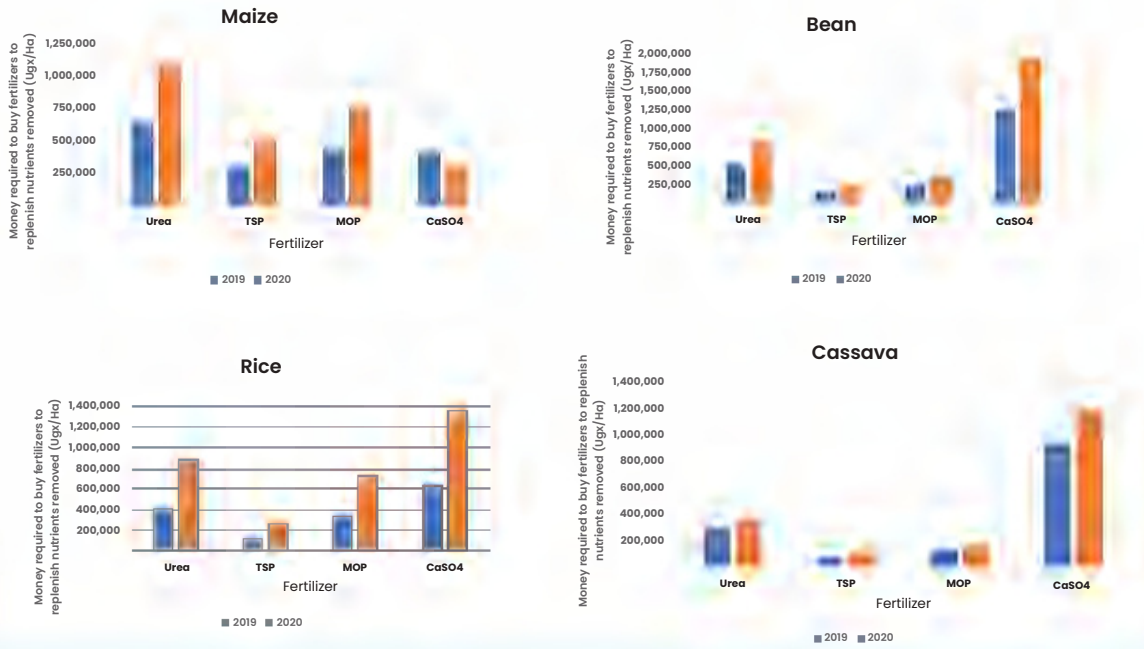

Figure 3.19. The cost of replenishing nutrients removed from the soil with harvested products, at 40% nutrient use efficiency. (Source of data: Price of 50kg bag of urea and TSP is Uganda shilling 200,000; and MOP is 149,000 and CaSO4 is 370,000 as Quoted from Crop Care – Uganda, and Grainpulse LTD).

3. 4.4 Responses

Enhancing and restoring soil fertility through the increased and efficient utilization of inorganic fertilizers is crucial for boosting agricultural production and productivity, aligning with the primary goal of the National Development Plan III (NDP III) 2020/21-2024/25. This objective aims at elevating household incomes and enhancing the quality of life for farmers, aligning with the broader targets of Africa Agenda 2063 and key global commitments like Sustainable Development Goals (SDG) 2, 9, 15, and 15. However, the utilization of fertilizers in Uganda faces challenges, including the high cost of inorganic fertilizers and limited knowledge among extension staff.

The recently formulated Agricultural Sector Strategic Plan 2020/21 to 2024/25 addresses the persistent issue of low fertilizer use by farmers. Among its four priority objectives, one focuses on "increasing access to critical farm inputs," particularly fertilizer, recognized as a vital mechanism for improving soil and overall agricultural productivity. Anticipated impacts include a reduction in malnutrition, elevated income, enhanced food security through higher yields, and a contribution to the export of strategic agricultural commodities.

3.4.5 Recommendations

The recommendations made in the national state of environment report 2018/2019 are still valid, and so far nothing has been done about them. In this report, emphasis is on action on fertilizer use in the country in two areas - review of policy and strategy and capacity building - and propose assessment of soil erosion management across the country.

(a) Reviewing the Fertilizer Policy and Strategy: There is a need to revisit the National Fertilizer Policy of 2016 and the National Fertilizer Strategy so as to take into account the changes since the policy and strategy were developed. This should be done to address constraints limiting or hindering fertilizer use by farmers so that at least nutrient application increases from current 1-4 kg ha^{-1} to closer to the Sub-Saharan average of 17 kg ha^{-1}.

(b) Building the capacity of stakeholder in fertilizer knowledge: Increased use of fertilizers from the current national average of 1 - 4 kg ha^{-1} is required to not only address the low soil fertility and subsequent low crop yield, but also to achieve the NDP III objective of increasing agricultural production and productivity. However, farmers and their advisors have limited knowledge of fertilizers, the suitability of different products on different soils, and are not aware of the 4Rs nutrient steward approach described above. This has led to low fertilizer use efficiency, which is less than 40%. Therefore, building the capacity of stakeholders is required.

(c) Soil erosion control using recommended soil conservation measures: A meta-analysis of studies of soil erosion and conservation should be undertaken so as to guide the development of landscape-specific soil conservation strategies for use by extension workers and farmers. This will go a long way to support efforts to conserve soil across the country.

3.5. Minerals and Energy

3.5.1 Minerals

3.5.1.1 Status of the mining sector

Uganda has abundant minerals distributed across the country (Figure 3.20), which are increasingly exploited. Over the past 10 years, the formal mineral sector has experienced an annual growth rate averaging 10.9%. Medium to large scale production is currently undertaken for a range of minerals, including limestone, pozzollana, kaolin, gold, tin, tantalum, tungsten, vermiculite, among others. Large scale mines for phosphates, iron ore, copper-cobalt and marble are under development. Figure 3.21) below, is a map of concessions in different parts of the country, highlighting the level of development of the mining sector.

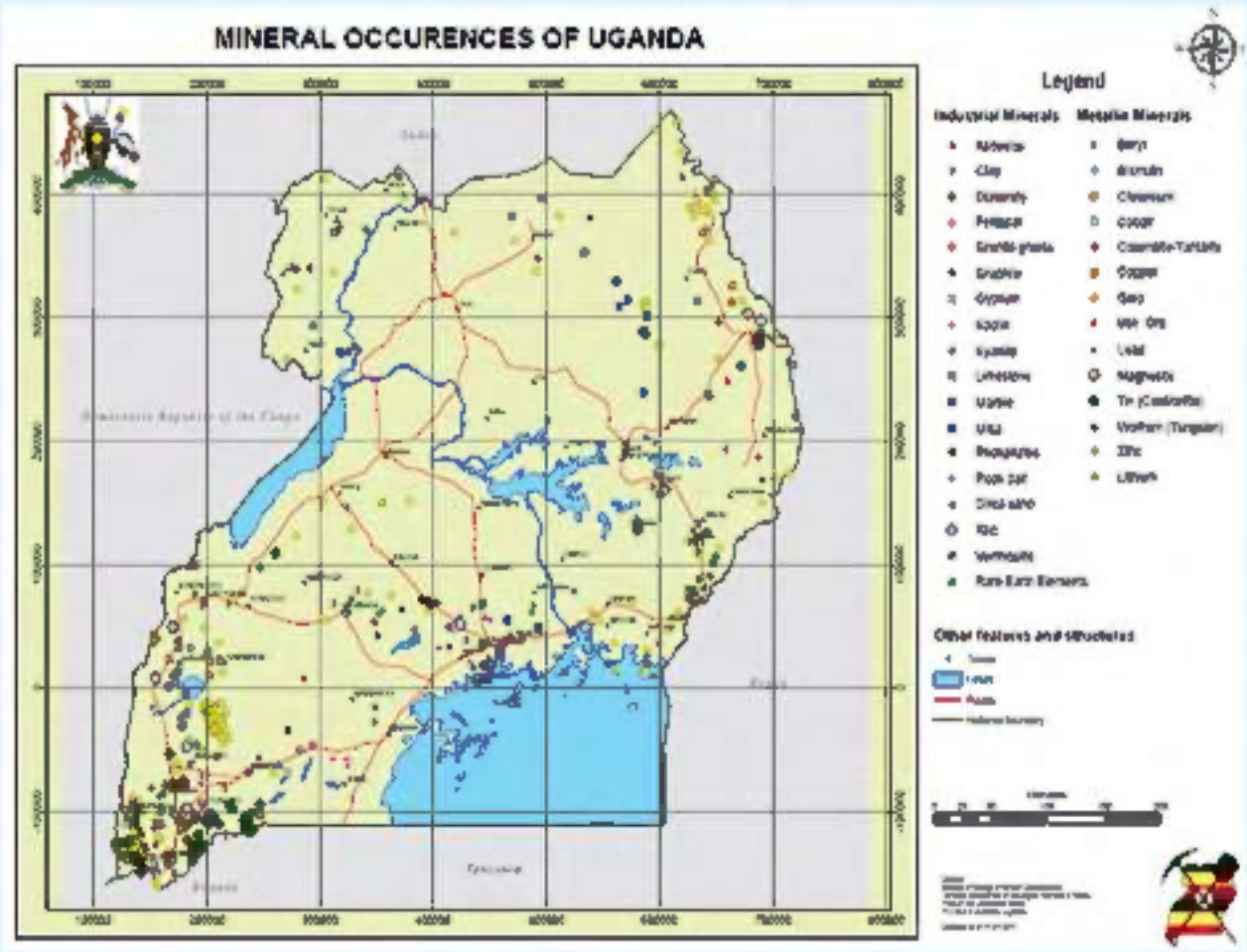

Figure 3.20. Occurrence of minerals in Uganda.

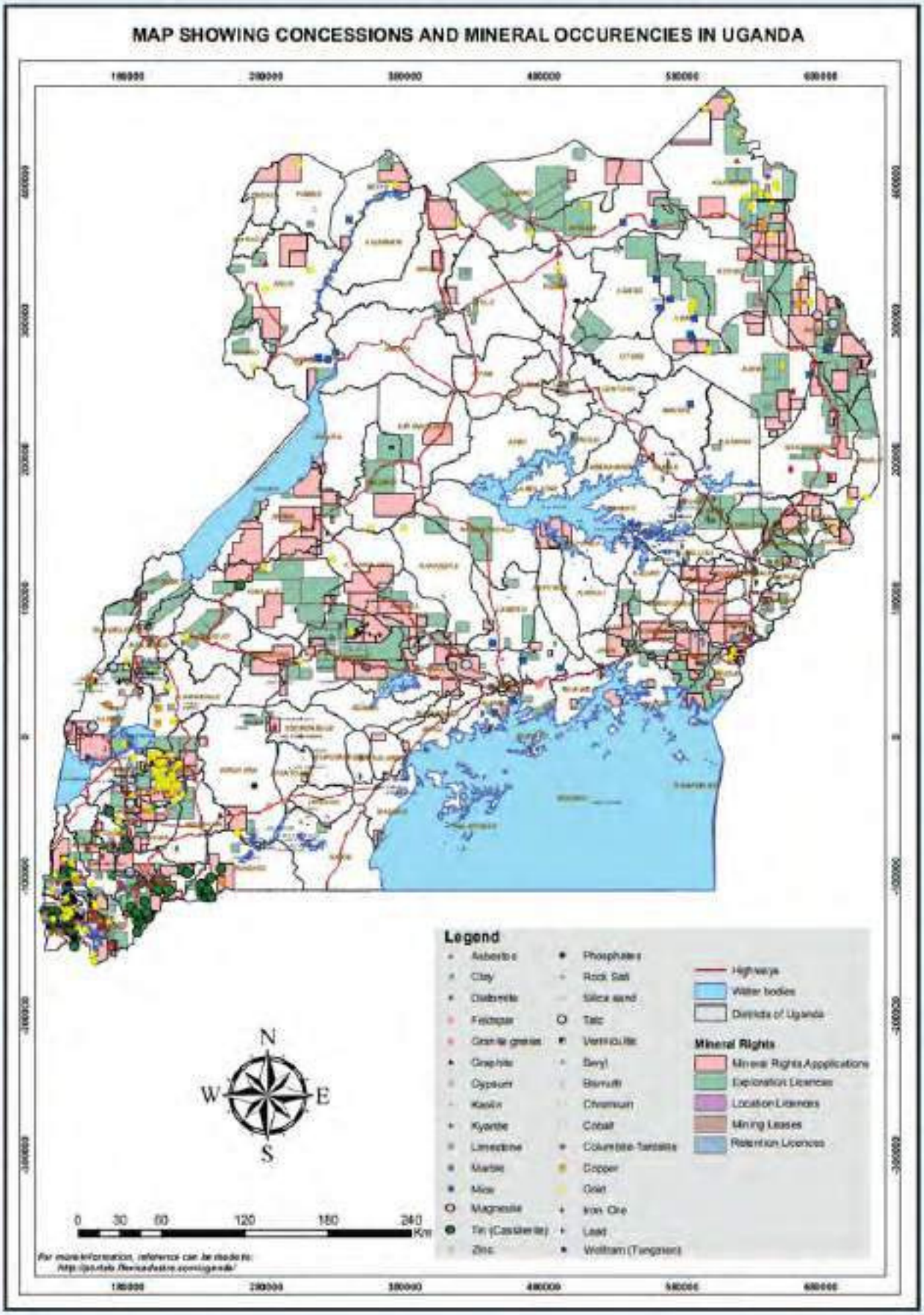

Figure 3.21. Map showing mining concessions as at the time of writing this report.

Artisanal mining has persisted, and is associated with serious environmental impacts, whose mitigation is constrained by absence of policies, strategies and regulations. The government has put in place a strategy targeting artisanal and small-scale mining (ASM), aimed at strengthening regulatory oversight through formalization, appropriate licensing, biometric registration of miners and harnessing sustainable mining, among other outcomes.

3.5.2.2 Impacts of mining on the environment

Mining is often carried out at a huge cost to the environment. It disfigures land, oftentimes is associated with tillings known to contaminate water and land, is associated with loss of vegetation and forest degradation, is responsible for loss of important cultural heritage, causes noise pollution and generates dust, some of which is hazardous. In other cases, mined areas are not rehabilitated, leaving derelict land with pits, which pose a risk to people and grazing animals in the neighbourhood.

