THE REPUBLIC OF UGANDA

NATIONAL STATE OF THE ENVIRONMENT REPORT 2018-2019

"Managing the Environment for Climate Resilient Livelihoods and Sustainable Economic Development"

National Environment Management Authority

ENSURING SUSTAINABLE DEVELOPMENT

THE REPUBLIC OF UGANDA

NATIONAL STATE OF THE ENVIRONMENT REPORT 2018-2019

"Managing the Environment for Climate Resilient Livelihoods and Sustainable Economic Development"

National State of the Environment Report 2018-19

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Cover pages photo: A School in Kitholhu, Kasese destroyed by floods (NEMA.2019)

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Acronyms

ABC	Atmospheric Brown Clouds
ACP	African, Caribbean and Pacific (ACP) Group of States
ACP-EU/UNDP	African, Caribbean and Pacific (ACP) Group of States, financed by the European Union and the United Nations Development Programme (UNDP)
AGO	Automotive Gas Oil
AQI	Air