Where mercury is used in the mining process, surrounding ecosystems are at risk of pollution because the quantities of mercury are substantial. A study in Uganda in 2019-2020 found a large proportion of gold mining based on the use of mercury (NEMA, 2020). Slightly lower than where cyanide is used, but higher than the use of gravitation (Figure 3.22). This translates to a large release of mercury in the air (19,926 kgyr-1), land (4,770 kgyr-1) and water (3,719 kgyr-1), more so by artisanal miners who use crude mining technologies. Indeed, this study reported artisanal gold miners to contribute about 60% (i.e., 18,495 kgyr-1) of total annual mercury releases.

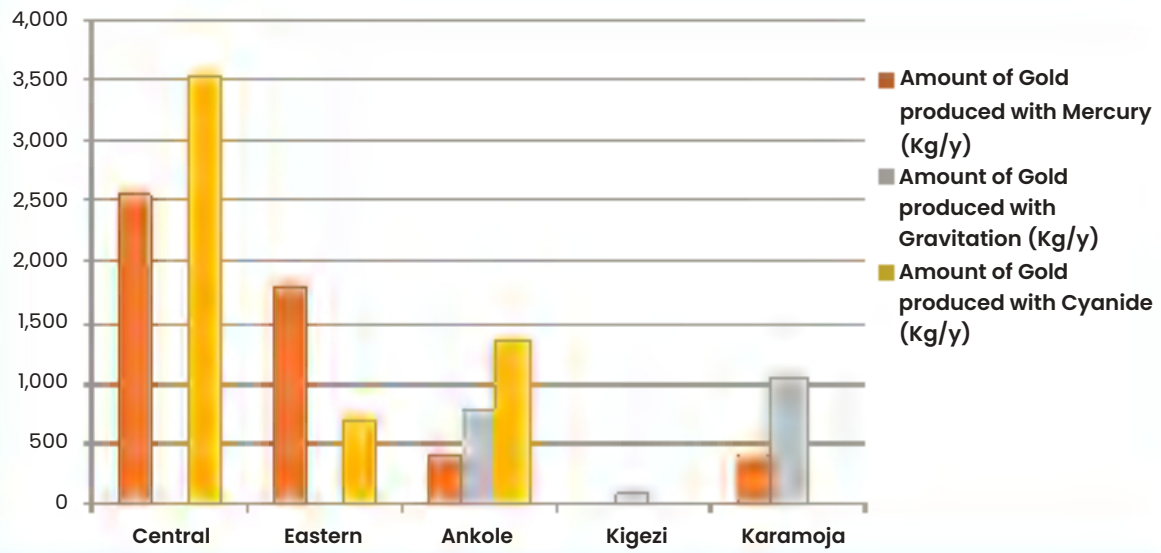

Figure 3.22. Quantity of gold extracted using mercury, gravitation and cyanidation. (Source: The NEMA study of 2019-2020).

3.6. Energy

3.6.1 Electricity capacity and generation

Uganda's power generation is mainly diversified across four (4) different sources as follows (Figure 3.23)

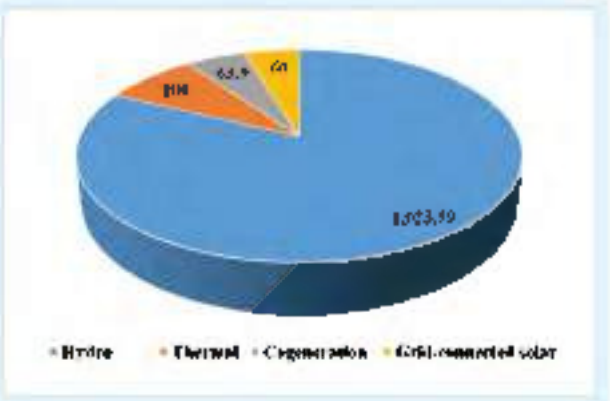

Figure 3.23. Uganda power generation Megawatt (MW)

Uganda's electricity sub-sector has grown from three generation plants in 2001 to over 40 plants and is still growing. The Total Installed Generation Capacity has grown from 60 MW in 1954, 400 MW in 2000 to 1237.49 MW as of October 2020. Figure 3.24 shows the capacity of the hydropower dams by 2020.

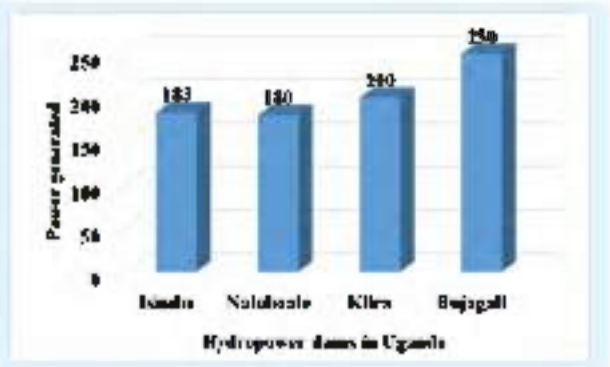

Figure 3.24. Capacity of hydropower dams in Uganda

3.6.2 Projects under construction

3.6.2.1 Karuma Hydropower Project

Karuma Hydropower Project is located on the Nile River in Kiryandongo District in mid-northern Uganda, about 110km downstream of Lake Kyoga, and 270km from Kampala, the Capital of Uganda. Physical progress is currently at 98.5%. It is envisaged that it will have the capacity to generate 600 MW.

3.6.2.2 Muzizi Hydropower Project

Muzizi Hydropower Project (HPP), is to be developed at the lower course of the Muzizi River in western Uganda, south east of Lake Albert with the powerhouse approximately 6km upstream of Lake Albert at the eastern flank of the Albertine Graben. It will generate up to 48 MW.

3.6.2.3 Nyagak III Small Hydro Power Project

The proposed Nyagak III Small Hydropower Project (SHPP) is located in Paidha Sub-County, Zombo District. By end of August 2020, actual progress for civil and penstock works was at 20.8%. It is projected to generate up to 6.6MW.

3.6.2.4 Solar Energy

There are four major solar plants in Uganda and these include the 20 MW plant in Kabulasoke district, Central Uganda, 10 MW Soroti power plant in Soroti district, Eastern Uganda, 10 MW Simba Telecom Tororo power plant, and Tryba energy's 10 MW Mayuge power plant. The other 10 MW are generated by small other solar plants.

3.6.3 Distribution of electricity sources

Table 3.2 illustrates that a significant portion of Uganda's electricity production in 2020 originated from renewable sources. Figure 3:25 provides a breakdown of various categories within renewable energy sources along with the corresponding power generation quantities in 2020.

Table 3.2. Installed Electricity Capacity of Uganda in 2020

Capacity in 2020	MW	%
Non-renewable	103	8
Renewable	1 184	92
Hydro/marine	1 011	79
Solar	77	6
Wind	0	0
Bioenergy	96	7
Geothermal	0	0
Total	1 287	100

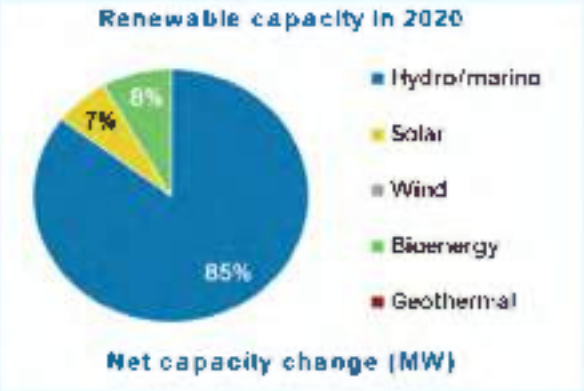

Figure 3.25. Renewable Energy Capacity in 2020

Energy firms operate across different regions of the nation, contributing to the improved accessibility of electricity. The figures for energy purchase and energy sold have risen from 3,161.9 and 2,535.2 in 2015/2016 to 3,898.6 and 3,223.0 in 2019/2020, as depicted in Figure 3.26.

Figure 3.24. Capacity of hydropower dams in Uganda

3.6.4 Pressures and impact of the energy sector

Majority (75 percent) of the Ugandan population is rural and does not have access to the electricity grid. As a result, they depend on biomass for basic household energy needs. Direct combustion of fuel for energy in the residential sector energy was approximately 369,000 TJ (Ministry of Energy and Mineral Development, 2019), of which the vast majority (almost 90%) was from biomass sources.

Demand for wood fuel in Uganda is projected to reach between 100 and 210 metric tonnes per year by 2040. The use of wood energy is one of the drivers of deforestation and forest degradation. Biomass is the primary source of energy in all the sectors apart from transport and service sector and thus a significant source of environmental foot print in terms of forest and woodland cover. Almost 90% of the households in Uganda use biomass for their energy.

Generation of electricity, transmission and distribution of power to both household and industrial use significantly affect the environment in terms of emission of greenhouse gases. The emissions under the business-as-usual scenario in the energy sector (excluding transport) will increase from 6.2 MtCO2e by 2015 to about 12 MtCO2e by 2030 (Figure 3.27).

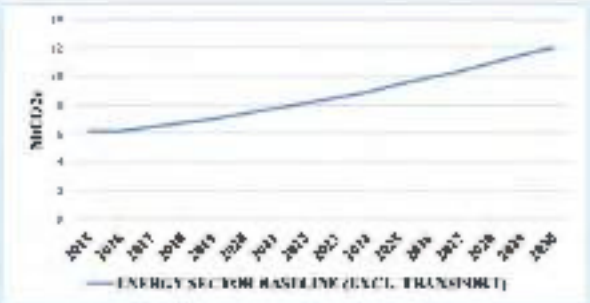

Figure 3.27. The projected greenhouse gas emissions for the energy sector

The energy sector is the second largest source of emissions in Uganda. It accounts for 10.8% of the emissions (MWE, 2019)

3.6.5 Responses

a) Increase access to reliable, affordable and modern energy services
b) Improve energy sector governance, capacity building and integrated planning of educational institutions, especially technical and vocational institutions
c) Promote renewable and alternative energy
d) Raise public awareness on energy resources, services and programmes
e) Create incentives for emerging energy efficient technologies
f) Address barriers to clean energy uptake by industries and the population
g) Support research and innovation in clean energy
h) Restore degraded woodlands to ensure stable biomass supply
i) Promote growing of biomass energy tree species
j) Promote energy efficient kilns

3.7. Petroleum Resources

3.7.1 Resource base

Currently, Uganda's petroleum resources are estimated at 6.5 billion barrels of Stock Tank Oil-Initially-In-Place (STOIIP), of which 1.4 billion barrels are estimated to be recoverable. In addition, gas resources are currently estimated at 500 billion standard cubic feet (BCF). There is potential for additional resources in the country expected from the 60% of the Albertine Graben that is unexplored and Moroto-Kadam, Lake Kyoga and Hoima basins that are yet to be explored.

To date, 21 oil and gas discoveries have been made in the country out of the 31 prospects drilled, putting the prospect success rate in the Albertine Graben at 68%. One hundred and twenty-one exploration and appraisal wells have been drilled with 106 wells encountering oil and/or gas which is an unprecedented drilling success rate of over 88%.

3.7.2 Sedimentary Basins

Uganda is characterized by six sedimentary basins: The Albertine Graben, Hoima Basin, Moroto-Kadam Basin, Lake Kyoga Basin, Lake Wamala Basin, and Lake Victoria Basin (Figure 3.28). Among these, the Albertine Graben stands out as the most prospective and holds the highest potential for petroleum exploration and production in the country. Ongoing investigations are being conducted to assess the petroleum potential of the Hoima Basin, Moroto-Kadam Basin, and Lake Kyoga Basin. In contrast, the Lake Wamala Basin and Lake Victoria Basin are considered less prospective due to their thin sediment thicknesses, which are deemed insufficient for petroleum generation.

3.7.2.1 The Albertine Graben

The Albertine Graben constitutes the northernmost section of the western arm within the East African Rift System. It extends from the northern border shared by Uganda and South Sudan to the southern shores of Lake Edward, covering a total distance of around 500km and maintaining an average width of 45km. This geological formation spans the borders of both Uganda and the Democratic Republic of Congo, with the Ugandan segment encompassing an area of about 23,000km^2.

3.7.2.2 The Moroto-Kadam

The Moroto-Kadam Basin is located in north-eastern Uganda covering the districts of Moroto, Napak, Nakapiripirit, Katakwi, Kween, Bulambuli, Kumi, Bukedea and Bukwo. It is predominantly a flat terrain measuring approximately 81km in width and 74km in length with a total surface area of approximately 5,672km^2.

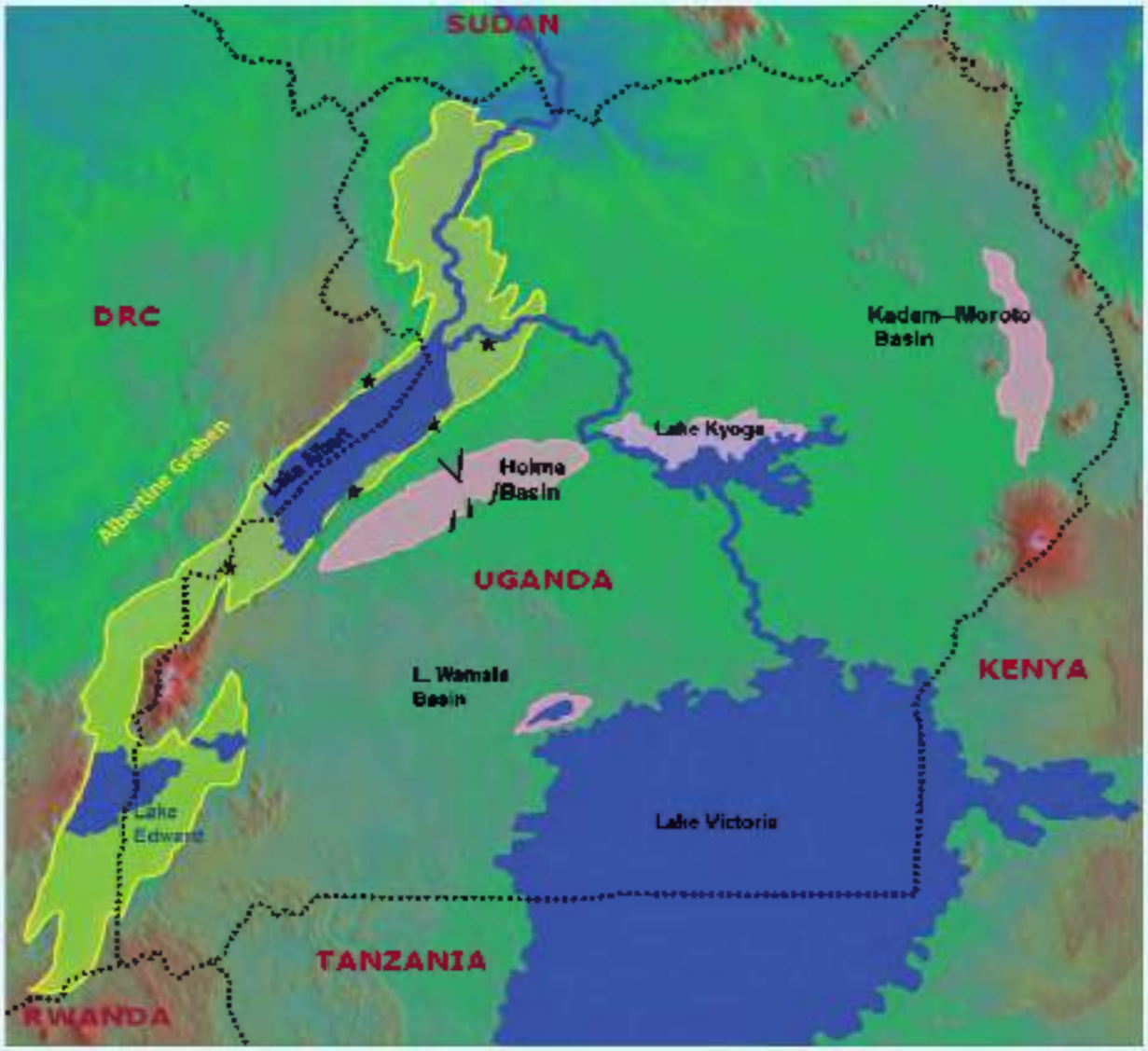

Figure 3.28. Map showing the sedimentary basins in Uganda

3.7.2.3 The HoimaBasin

Hoima Basin is an old sedimentary basin which lies to the east of the Albertine Graben, trending parallel to the rift strike direction. The basin occupies current districts of Kibaale, Hoima, Kikuube, Masindi and Buliisa, covering an approximated area of 3741km^2.
3.7.2.4 The Kyoga Basin

Lake Kyoga basin is found in central region of Uganda covering parts of Amolatar, Kaberamaido, Dokolo, Buyende, Apac, Serere, Soroti, Pallisa, Ngora and Nakasongola districts with an approximated area of 7,831km^2.

3.7.2.5 The Lake Victoria and Lake Wamala basins

Lakes Victoria and Wamala basins are situated in the central part of the country (Figure 3.29). Aeromagnetic surveys conducted in 1992 identified a thin sediment thickness which is considered not sufficient for the generation of petroleum.

8.6 Status of petroleum activities/developments

3.7.3 Licensing and exploration

Currently, approximately 15% of the Albertine Graben is licensed to four oil licensees and eight petroleum production licences have been issued in the Albertine Graben. UNOC is mandated to manage 15% participating interest in all the production licences issued on behalf of the state.

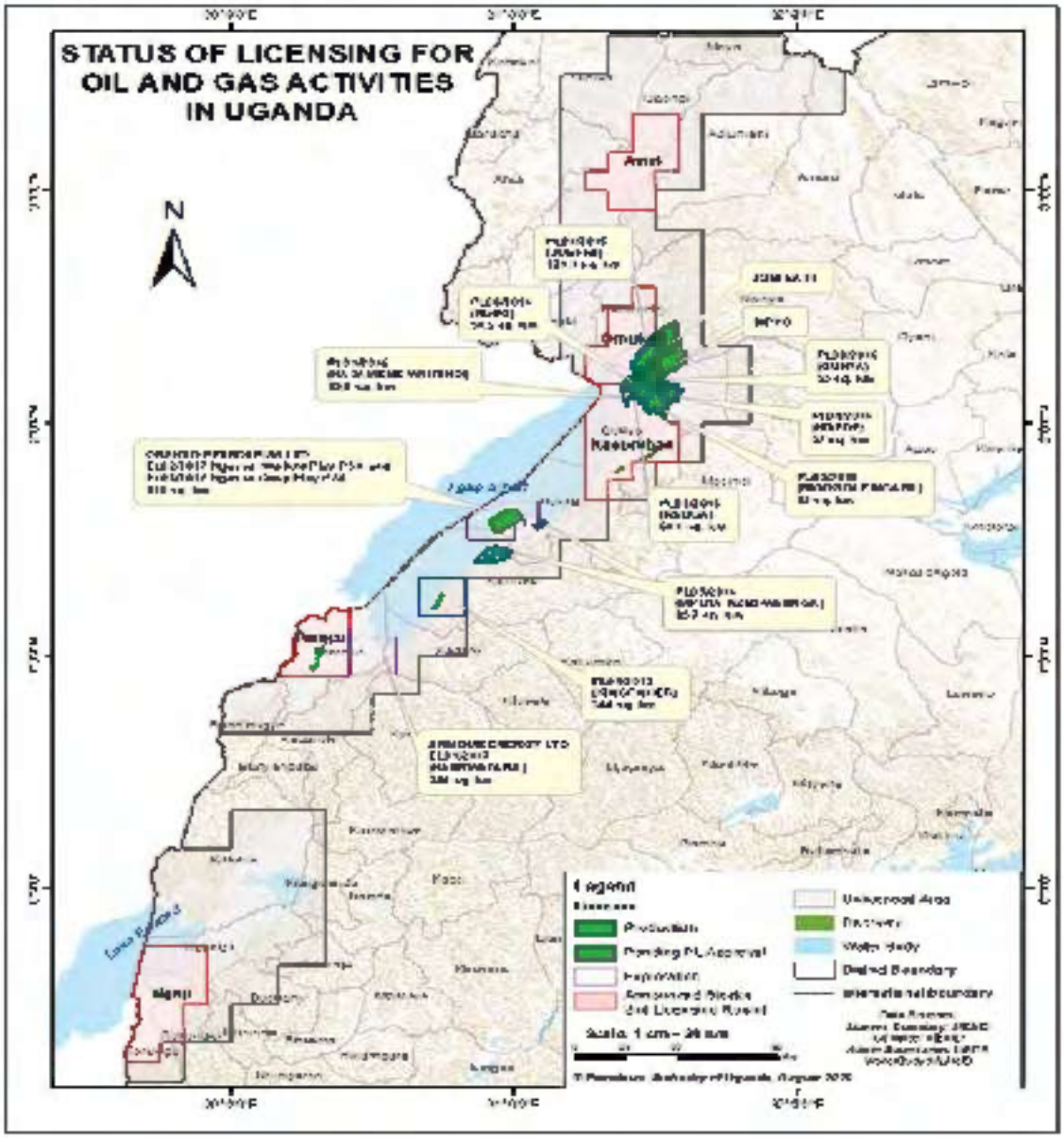

Figure 3.29. Map showing the status of petroleum licencing in the Albertine Graben as at August 2020

3.7.3.1 Upstream Petroleum Development and Production

The development of the fields is ongoing through two upstream development projects. These are: Tilenga Project which constitutes fields from Contract Area 1 (CA1) and Licensing

Area 2 (LA2) under the operatorship of Total Energies E&P Uganda, and the Kingfisher Development Area project (KFDA) under the operatorship of CNOOC Uganda Limited (CUL).

The Final Investment Decisions (FIDs) for development projects have been taken and the engineering, procurement and construction (EPC) has commenced. The magnitude of these projects and the planned duration of their execution towards production will lead to a steep ramp up in activities, hence the need to fully regulate the sector.

3.7.3.2 Midstream projects

There are a number of projects under development and planned in the midstream petroleum segment. These include the East African Crude Oil Pipeline (EACOP), refinery, product pipeline, storage and distribution terminals. The FID for the EACOP was taken and the EPC phase commenced. The refinery project's final FEED is completed and awaiting FID to be taken.

3.7.4 Enabling infrastructure

Kabaale Industrial Park (KIP)

Kabaale Industrial Park (KIP) is a petro-based industrial park that will be developed on 29.57km2 of land in Hoima District. It is a specialised and extra ordinary industrial park that has been zoned to be developed as a strategic commercial venture that will accommodate anchor projects such as the refinery, the second largest international airport and crude export hub. In addition, it will host petro-based industries such as plastics, fertilizers and petrochemicals, among others.

3.7.4.2 Kabaale International Airport

The government is developing an international airport to support the petroleum sector, and tourism operations, among others. The construction of Kabaale International Airport (KIA) which includes, a Code 4F runway (which can handle big and heavy aircraft), taxiway, apron, multi-purpose terminal building for cargo and passengers, fire station, car park, access road, perimeter fence and electrical centre, among other facilities. The airport will support delivery of some of the equipment required for the upstream and midstream projects, together with the transportation of personnel.

3.7.4.3 Critical oil roads

The construction of approximately 660 kilometres of road infrastructure to support the petroleum operations in the country is ongoing.

3.7.4.4 Natural gas pipeline

Development of the natural gas pipeline from Tanzania to Uganda is being explored to provide natural gas for iron and steel industry in Uganda. In this regard, a memorandum of understanding (MOU) was executed between the governments of both countries.

3.7.5 Pressures and impacts

(i) Noise pollution due to blasting of rocks during exploration and blasting of rocks to acquire materials for construction.
(ii) Soil erosion due to clearing of vegetation during road/camp/pad construction.
(iii) Wildlife disturbance due to increased human activity and noise from blasting of rocks.
(iv) Road kills of wildlife and domestic animals by public traffic on "oil roads"
(v) Displacement of important cultural heritage in areas earmarked for oil and gas infrastructure.

3.7.6 Responses

a) A multi-institutional monitoring team from NEMA, PEPD, UWA, National Forestry Authority (NFA), DWRM, and Directorate of Fisheries Resources together with the respective district environment officers continually monitor the activities.
b) A Strategic Assessment for oil and gas activities has also been developed to ensure that environmental concerns are included in all government plans, programmes and policies.
c) A National Oil Spill Contingency Plan was prepared in 2020 to address the risks and vulnerabilities identified in the Environmental Risk Assessment in the oil and gas sector.
d) Implementation of ESIA for all activities as prescribed in the law.
e) Environmental Sensitivity Atlas for the AG, an Environment Monitoring Plan, and an Enforcement Strategy together with guidelines for waste management and operations in protected areas have been developed.

3.7.7 Recommendations

(i) Strengthening of the infrastructure and human resource of agencies mandated to enforce social and environmental safeguards in areas of oil and gas exploration, production and development
(ii) Regular and effective monitoring activities of contractors in the oil and gas sector to ensure implementation of environmental safeguards
(iii) Building capacity of all lead agencies involved in ensuring environmental sustainability in oil and gas sector

3.8. Biodiversity

Biodiversity, derived from 'Biological Diversity,' refers to the different variety of all living organisms on earth and the different habitats (Adom et al., 2019). As defined by Article 2 of the Convention on Biological Diversity (CBD), it encompasses the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Uganda is endowed with a great biodiversity of animal and plant species which forms the foundation of the wildlife economy (Snyman et al., 2021). Essential to Earth's life support system, biodiversity is the cornerstone of all ecosystem services. It plays a pivotal role in sustaining and enhancing the global population by providing fundamental natural services such as freshwater, fertile soils, and clean air. Furthermore, the concept of biodiversity also encompasses genetic diversity, species diversity, and ecosystem diversity.

Biodiversity contributes to the broader category of 'Biological resources which includes genetic resources, organisms, populations, or any other biotic components with actual or potential value for humanity. These resources are integral to the well-being of human societies, offering benefits such as medicinal discoveries, food security, and ecological balance.

3.8.1 Benefits of Biodiversity

Biodiversity provides a myriad of benefits through the Ecosystem Services framework, crucial for the well-being of human societies (Figure 3.30). In terms of provisioning benefits, diverse ecosystems including forests offer essential resources such as food, medicine, and raw materials to mankind (Kusiima et al., 2022). Regulating benefits involve natural processes that maintain balance in ecosystems including climate regulation, with forests acting as carbon sinks, mitigating the impacts of climate change. Additionally, diverse

ecosystems help in pest control, as various species maintain ecological balance; for example, predators controlling insect populations in agriculture (Jankielsohn, 2018).

Figure 3.30. Ecosystem services framework (Source: Worldwide Fund for Nature Report 2016)

Supporting benefits of the ecosystem include services that uphold the structure and functioning of ecosystems (Kusiima et al., 2022). Biodiversity aids in soil fertility through the activities of microorganisms, supporting agriculture. Furthermore, the genetic diversity within species ensures adaptability and resilience, as seen in crop varieties that withstand diverse environmental conditions.

Cultural benefits of biodiversity highlight the aesthetic, recreational, and spiritual value of biodiversity. Natural landscapes and diverse ecosystems contribute to tourism and recreational activities, promoting physical and mental well-being. Furthermore, various cultures derive spiritual and symbolic significance from specific plant and animal species, emphasizing the interconnectedness of biodiversity with human culture and identity.

3.8.2 Biodiversity and pollination

Biodiversity plays a pivotal role in pollination, benefiting various ecosystems and agricultural systems (Katumo, 2022). The complex relationships between plants and their pollinators contribute to the reproduction and genetic diversity of plant species. Diverse pollinator species, including bees, butterflies, birds, and other insects, facilitate the transfer of pollen between flowers, ensuring the fertilization and production of seeds.

The pollinating services provided by biodiversity are fundamental to the production of numerous crops that humans rely on for food, including fruits, vegetables, and nuts. This process directly impacts agricultural yields and, consequently, global food security. Across Tanzania, Malawi, Uganda, Nigeria, and Ethiopia, a total of 137 food crops are cultivated, with a notable reliance on pollinators for 77 of these crops. On average, this translates to approximately 1193 kg of pollinator-dependent crops produced per household annually.

Intriguingly, Uganda leads the Sub-Saharan African countries in generating the highest proportional yields of pollinator-dependent crops per household, followed by Nigeria, Tanzania, Ethiopia, and Malawi, as per findings by Kumsa and Ballantyne in 2020. However, concerns arise regarding the sustainability of this agricultural resource due to potential threats to the rich pollinator diversity in Sub-Saharan Africa. The region faces challenges stemming from the escalating use of fertilizers and pesticides, practices that could undermine the crucial role of pollinators in crop production (Kayuki et al., 2017). The delicate balance between agricultural intensification and the preservation of pollinator habitats raises questions about the long-term viability of these practices in sustaining food security.

Thus, there is a pressing need to address and mitigate the potential risks associated with the intensification of agricultural methods to ensure the continued resilience of pollinator-dependent crop yields in the region.

3.8.3 Biodiversity and Tourism

Uganda boasts twelve National Parks and three active game reserves, offering a diverse array of tourism products. These attractions include gorilla tracking, nature-guided walks, village excursions, butterfly and bird watching, as well as the opportunity to explore rare fauna and flora species. Notably, Murchison Falls and Queen Elizabeth National Parks stand out as the most frequented destinations, as illustrated in figure 3.31.

Over the years, there has been a positive trend in tourism, with a notable increase in the number of both local and foreign tourists to Uganda National parks. In 2017, the country welcomed 285,671 tourists to the various national parks in the country, a figure that rose to 323,861 in 2019. However, the global impact of the Covid-19 pandemic in 2020 led to a substantial drop in tourism, with only 101,331 visitors recorded in the various national parks across the country. Despite the challenges posed by the pandemic, there was a modest recovery in 2021, witnessing an increase in the number of tourists to 189,988. The fluctuation in tourism numbers highlights the resilience of Uganda's tourism sector in the face of external challenges, with efforts to adapt and recover evident in the post-pandemic rebound. The diverse attractions offered by the National Parks and reserves continue to position Uganda as an appealing destination for nature enthusiasts and wildlife lovers.

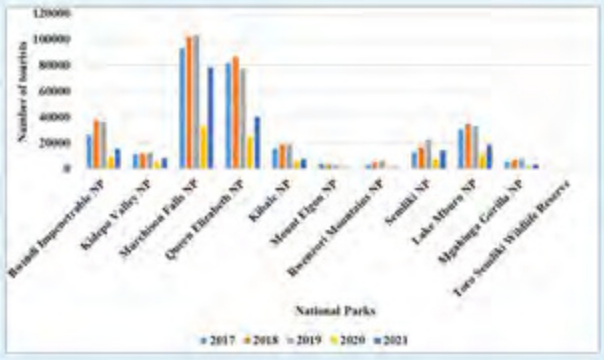

Figure 3.31. Visitors to National Parks (Citizens and Foreigners), 2017 – 2021 (Data Source: UBOS Statistical Abstract, 2022)

3.8.4 Ecosystems Diversity

8.8.4.1. Hilly and Mountainous

Uganda's hilly and mountainous regions, characterized by delicate ecosystems, face escalating threats due to a surge in population. The primary drivers for this vulnerability are agricultural expansion and burgeoning human settlements. These activities, incompatible with the fragile nature of these areas, have triggered a destructive cycle, leading to recurrent landslides, particularly in the Rwenzori and Mt Elgon regions. Tragically, each landslide event results in the loss of both property and human lives.

The pressing concern revolves around the clash between human activities and the intricate balance of these terrains. As agricultural endeavors and settlements encroach upon these hilly landscapes, the natural equilibrium is disrupted, paving the way for devastating consequences. The pronounced consequences of this clash are most evident in the form of landslides, a recurring menace that looms over these regions.

The urgency lies in addressing the root causes of this conflict to safeguard both the environment and the livelihoods of the communities inhabiting these precarious areas. Striking a harmonious balance between sustainable practices and the preservation of these fragile ecosystems is vital to mitigate the ongoing risks and protect the well-being of the people and the land.

3.8.5 Pressures and impacts

An overwhelming 95% of the population in Uganda relies on firewood and charcoal for cooking, contributing to a concerning drop in forest cover in the Mbarara District from 20% to 8% (DDP III, 2020-2025). Bamwesigye et al.'s 2020 study also identified charcoal and firewood biomass utilization as the primary driver of deforestation in Uganda. This unregulated tree felling for these energy sources has systematically stripped once-lush hills, underscoring the severe environmental repercussions.

A study by Opedes et al., 2022 showed that in 1978, the dominant land cover was tropical high forest well-stocked (43.64%), grassland (15.55%), and agriculture (10.63%). However, by 2020, this trend changed to the major land cover being agriculture (30.43%), tropical high forest well-stocked (21.63%), and tropical high forest low-stocked (18.96%). This finding showed that there has been great deforestation and loss of natural vegetation cover within the mount Elgon over time. Similarly, Iacopino et al.'s 2022 study highlights human population pressures as a major factor in deforestation and degradation around Mount Rwenzori, affecting biodiversity and altering landscape functions such as watershed protection and carbon sequestration. These findings underscore the urgent need for sustainable practices to preserve Uganda's diverse ecosystems.

3.8.6 Responses

In collaboration with UNEP and the National Strategy for Advancement of Rural Women in Uganda (NSARWU), NEMA initiated a successful project for the restoration of degraded bare hills in Ntungamo District. The project's success in Nyamukana Town Council prompted NEMA, in collaboration with NSARWU and UNDP, to upscale the restoration activities. This expansion involved the establishment of community tree nurseries at Hakashenyi Church of Uganda (C.O.U) and Bucuro C.O.U, both located in Buhanama Parish, Nyamukana Town Council (Figure 3.32).

Figure 3.32. Seedlings for the restoration process. A. The community tree nursey at Hakashenyi Church of Uganda. B. The community tree nursery at Bucuro Church of Uganda

The generated seedlings were used to restore the bear land on the hills of Nyamukana Town Council (Figure 3.33).

Figure 3.33. Pinus carribaea planted in late 2020 on the hills of Nyamukana Town Council

The notable outcomes of these restoration efforts include the enhancement of environmental quality and micro-climate in the area, along with a significant reduction in soil erosion and the absence of reported landslides. Local communfities have recognized the economic benefits of tree cultivation. However, the primary challenge remains the limited financial resources to extend restoration efforts to other areas within Ntungamo District and throughout the country.

Addressing this challenge, various NGOs and corporate entities have collaborated with the government in restoring hilly and mountainous regions. For instance, WWF planted 1,400 hectares of new trees in the buffer zone of the Rwenzori Mountains National Park between 2020 and 2021, benefiting 1,712 families and farmers. Similarly, the Agency for Rural and Urban Development (ARUD) successfully restored 128.9 hectares of degraded land in Kasese District along the Rwenzori Mountains National Park buffer zone, resulting in improved household incomes for the local community.

Mobile Telephone Network (MTN) Uganda also contributed significantly to nationwide forest restoration projects. Between 2020 and 2021, they restored 50 hectares of forest cover in Ogera Hills Central Forest Reserve in Serere District and additional hectares in various central forest reserves across different regions of Uganda. These collaborative initiatives highlight the collective efforts to combat deforestation, promote sustainable practices, and enhance the overall environmental well-being of Uganda.

3.8.7 Recommendations

(i) Strengthen partnerships with local communities to actively involve them in the restoration process, ensuring shared responsibility and ownership.

(ii) Implement extensive awareness campaigns aimed at educating residents on the pivotal role of hill and mountain restoration in maintaining ecological balance and fostering sustainable livelihoods.

(iii) Advocate for the creation of additional community-based tree nurseries throughout the country, establishing them as sustainable and local hubs for diverse plant species.

(iv) Expand collaborative efforts with corporate entities and non-governmental organizations to secure both financial resources and technical expertise for large-scale restoration projects.

(v) Emphasize the strategic planting of trees in mountainous regions that offer multiple benefits, including income generation. This approach ensures that communities appreciate the economic value of trees on their limited land.

3.9. Wetlands

The Constitution of Uganda, 1995 recognizes wetlands and other natural resources as important resources that should be held in trust for the good of all citizens. The Uganda National Policy for the Conservation and Management of Wetland Resources (1995) defines them as "areas where plants and animals have become adapted to temporary or permanent flooding by saline, brackish or freshwater.

The network of Uganda's wetlands ecosystems makes them an essential part of the entire drainage system in Uganda (UN-WWAP and DWD, 2005). The wetlands have so many tributaries that are difficult to disaggregate and hence the description of wetlands as a network of tributaries that form systems. These wetlands form part of the eight main drainage basins in Uganda namely; Albert Nile, Aswa, Lake Edward, Lake Kyoga, Kidepo, Lake Victoria, Victoria Nile and Lake Albert.

The transformation of Uganda to a middle-income country would imply that the country's natural resources are harnessed and utilized in a sustainable manner. The contribution of wetlands to other sectors such as agriculture, industry, and energy needs to be clearly quantified so that these vital resources are given the due conservation profile they deserve.
Wetlands in Uganda cover a very extensive area and there are several interests and users. This alone brings with it problems that include;

(i) Managing a very large area with inadequate funding
(ii) Inadequate knowledge base especially on the economic value of wetlands and their contribution to GDP.
(iii) Limited awareness coupled with impunity despite the various awareness campaigns
(iv) Weak institutional arrangements with some districts even lacking wetland officers and yet wetland management is a decentralized function
(v) Weak and conflicting policies and legal frameworks that are not as punitive to deter wetland encroachment.
(vi) Political interventions that compromise ongoing efforts;

However, if the target to have the wetlands coverage at 13% as envisioned in vision 2040 is to be realized, there is a need to move from the status quo and intensify the various interventions geared at wetland restoration.

3.9.1 Status and trend of wetlands

The coverage of wetlands in 1994 was at 15.6%, 2015 at 13% and 2021 at 13.9% of Uganda's surface area (Figure 3.34). Figure 3.35 shows the wetland status of Uganda as per 2021. The intact wetland covers as recorded in 2021 is 9.3% compared to 8.9% intact cover in 2015 indicating a positive trend and this is attributed to several efforts including awareness raising, demarcation and restoration of wetlands.

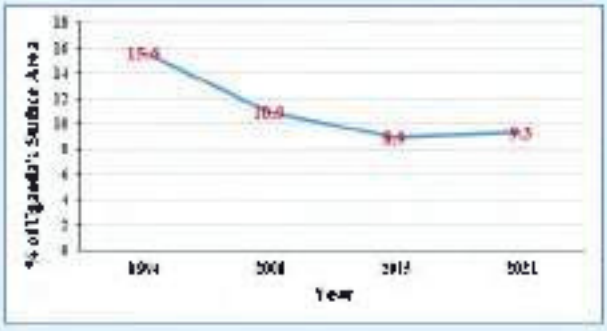

Figure 3.34. Coverage of intact wetlands in Uganda in 1994, 2008, 2015, and 2021(Source: State of wetland report, 2021).

Figure 3.35. Status of wetlands in Uganda in 2021 (Source: State of wetland report, 2021)

The intact wetlands of Uganda currently cover a total area of 22,457.4 Km^2 (9.3% of Uganda's surface area) from the previous coverage of 21,526 Km^2 (8.9% of Uganda's surface area) as recorded in the 2019 State of wetlands report. Whereas the degraded wetlands currently cover a total area of 11,305.1 Km^2, the Eastern Region of the country registered the highest level of degraded wetlands (Table 3.3).

Table 3.3. Status of wetlands in the different regions of Uganda (Source: National Wetland Information System)

Region	Degraded		Intact	
	Area (Km2)	%	Area (Km2)	%
Central	2,409.7	21.3	7,363.9	32.8
Eastern	4,638.3	41.0	4,533.4	20.2
Northern	2,779.7	24.6	6,800.0	30.3
Western	1,477.5	13.1	3,760.1	16.7
National Total	**11,305.1**	**100**	**22,457.4**	**100**

Wetland degradation in Uganda has been assessed by district, revealing notable proportions in certain regions (Figure 3.36). The districts with the highest extent of degraded wetlands are as follows: Sironko (99.8%), Manafwa (99.7%), Mbale (99.6%), Butebo (97.2%), and Kapchorwa (95.9%).

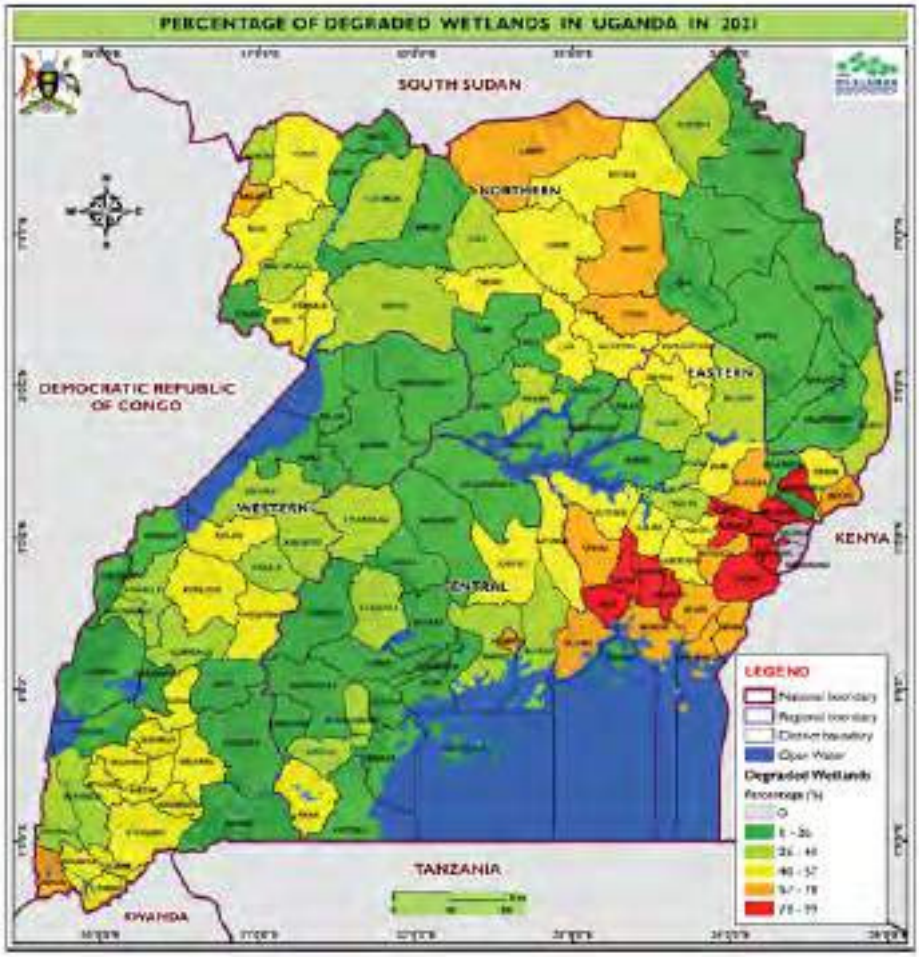

Figure 3.36. Percentage of degraded wetlands in Uganda by district (Source: State of wetland report, 2021)

Given the trends in wetlands, analysis of drivers and pressures in both Urban areas and rural areas indicates that population explosion, settlement, industrial development and agriculture are the highest drivers of wetland degradation. Small scale farming accounts for the highest threat to wetlands accounting for 31% of wetland use across the country which built up areas account for only 0.6%.

3.9.2 Wetlands status in selected cities

Based on the 2020/21 mapping, wetlands in the urban areas have been heavily degraded as shown in figure 3.37 below that represents the status of wetland in the 6(six) selected cities. This implies that the wetlands ability to perform ecological functions in the cities is greatly compromised and as a result, the intensity of flooding, outbreak of waterborne diseases, increased pollution has been registered in the urban settings.

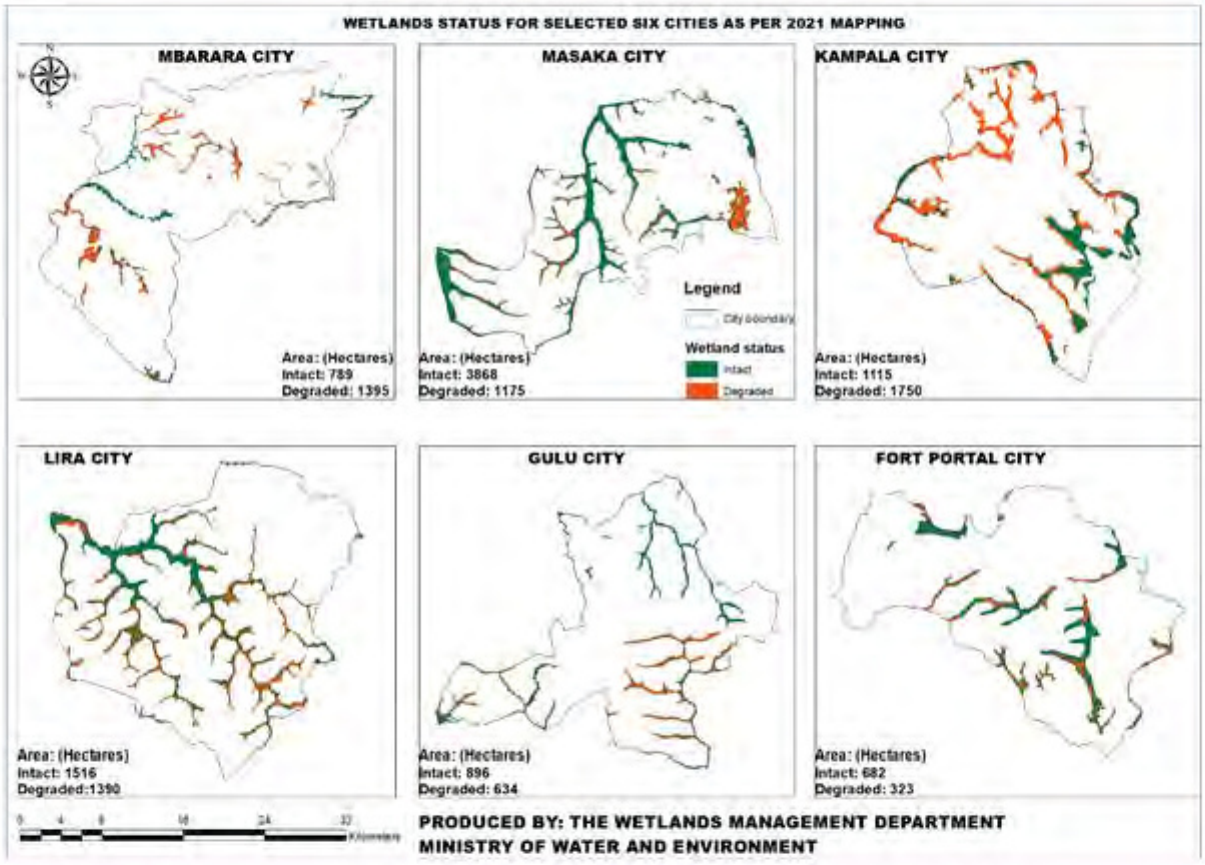

Figure 3.37. Status of wetlands in selected cities in Uganda
(Source: National wetland Information system)

3.9.3 Pressures and impacts of wetland degradation

The degradation of wetlands is a cause for concern due to its adverse effects on the ability of ecosystems to provide essential ecological and socio-economic services, thereby posing a threat to the livelihoods of dependent communities. The impacts of wetland degradation manifest across varying time frames, ranging from short-term to long-term consequences. Loss of wetland vegetation cover, alterations in water regimes, and soil deterioration are primary contributors to these impacts, all of which are intrinsic characteristics of wetlands.

As a consequence of degradation, wetlands have experienced significant reductions in areas that once served as habitats for wildlife. Additionally, their capacity to store and filter water has diminished, along with their ability to store carbon. This degradation amplifies negative repercussions such as heightened risks of floods, increased prevalence of diseases, and prolonged periods of drought.

3.9.3.1 Major impacts of wetland degradations

Uganda's wetlands harbor diverse and often endemic biodiversity, serving as temporary refuges for nearly 100 migratory bird species and hosting over 1057 bird species in total across 34 Important Bird Areas, predominantly wetlands and forests (Nature Uganda, 2015). Despite their ecological significance, these wetlands face degradation, resulting in the loss of critical habitat and biological diversity.

The encroachment and destruction of wetlands have disrupted the natural water flow within these ecosystems. Previously homogeneous water distribution has been altered through channelization, often involving embankments to address issues like waterlogging and flooding within settlements established in wetland areas. Such alterations, while mitigating local issues, contribute to increased water runoff downstream, leading to flash floods. Furthermore, these modifications reduce the residence time of water in wetlands, impacting essential functions such as groundwater recharge and water purification.

Most of Uganda's wetlands are riverine and lacustrine, playing a crucial role in buffering water bodies from sediment and pollution. Unfortunately, pollution from agricultural activities, industrial developments, and settlements has compromised the integrity of these wetlands. The loss of wetland cover and channelization accelerate the discharge of water loaded with sediments and pollutants into lakes and rivers without undergoing natural sieving processes. This results in the cumulative siltation of remaining wetland areas, affecting habitat quality, aquatic biodiversity, and the health of communities reliant on wetlands for water and food.

The encroachment and destruction of storm water absorption areas and waterways contribute to frequent and intense flooding in and around wetlands. This has far-reaching consequences, causing destruction of infrastructure, loss of property and lives, and significant economic losses. According to the annual state of disaster report for 2020, floods, landslides, drought, and storms in 2019/2020 caused direct economic losses amounting to UGX 563.24 billion, equivalent to 0.42% of Uganda's nominal GDP. Urban areas, such as Kampala, face additional challenges, with population growth exerting pressure on drainage systems, leading to flooding. The floods of 2020 disrupted service delivery, caused damage to property and loss of lives, and resulted in the destruction of critical infrastructure such as roads and bridges.

3.9.4 Responses

Uganda's wetlands, once conserved and harnessed, have the ability to provide benefits for the present and future generations. In light of climate change, wetlands are nature's disaster management systems. They buffer communities from extreme events arising for climate change and provide livelihood to many who are entirely dependent on them.

Based on their importance and the increasing threat to their existence,

the Ministry of Water and Environment, working with development partners, Local Governments, NEMA and NGOs is implementing interventions aimed at conserving these wetlands which are described below.

3.9.4.1 Restoration/rehabilitation of degraded wetlands

The restoration and rehabilitation of wetlands respond to the evolving condition of these ecosystems. The objective is to aid nature in recovering from the degradation of wetland ecosystems and their functions. Mapping initiatives conducted by the Wetlands Management Department reveal a growing level of degradation, with over 4.1% of wetlands experiencing various forms of encroachment. Consequently, both NDP III and Vision 2040 set a target that necessitates concerted efforts towards wetland restoration. As illustrated in Figure 3.38, there is a discernible trend in wetland restoration activities. To reinforce these endeavors, a ten-year Environmental and Natural Resources (ENR) restoration action plan has been devised. All these initiatives aim to restore wetlands to at least 13%, aligning with the established targets.

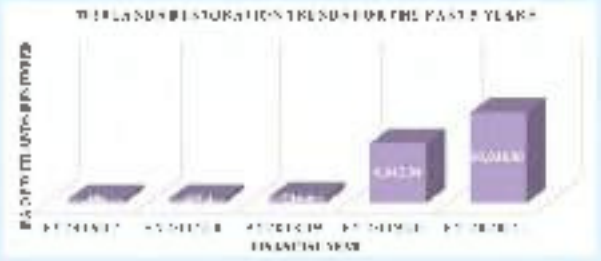

Figure3.38. Wetlands restoration trends (Source: WMD)

The restoration efforts are beginning to bear positive fruits and with continued funding and intervention, the country will be able to recover most of its degraded wetland. Figure 3.39 shows part of the restored Mushasha wetland in Buhweju District

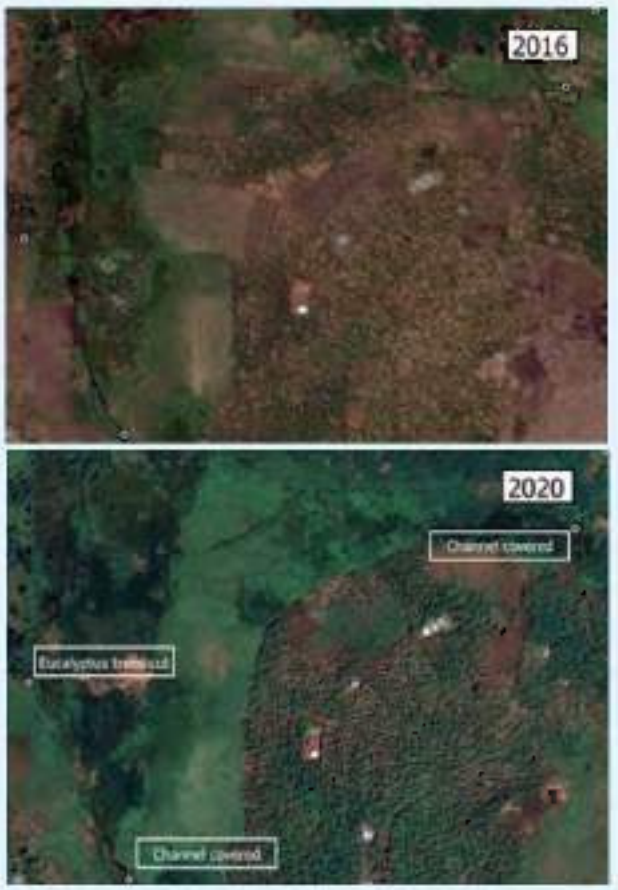

Figure 3.39. Images showing restoration of Mushasha wetland in Buhweju District

3.9.4.2 Demarcation of wetland boundaries

The Government of Uganda has undertaken the crucial task of delineating and marking the boundaries of individual wetlands across the country. This initiative is driven by the objective of informing the public and local communities about the specific limits of wetlands, thereby promoting adherence to regulations. While the perimeters of wetlands are extensive, the focus is primarily on urban wetlands, where there is evident pressure from settlements and industrial development, posing a significant threat to the ecological balance of these areas.This undertaking is a collaborative effort involving NEMA, MWE, District Local Governments, security agencies, and Lower Local Governments, with substantial support from the Government of Uganda and various development partners. Through

this joint endeavor, the aim is to address the challenges posed by urbanization and industrialization, safeguarding the integrity of wetland ecosystems.

3.9.4.3 Development of wetland management plans

A wetland management plan is a tool that guides wetland wise use practices by communities living adjacent to the wetland ecosystem. The area under wetland management plans has increased to 6507.34 Km2 from 6376.5km2 in 2019/2020. The management planning process is highly consultative and helps identify management actions that are aimed at reducing resource use conflict at the same time increasing the benefits to communities both in the short term and in the long run. So far, the Ministry has developed 4 framework management plans (Sezibwa, Okole, Rwizi-Rufuha and Awoja). These are inter-district management plans that transcend several districts where the wetland system traverses. The Department also develops Community based wetland management plans which are more site specific.

3.9.4.4 Gazettement of wetlands

As indicated by definition of wetland in the NEA,2019, and also to strengthen the management of wetlands, WMD embarked on a process to gazette all wetlands. The process involved delineation of all wetland boundaries, generation of boundary coordinates, production of maps and agreement on the categorization criteria. This was then followed by consultations for the Gazettement of Wetlands and a Gazettement instrument was prepared in consultation with the Ministry of Justice and Constitutional Affairs. The Legal instrument has since been signed by the Minister of Water and Environment.

3.9.4.5 Wetland title cancellation

To-date, 330 certificates of land titles erroneously issued in wetlands have been canceled, and preparations for canceling another 300 are in final stages. This is an effort to implement the cabinet decision, Minute 114 (CT 2014) to cancel titles in wetlands acquired unlawfully after 1995. The exercise, aimed at preventing individual ownership of wetlands held in trust for the common good of the people of Uganda, is expected to spread to all wetlands in the country.

3.9.5 Recommendations

Uganda's economic production and development have historically relied heavily on the exploitation of natural resources. The nation's ongoing dependence on nature signifies the vital role it plays in safeguarding existing investments. However, the absence of modern waste treatment facilities has led to the establishment of industries and settlements directly within wetlands-areas crucial for water supply, waste treatment, eco-tourism, and livelihoods.

This practice is counterproductive, jeopardizing the very ecosystems that sustain the country's industrial growth. To ensure a sustainable industrial drive, it is important for the government to reconsider its policy and practice of allocating wetland areas for industrial development. This approach has not only created a negative public perception of wetlands but also contradicts government efforts to conserve and protect these vital areas, inadvertently encouraging the degradation of wetlands by local communities.

To strike a balance between protecting essential ecosystems and fostering development, there is a pressing need to harmonize all policies and legal frameworks related to wetlands. Conducting a

comprehensive policy analysis would help identify overlaps and gaps, allowing for the strengthening of wetland management through a more robust and punitive legal framework that addresses current drivers and impacts.

Furthermore, the planning and implementation of activities in and around wetlands should be harmonized, emphasizing increased community participation in resource management through measures like community policing. Conservation efforts could be incentivized to reward communities that actively preserve their wetland resources. While the current practice focuses on offering livelihood options to communities relocated from wetlands, a parallel emphasis should be placed on rewarding those who contribute to wetland conservation.

The funding gaps at both the central and local government levels are crucial and should be addressed. Increasing the resource envelope for various government entities involved in wetlands management will enable more effective conservation efforts and sustainable development practices. Overall, a holistic and integrated approach is essential to ensure the long-term health of Uganda's wetlands while supporting the nation's economic aspirations.

3.10. Forest

Forests play a crucial role in human well-being and environmental health, providing essential goods such as medicines, edible fruits, and game meat, while also serving as a source of income for over a billion people worldwide. In Uganda, the significance of forests is evident through the presence of approximately 506 Central Forest Reserves (CFRs), covering an expansive 1,262,090 hectares. These forests are classified into four main groups: Central Forest Reserves, Local Forest Reserves, Community Forests, and Private Forests.

Despite the substantial forest cover in Uganda, many Protected Areas face the challenge of increasing isolation. The burgeoning human population, new settlements in previously untouched areas, shifts in land use towards agriculture, and ongoing infrastructure developments contribute to this isolation. A study by Bamwesigy et al., 2022 showed that natural forest loss in Uganda is threatening forests' co-existence services and values such as biodiversity and forest ecosystems, climate mitigation, air and water purification, and soil protection in the region.

Projections for 2040 suggest a 1% increase in subsistence agricultural land, a 0.2% decrease in tropical high forest with livestock activities, and a 0.07% decrease in woodland and unprotected forests. These trends emphasize the urgent need for strategic conservation efforts and sustainable land management practices. As Uganda's landscapes undergo transformation, striking a delicate balance between human development and the preservation of vital ecosystems becomes imperative. It is crucial to adopt approaches that ensure the long-term health and biodiversity of the country's forests and protected areas, promoting a harmonious coexistence between human activities and environmental conservation.

3.10.1 Status and trends

The forest cover increased from 9.5% in 2015 to 12.3% in 2017 and then to 13.3% in 2019 (Table 3.4). This is attributed to concerted effort to restore the degraded forests by planting trees and allowing the natural forests to regenerate after evicting encroachers.

Table 3.4. Status of Forest ecosystem in Uganda by 2019

Type	1990	2000	2005	2010	2015	2017	2019
Forest Cover	4,933,730	3,786,547	3,604,219	2,199,309	1,938,990	2,505,266	2,729,159
Land Area	20,465,767	20,474,477	20,448,880	20,466,001	20,405,110	20,409,126	20,454,009
Forest % of land area	24.10%	18.50%	17.60%	10.70%	9.50%	12.30%	13.30%
Deforestation (ha)		1,147,183	182,328	1,404,910	260,320	-566,277	-223,893
Forest Loss per year		114,718	36,466	280,982	52,064	-283,138	-111,947
Periodic Deforestation %		23%	5%	39%	12%	-15%	-9%
Annual Deforestation		2.30%	1.00%	7.80%	2.40%	-7.30%	-4.50%
All THF	924,166	930,475	792,648	685,703	629,726	626,339	674,848
Degraded THF	30%	24%	24%	18%	17%	16%	23%

The depletion of Uganda's forest cover persisted, with a notable decline observed between 2005 and 2010, plummeting from around 18% to approximately 11%, as detailed in Table 3.4. Subsequent data from 2015 revealed a further deterioration, reaching an alarming low of 9.5% of the country's geographical area. Notably, the steepest reductions occurred on private lands compared to protected areas. Encouragingly, by 2017, a modest recovery surfaced, elevating the forest cover to 12.3%. However, skeptics attributed this increase to a methodological adjustment related to bias area corrections undertaken for REDD+ in generating Forest Reference Emission Levels (FREL) for IPCC submission. The positive trajectory continued in 2019, marking a significant 13.3% surge-the highest level since 2007. This apparent rebound, while acknowledged on the ground, was tempered by the recognition of methodological nuances influencing percentage cover calculations.

3.10.2 Land cover of Uganda

Uganda's land cover is diverse (Figure 3.40), with over one-third dedicated to crop and livestock production, utilizing nearly three-quarters of available fresh water resources. Since the early 1990s, satellite data has been employed to monitor the country's forests, revealing that 24% of Uganda's land is covered by woods (IPBES (2019). The nation boasts significant tropical rainforests and savanna woodlands, essential for biodiversity. Extensive wetlands, including swamps and lakeshores, play a vital role in water regulation and support agriculture. Savannas and grasslands are predominant in central and northern regions, crucial for agriculture and livestock.

Agriculture, dominated by crops like coffee, tea, and bananas, is a key economic activity. Urbanization, particularly in Kampala, has spurred infrastructure development and altered land use and land cover. Lakes and rivers, such as Lake Victoria, contribute to biodiversity and economic activities like fishing. Mountainous terrain in the southwest, like the Rwenzori Mountains, enhances tourism and conservation efforts. National parks safeguard biodiversity, attracting global tourists. However, desertification threats in some regions necessitate sustainable land management to address deforestation and climate change impacts.

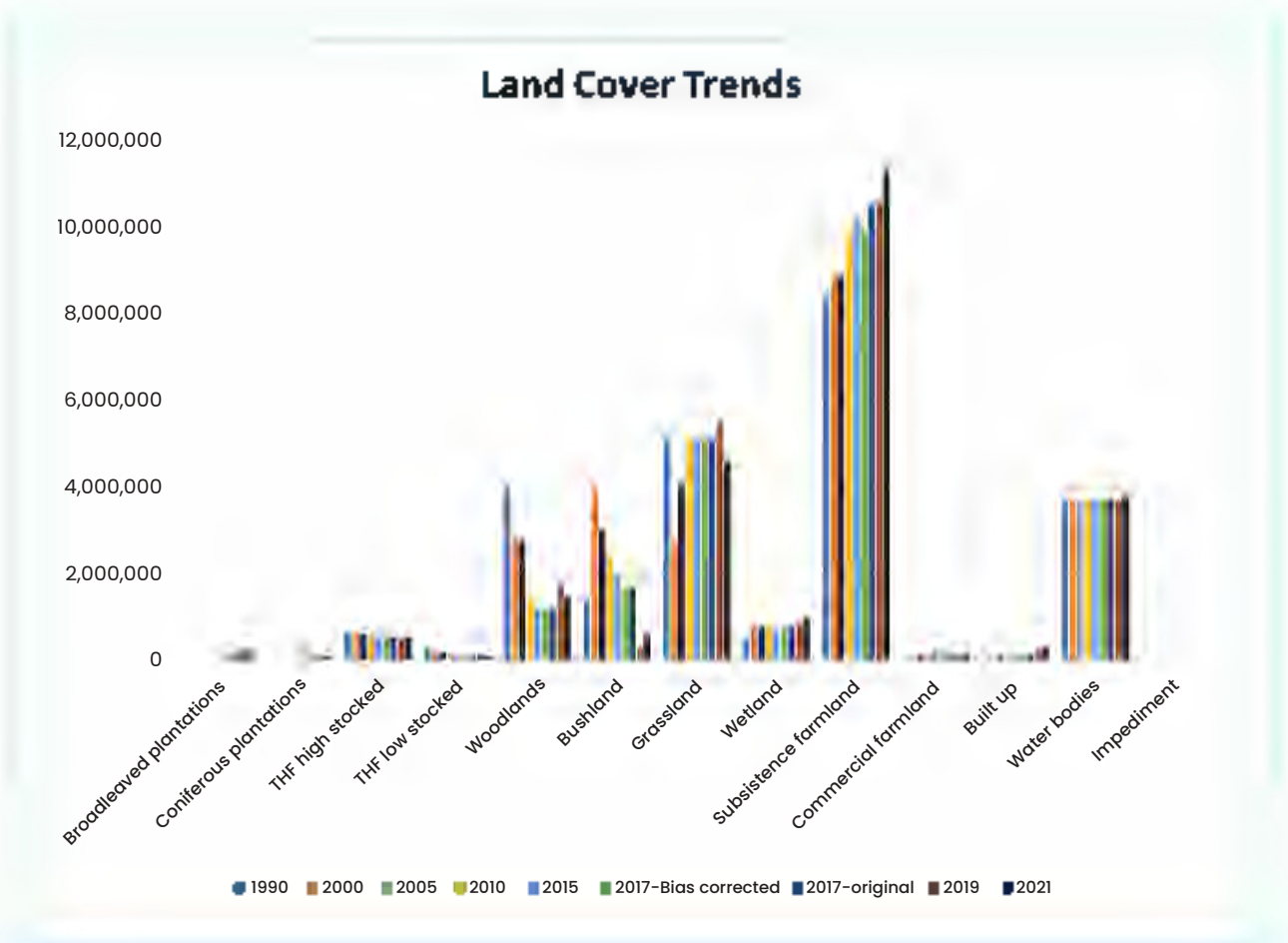

Figure 3.40. Land cover trends in Uganda (Source: NFA unpublished data)

3.10.3 Responses

Land takeovers often lead to legal battles, with the National Forestry Authority (NFA) and NEMA deploying forest officers and Environmental Police Protection Force (EPPF) respectively, and the Uganda People's Defence Forces (UPDF) to evict encroachers. Section 59 of the National Environment Act No.5, 2019, emphasizes the conservation of biological diversity, a strategy successfully employed in various forest reserves. Notably, Kalagala and Itanda forests in eastern Uganda have been designated as special conservation areas, supported by the Bujagali and Isimba dams, with a protective 100-meter zone along riverbanks.

Efforts to restore degraded areas include planting native seedlings in Mabira CFR, which has now reclaimed 2,250 hectares. Live markers delineated 501 hectares in Mabira Central Forest Reserve, with species like Spathodia compamulata and Eucalyptus grandis. A 200-hectare initiative in Jinja, Kayunga, and Buikwe districts involves planting Bambusa bamboo trees to restore Nile River banks.

Forestry services have been de-concentrated into four regions, fostering institutional partnerships with schools and churches for woodlots. In northern Uganda, a collaboration with the Catholic Church and Church of Uganda has planted 103.3 hectares of woodlots. Technical assistance and tree seedling distribution in the north and east support catchment-based management projects. The National Bamboo Strategy and Action Plan, 2019–2029, is poised to contribute significantly to conserving forestry resources.

3.11. Species Diversity

Uganda's species diversity spans a vast spectrum, encompassing wild animals, fish, worms, insects, plants, fens, fungi, and a rich tapestry of genetic diversity. The country's wild animals include iconic species like elephants, lions, and diverse antelopes, while its water bodies teem with a multitude of fish species. Insects and worms contribute to the intricate web of terrestrial life, and a plethora of plant species thrive in diverse ecosystems, from lush rainforests to arid savannas. Fens, characterized by waterlogged conditions, harbor unique flora and fauna, while fungi play a vital role in nutrient cycling. Uganda's commitment to conservation preserves genetic diversity crucial for species adaptation and resilience. This harmonious interplay of diverse life forms underscores Uganda's significance in fostering a thriving and interconnected natural world.

3.11.1 Wild Animals

Wildlife protected areas in Uganda are not only for safeguarding biodiversity but also for providing crucial ecosystem services. These areas play important roles in flood control, water retention, purification, soil erosion prevention, landslide mitigation, carbon storage, and pest and disease control. Beyond conservation, they significantly contribute to Uganda's economy and development goals by offering these vital services. Since the restoration of peace in the 1980s, Uganda's wildlife resources have been on a recovery trajectory (Table 3.5).

The Uganda Wildlife Authority (UWA) employs a monitoring database to assess the status and trends of wild animals, primarily within protected areas. While UWA regularly conducts wildlife surveys within these designated zones, limited funding has hindered deliberate efforts to extend comprehensive surveys beyond protected areas. This focus on understanding the status and trends of mammals within protected areas reflects the ongoing commitment to wildlife conservation and sustainable management in Uganda.

Table 3.5. Population estimates of selected medium to large mammals in Uganda

Species	2011-2014	2015-2017	2018- 2020
Buffalo	36,953	37,054	44,163
Burchell's Zebra	11,888	11,897	17,516
African Elephant	5,739	5,808	7,975
Rothschild's Giraffe	880	880	2,072
Hartebeest	9,667	9,841	17,274
Hippopotamus	5,838	5,838	10,165
Impala	33,565	33,565	53,636
Topi	2,222	2,222	2,713
Ugandan Kob	77,759	74,702	175,590
Waterbuck	12,222	12,809	22,244
Common Eland	1,351	1,742	2,502
Bright's Gazelle	57	57	750
Roan Antelope -sub-species - langheldi		118	190
Southern White Rhino	17	22	35

Lion	493	493	373
Gorilla	400	400	459
Chimpanzee	5,000	5,000	5,072
Ostrich			1,856
Lesser Kudu			806
Greater Kudu			206

Source: Animal censuses in Uganda since 2011

In the Protected Areas of Uganda, wildlife populations have shown a positive trajectory, reflecting an overall increase since 2017. Notably, Ugandan Kob numbers have nearly tripled during this period. However, the lion population has experienced a decline due to persistent Human Wildlife Conflict with neighboring communities, leading to instances of poisoning and fatal encounters.

A significant conservation success is observed at the Ziwa Rhino Sanctuary, where the Southern White rhino population increased by 13 individuals, reaching a total of 35. The management transition from Rhino Fund Uganda to Uganda Wildlife Authority (UWA) aims to enhance further species management. Plans to translocate some rhinos to the wild, identified through a 2019 feasibility study, prioritize Kidepo Valley National Park, Ajai Wildlife Reserve, and Murchison Falls National Park. Table 3.6 shows translocation of mammals in selected protected areas. UWA's deliberate effort to diversify and increase wildlife populations through translocation underscores the commitment to fostering sustainable biodiversity and conservation in Uganda's Protected Areas.

Table 3.6. Translocated Mammals in selected Protected Areas

Species	LMNP	KVNP		PUWR		Others	
	Translocated	Current number (2021)	Translocated	Current number (2021)	Translocated	Current number (2021)	Translocated
Giraffe	15	24	14	81	15	29	
Ugandan kob			110	280-300			
Zebra							2 (Kalangala)
Topis							2 (Kalangala)
Impala			183	240	91	183	

3.11.1.1 Chimpanzee surveys in the Graben

Chimpanzee surveys conducted primarily between 2020 and 2021 by the Wildlife Conservation Society (WCS) (Figure 3.41), unveiled intriguing variations in population trends. Over a total distance of 1,848.7 km surveyed across six Protected Areas (refer to Table 3.3), an estimated population of 3,337 chimpanzees was recorded. This figure accounts for approximately two-thirds of the known chimpanzee population in Uganda. However, the Bugoma Central Forest Reserve exhibited a concerning decline in chimpanzee numbers, dropping from 497 individuals in 2009 to 390 in 2020 (Table 3.7). Notably, chimpanzees were also identified outside Protected Areas, particularly in the riverine forests between Budongo and Bugoma Central Forest Reserves. These findings

emphasize the importance of ongoing surveys and conservation efforts to monitor and address population changes and habitat dynamics among chimpanzee populations in Uganda.

Table 3.7. Chimpanzee population estimates in six Protected Areas

Protected area	Density (Se)	95% confidence limits	Population size (Se)	95% confidence limits	CV (%)
Kibale National Park	1.26(0.2)	0.91-1.73	1001 (160)	725-1381	16.04
Kasyoha-Kitomi FR	1.14 (0.23)	0.76-1.71	449(90)	300-672	20.3
Bugoma FR	0.97 (0.23)	0.6-1.55	390 (93)	243-525	23.9
Budongo FR	1.87 (0.24)	1.4 -2.4	802 (106)	617-1043	13.2
Maramagambo FR	0.62 (0.13)	0.41 -0.95	277 (57)	183-419	20.7
Kalinzu FR	3.1 (0.82)	1.68-5.54	418 (113)	230-759	26.9

For sights where only presence data had been obtained, it was hypothesised whether the population was stable, increasing or decreasing depending on the amount of threats encountered during the survey (Table 3.8). The main threats were habitat loss and illegal hunting, which often result in trapping and/or maiming chimpanzees even when they are not the targeted species.

Table 3.8. Number of nests encountered and encounter rate of chimpanzee nests in Protected Areas where data was not sufficient to estimate chimpanzee population.

Protected area	Distance walked	Number of nests	Encounter rate	Hypothesized population trend
Bwindi NP	1816	1035	0.57	Stable or inctreasing (threats low)
Wambabya FR	21	99	4.62	Stable or declining (threats high)
Kikumiro FR, Kagarro FR & Kagombe FR,	154	75	0.48	Declining (threats high)
Kyambura WR	3	54	16.4	Stable (threats low)
Kasito FR, Kyamurangi FR, Rwengeye FR	41	4	0.09	Declining (threats high)
Toro - Semuliki WR	26	27	1.01	Stable (threats low)
Corridor forests	341	209	0.76	Declining (threats high)

Note: Although repeat surveys were used for the Kagombe, Muhangi, Kagora, Kibego and Kakumiro CFRs, chimpanzee estimates could not be carried out because of the excessive fragmentation of the habitat that had taken place between the previous surveys in 2002 and 2019 resulting in shorter and unequal distance transects in most areas of these forests. Table 3.9 indicates the density, population trends and presence of chimpanzees in Uganda's forests (The figures in brackets indicate density estimates).

Table 3.9. Abundance estimates of the chimpanzee population in Uganda

Species	Abundance estimates (Density /sq km)				
	1999/2001	2005	2008/10	2017/19	2020/21
Kibale National Park	1,298 (2.3)	921 (1.2)		1001 (1.3)	
Kasyoha-Kitomi FR	369(0.92)		425 (1.07)		449 (1.14)
Bugoma FR	570 (1.9)		497 (1.24)		390 (0.97)
Budongo FR	581 (1.36)		811 (1.89)		802 (1.87)
Maramagambo FR	202 (0.46)		270		277 (0.62)
Kalinzu FR	212 (1.55)		445(3.2)		418(3.1)
Bwindi FR	193 (0.6)				Presence
Wambabya FR	123 (3.62)		88 (2.57)		Presence
Kagombe FR	80 (0.71)				Presence
Toro - Semuliki WR	60				Presence
Kagorra region	13 (0.3)				Presence
Kasato & Rwengyeye	2.15 (0.08)				Presence
Kyambura WR	50			24	Presence

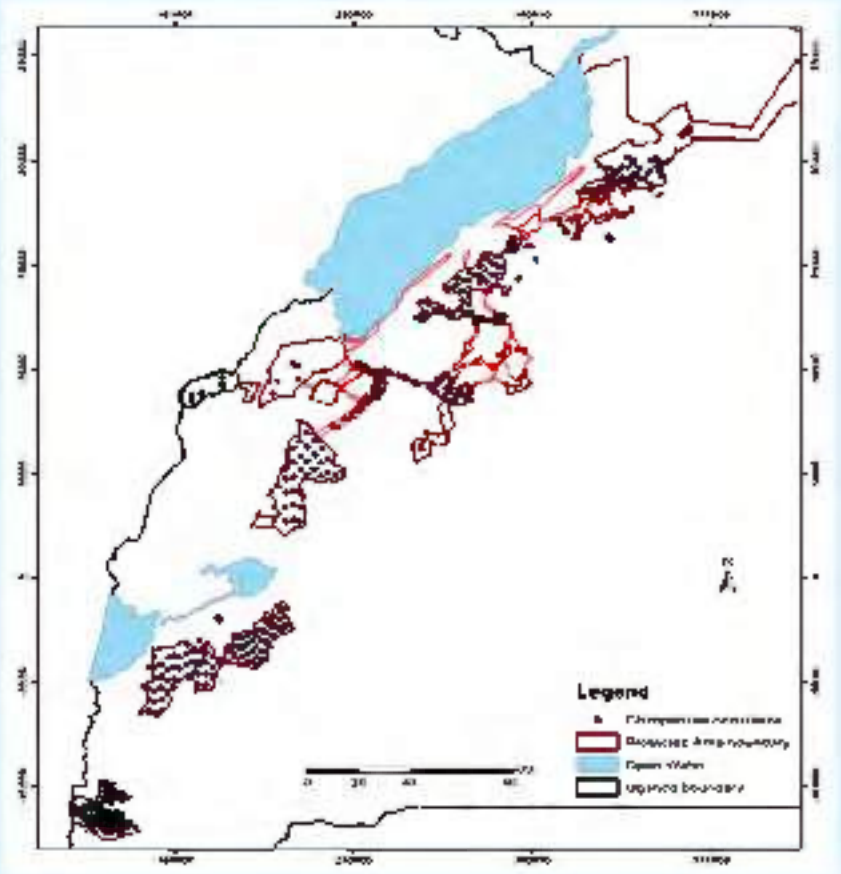

Figure 3.41. Occurrence of chimpanzees in the surveyed areas

3.11.2 Pressures and impact

The pressures and impacts on the wild animals in Uganda include the following:

3.11.2.1 Disease outbreak

There have been intermittent disease outbreaks in some Protected Areas including anthrax in hippos, respiratory infections in gorillas, Foot and Mouth Disease (FMD) in buffaloes, and fungal skin infections in zebras among others (Table 3.10). These diseases lead to wildlife mortality which affects the wildlife numbers. UWA undertakes periodic disease surveillance for early detection of diseases among the animal population. This has helped in arresting disease outbreaks before spreading. Where sicknesses are discovered, interventions are undertaken to minimize animal mortality. In some areas, UWA has facilitated vaccination of infected domestic animals to prevent spread of the disease to wildlife. UWA has also facilitated placing of tsetse fly traps in some areas to attract tsetse flies and in order to minimize disease transmission.

In addition, UWA with support from DITRA in 2019 started construction of the biosafety and biosecurity laboratory in QENP. This has been completed, commissioned and it is now operational.

Table 3.10. Cases of disease outbreaks in Protected Areas

Protected Area	Diseases
KVNP	Ketaro conjunctivitis (IKC) causing blindness in Uganda kobs, Oribis, Hartebeests and Reedbucks in KVNP
QENP	Anthrax
LMNP Katonga	Foot and Mouth Disease

Protected Areas in Uganda have experienced intermittent disease outbreaks, impacting various wildlife species, including hippos contracting anthrax, gorillas suffering respiratory infections, buffaloes affected by Foot and Mouth Disease (FMD), and zebras experiencing fungal skin infections (refer to Table 3.10). These outbreaks contribute to wildlife mortality, influencing overall population numbers. To address this challenge, the Uganda Wildlife Authority (UWA) conducts regular disease surveillance, enabling the early detection of illnesses within animal populations and preventing the spread of diseases.

Upon discovering illnesses, UWA implements interventions to minimize animal mortality. In some instances, UWA facilitates the vaccination of infected domestic animals to curb the spread of diseases to wildlife. Moreover, tsetse fly traps are strategically placed in certain areas to attract tsetse flies, minimizing disease transmission.

Due to the potential threat of zoonotic diseases, UWA, with support from DITRA in 2019, initiated the construction of a biosafety and biosecurity level two diagnostic laboratory in Queen Elizabeth National Park (QENP). This facility, completed and commissioned in 2021(Figure 3.42), is operational and serves as a crucial tool for detecting and monitoring wildlife zoonotic diseases, enhancing the overall health management of both wildlife and domestic animals.

Figure 3.42. Biosafety Level Two Wildlife Veterinary Diagnostic Laboratory at Mweya

3.11.2.2 Poaching

Poaching remains a critical challenge for wildlife management in Uganda, with both subsistence and commercial activities posing significant threats. Subsistence poaching, often driven by poverty, coexists with more organized and well-funded commercial poaching, particularly in Murchison Falls National Park (MFNP) and Queen Elizabeth National Park (QENP). Commercial poaching is typically armed and is financially backed by business individuals for international trade.

Uganda Wildlife Authority (UWA), in collaboration with various partners, has implemented measures to combat poaching and reduce animal mortality. However, the country continues to grapple with malicious killings leading to wildlife losses. A notable incident in 2020 saw the tragic loss of eight lions to poisoning in Queen Elizabeth National Park, highlighting the persistent challenges and the urgent need for enhanced conservation efforts to protect the country's precious wildlife resources.

3.11.2.3 Economic developments

As Uganda strives for middle-income status outlined in Vision 2040, numerous developments are underway, including projects planned within Protected Areas and sensitive ecosystems. Between 2019 and 2021, Uganda Wildlife Authority (UWA) reviewed over 80 requests, predominantly for mining, hydropower, oil and gas, road construction, and transmission lines. Some proposals were rejected due to potential severe ecological impacts. These developments impact on habitat for wildlife, increasing human-wildlife conflicts as animals venture beyond Protected Areas. Besides land-take, developments pose risks such as vegetation clearance, habitat quality loss, wildlife disturbance, and habitat fragmentation. UWA's 2020 operational guidelines aim to guide sustainable development, complementing Environmental and Social Impact Assessments, monitoring plans, and sensitivity atlases developed in collaboration with other agencies. Addressing these impacts is crucial for

balancing development and conservation goals.

3.11.2.4 Invasive species

Most of the Protected Areas are facing the invasive species problem (Table 3.11), which has affected the quality of habitat. These species are as a result of overgrazing, various developments in the PAs and climate change that lead to invasive species aggressive colonization of some areas.

Table 3.11. Invasive species that continue to affect the Protected Areas.

Protected Area	Invasive species
QENP	*Dicrostarchys cinerea, Chromelaena ordorata, Opuntia Vulgaris, Imperata cylindrical. Parthenium hystorophorus, Lantana camara*
LMNP	*Acacia hockii, Cymbopogon nardus*
MFNP	*Chromelaena ordorata, acacia spp,*
Kidepo Valley National Park	
Semuliki National Park	*Cedrella odorata spp and Terminalia, senna spectabilis*
Toro Semuliki Wildlife Reserve	*Dichrostachys cinerea, Lantana Camara*

Invasive species diminish habitat quality, compelling wildlife to relocate, disrupting animal distribution, and potentially affecting tourism. Uganda Wildlife Authority (UWA) has proactively targeted the eradication of invasive species in select Protected Areas. From 2017 to 2021, over 5,588.13 hectares were successfully cleared of invasive species (Table 3.12). This strategic effort has yielded positive outcomes, with wildlife returning to areas where invasive species have been effectively removed, contributing to habitat restoration and promoting a healthier ecosystem for both wildlife and tourism.

Table 3.12. Areas cleared of invasive species in various Protected Areas.

Year	Areas cleared (ha)
2017-2018	423.7
2018-2019	1,519.3
2019-2020	2,508.13
2020-2021	1,137
Total (ha)	**5,588.13**

The information in the table above highlights that the removal of invasive species remains limited compared to their colonization in Protected Areas, necessitating heightened efforts. Eradicating invasive species requires a multipronged approach, combining various methods for significant impact. Several strategies were employed, including community-led uprooting, the use of excavators, debarking, cutting, burning, and removing stumps and seeds from previously uprooted areas. Additionally, biological control measures involved using Zygo grama insects to manage Pathenium, a method successfully applied in Queen Elizabeth National Park (QENP). As evidenced, implementing a diverse range of methods is crucial to effectively combat the spread of invasive species and restore the ecological balance in Protected Areas.

3.11.2.5 Human wildlife conflict

Human-wildlife conflict persists as a significant challenge in wildlife management, with incidents on the rise, particularly involving elephants (Table 3.13). The Uganda Wildlife Act of 2019, in Section 84, acknowledges this issue by providing compensation for injury, death, or property loss caused by wildlife listed in the Fourth Schedule of the Act. While compensation is a positive step, it may not offer a comprehensive solution. Additional measures are imperative to safeguard people and their property from such conflicts. Therefore, addressing the root causes, enhancing community awareness,

and implementing proactive strategies for coexistence between wildlife and communities are essential steps to mitigate human-wildlife conflict and ensure the long-term harmony between local populations and wildlife conservation efforts.

Table 3.13. Human-Wildlife Conflict incidents across the Conservation Areas 2009 – 2020

Year	LMCA	BMCA	QECA	KCA	MFCA	KVCA	UWA Qqtrs	Total
2009	54	1,230	24	89	238	0	69	1,704
2010	61	1,153	16	128	216	0	89	1,663
2011	67	80	45	148	231	5	138	714
2012	103	127	65	182	236	35	165	913
2013	75	114	16	210	864	25	142	1,446
2014	50	260	71	166	1,192	33	179	1,951
2015	86	190	131	206	1,082	20	182	1,897
2016	99	104	212	161	1,173	149	179	2,077
2 017	210	169	302	287	774	208	136	2,086
2018	135	150	590	364	1336	408	133	3,116
2019	199	202	879	386	573	368	241	2,848
2020	190	228	1,066	1,152	992	356	234	4,218
TOTAL	**1,511**	**4,124**	**4,421**		**9,926**	**1,704**	**2,110**	**2,8269**

3.11.3 Responses

3.11.3.1 Revenue sharing

UWA shares 20% of all gate collections with neighboring communities. More than UGX 27 billion have been disbursed to communities since 2015 (Table 3.14).

Table 3.14. Revenue sharing trend -2015-2021

Year	BINP	KNP	KVNP	LMCA	MENP	MFNP	QENP	TSWR	SNP	RMNP	MGNP	Total
2015	-	0	143, 850, 000	**50, 000, 000**	0	2,082, 700, 000	513, 773, 705. 00	-	-	166, 624, 250. 00	**55, 008, 873**	**3,011,956,828.00**
2016	-	0		**0**		2,275, 900, 000	**907, 328, 137**	-	-		**-**	**3,183,228,137.00**
2017	894, 898, 005	0		639, 171, 933	72, 000, 701	**0**	-	-	-	-	**76, 013, 297**	**1,682,083,936.00**
2018	0	435, 414, 515. 00	428, 185, 240	634, 178, 736	0	1,877, 960, 000. 00	0	0	0	0	0	**3,375,738,491.00**

2019	4,332,000,000	**974,842,470**	-	602,821,879	105,010,500	4,189,834,069	3,000,000,000	-	-	155,043,079	**147,575,644**	**13,507,127,641.00**
2020				-		-						**-**
2021				669,752,674		-						**-**
Total	5,226,898,005	1,410,256,985	572,035,240	2,595,925,222	177,011,201	10,426,394,069	4,421,101,842	-	-	321,667,329	278,597,814	**27,690,135,033.00**

3.11.3.2 Management of human wildlife conflict

In 2018, the Uganda Wildlife Authority (UWA), initiated a project aimed at constructing electric fences within Protected Areas. The initial phase of the project was executed in Queen Elizabeth National Park (QENP), followed by implementation in Murchison Falls National Park (MFNP). Presently, over 100 kilometers of electric fencing have been successfully installed and are operational in both MFNP and QENP, leading to a noticeable reduction in human-wildlife conflicts based on preliminary assessments.

Funded by the World Bank Project, there are plans to extend the electric fencing, with a target of constructing an additional 161 kilometers in both QENP (Table 3.15) and MFNP (Table 3.16).

In 2019, UWA formulated the National Strategy to Manage Human-Wildlife Conflict in Uganda, with the overarching goal of fostering harmonious coexistence between wildlife and communities to contribute to national development. Various interventions have been implemented across different sections of Protected Areas, including the installation of electric fencing, trenches, crocodile cages, beehives, and the provision of support to community scouts. These collective efforts aim to mitigate human-wildlife conflicts and promote sustainable cohabitation between wildlife and local communities.

Table 3.15. Proposed areas to be fenced in QENP

Section	Area	Number of km
1	Nyamugasani -Isango	18 km
2	KCCL- Karusandara	21 km
3	Ishasha - Bwentale	9 km
4	Kagarama - Mahyoro	13 km
TOTAL		61 KM

Table 3.16. Proposed areas to be fenced in MFNP

District	Total boundary distance	Distance fenced so far	Distance to be fenced under World Bank Project
Nwoya	141.99	34	31
Buliisa	81.27	00	20
Masindi	35.9	00	20
Kiryandongo	62.2	00	30
Total	**321.36**	**44**	**101 KM**

3.11.3.3 Invasive species management

In 2018, the Uganda Wildlife Authority (UWA) developed a comprehensive invasive species management plan aimed at providing guidance on addressing this pressing challenge. Previously, various Protected Areas had employed diverse methods to manage invasive species, including mechanical means and physical removal efforts.

As part of the World Bank Project, a consultant will be engaged to undertake a systematic assessment. The consultant's

role will involve mapping out areas affected by invasive species and recommending optimal strategies for effective management and control to curb further spread. This initiative is a proactive step towards fostering a unified and strategic approach to invasive species management within Protected Areas.

3.12. Fish

In the financial year 2021/22, the fishing sector displayed a positive trend, with a 0.3 percent growth in value added, contrasting the 8.8 percent decline observed in the preceding financial year, 2020/21. In terms of nominal prices, the sector generated a value addition of 3,298 billion shillings in 2021/22, slightly lower than the 3,351 billion shillings recorded in 2020/21. Despite this, fishing activities contributed 2.0 percent to the GDP in 2021/22, showing a marginal decrease of 0.3 percentage points from the 2.3 percent contribution observed in 2020/21. The fishing sector encompasses activities such as freshwater lake and river fishing, as well as fish farming.

Uganda holds the position of Africa's third-largest aquaculture producer, following Egypt and Nigeria, and secures the second-largest spot in Sub-Saharan Africa, as indicated by research by Egessa et al. in 2022. The country has witnessed a significant shift in aquaculture dynamics, notably with the rise of Nile tilapia cage aquaculture. This transformation, coupled with a favorable international market standing, has attracted investor attention, leading to a notable increase in Nile tilapia production. Consequently, Nile tilapia has surpassed catfish production in Uganda

.

The production landscape reflects this shift, with Nile tilapia currently standing as the foremost cultured species in the country. This trend has been consistent since 2016, with Nile tilapia consistently outpacing African catfish in terms of production volume. The estimated production figures for 2020 underscore this shift, with African catfish registering 37,488 tons, whereas Nile tilapia dominated with an estimated production of 86,011 tons (Figure 3.43).

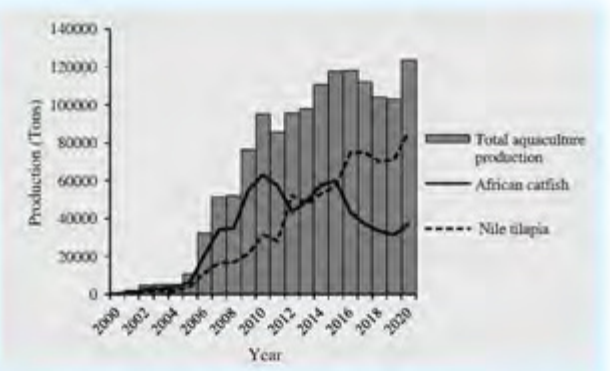

Figure 3.43. Trends in annual aquaculture production (tons) in Uganda (2000-2020) (Egessa et al., 2022).

3.12.1 Pressures and impacts

Aquaculture production in Uganda faces various pressures that impact its sustainability and growth. These pressures include environmental challenges such as water pollution, habitat destruction, and climate change. Additionally, the industry is influenced by socio-economic factors including inadequate infrastructure, and fluctuating market demand. These pressures have notable impacts on production including water quality deterioration which affect fish health and growth, the habitat destruction may result in the loss of critical breeding grounds for fish species.

3.12.2 Responses

A number of responses have been initiated in Uganda's aquaculture sector to address the pressures and mitigate their impacts. Government and non-governmental organizations are working towards improving water management practices, promoting sustainable farming techniques, and implementing regulations to curb environmental degradation. Efforts

are also being made to develop market linkages to improve socio-economic conditions for aquaculture practitioners.

3.13. Genetic Diversity

Uganda stands as a treasure trove of genetic resources, spanning plants, animals, and microorganisms, each holding invaluable hereditary units. Renowned for its diverse ecosystems, Uganda's wealth of genetic resources not only presents a promising avenue for driving socio-economic development but also holds the key to fostering wealth creation and improving the well-being of local communities (Snyman, 2021).

The country showcases a diverse range of animal genetic resources, ranging from wildlife to livestock, and plant genetic resources encompassing indigenous wild fruits, vegetables, medicinal plants, and introduced crops like maize, tobacco, coffee, cotton, and beans. People's daily lives are intricately connected with various semi-domesticated and wild plant species (NARO), distributed across the diverse ecological zones of Uganda (NEMA, 2016). Notably, research on Ugandan Robusta coffee has unveiled distinct genetic clusters, underscoring the nation's unique genetic diversity (Kiwuka et al., 2021).

Uganda boasts rich genetic diversity, housing approximately 38,700 species, including around 5,950 animal species and 32,800 plant species across diverse habitats. Genetic Resources for Food and Agriculture (GRFA) directly or indirectly contribute to approximately 24.1% of the Gross Domestic Product (GDP) (UBOS 2021/22). However, a cause for concern arises as genetic erosion poses a serious threat to these invaluable genetic resources.

The country's genetic diversity not only serves as a cornerstone for tourism, earning Uganda the moniker "Pearl of Africa" (UWA, 2021) but also proves indispensable in agriculture, industry, and pharmaceuticals, playing a pivotal role in research and development. As Uganda grapples with the challenge of genetic erosion, it becomes imperative to implement strategies that safeguard and sustainably manage these genetic resources for the benefit of current and future generations.

3.13.1 Pressure and impacts

Genetic resources in Uganda are facing significant threats arising from the shift from a subsistence-oriented agrarian economy to a consumption-driven cash economy. These challenges encompass competing land-use, poaching of wild flora and fauna, localized overharvesting of timber, human-wildlife conflicts, and the impact of climate change. The endangerment of domestic animal diversity, as highlighted by the National Environment Management Authority (NEMA) in 2016, is attributed to various factors:

a) Economic struggles, where the best animals are often sold for slaughter during difficult times, leaving inferior ones for breeding purposes, contributing to genetic degradation.
b) Introduction of new breeds, leading to the erosion of the genetic base of indigenous animals, as breeds designed for more intensive management replace local livestock.
c) Systematic breed substitution and irrational genetic transformation, involving practices like crossbreeding and breed replacement for intensified livestock management, potentially replacing valuable indigenous breeds.

Similarly, NEMA identified threats to plant genetic resources, including:

i. Replacement of local crop varieties with introduced commercial ones.
ii. Loss or neglect of traditional crop varieties.
iii. The introduction of invasive alien species.
iv. Genetic erosion of plant resources due to changes in land use.
v. Climate change, resulting in droughts, diseases, pests, and famine.

In the wildlife sector, certain species such as the Beisa Oryx, Eastern Black rhino, Northern White rhino, and Lord Derby's Eland have experienced severe declines, with some even facing extinction, according to the Uganda Wildlife Authority (UWA) in 2021. Addressing these multifaceted threats is crucial for safeguarding Uganda's rich genetic resources and promoting sustainable biodiversity conservation.

3.13.2 Responses

The Uganda government recognises the importance of its genetic resources and has undertaken several initiatives towards the conservation and improvement of farm genetic resources (MAAIF, 2002). For conservation efforts, the National Animal Genetic Resources Centre and Databank (NAGRC&DB) was established as a result of the Animal Breeding Act in 2001. The NAGRC&DB plays a leading role in the production of quality livestock genetics as well as in developmental activities such as training and sensitisation of extension staff and farmers to improve their breeding techniques as well as their management of livestock. It also plays a leading role in commercial activities such as the production, procurement and sale of genetic resources.

Geared towards the conservation of plant genetic resources (PGR), Uganda established the Plant Genetic Resource Centre (PGRC) under the National Agricultural Research Laboratories (NARL) of the National Agricultural Research Organisation (NARO). The center has the mission to ensure the conservation, management, and sustainable use of Uganda's plant genetic resources for food and agriculture (PGRFA).

These PGRFA can contribute to Uganda's development goals such as poverty eradication, food security, medical and industrial advancement. To support the development goals, PGRC, among other activities, collects and maintains stocks of diverse plant germplasm, enhances its utilization, develops information and documentation systems, and promotes community based and on-farm conservation of plant genetic resources.

More than 5,000 seed accessions comprising vegetables, indigenous fruit species, gum, cereals, crop wild relatives, legumes, forage and oil crops are being conserved in the Uganda National Gene Bank operated by the center. The germplasm conserved ex-situ includes those of most traditional crops including sorghum, maize, finger millet, pearl millet, cowpea, beans, groundnuts, sweet potato and cassava. Farmers generally use several seed storage methods. There are15 farmer groups with seed banking initiatives; five located in south-western, three in northern, five in West Nile region and one from the eastern part of Uganda, and one established in the central region. The seed banks are managed by farmers themselves and are registered as community based organizations (CBOs). The gene banks have management committees composed

of the gene bank manager, records manager, distribution manager, quality assurance manager and community mobilisers.

At the National Gene Bank, more than 5,000 accessions are being conserved in both the active (short term storage 5°C) and base (long term storage -20°C) collections. The bank ensures that seeds placed in storage are of the highest quality and achieve maximum longevity. The seeds are occasionally regenerated to ensure their genetic integrity is maintained. Species whose seed cannot survive desiccation and very low temperature levels (referred to as recalcitrant) are conserved in the botanic gardens as live collections. The germplasm held is available for different users on request. The bank includes a database on all stored collections in the Uganda National Gene Bank under priority activity of ex situ conservation.

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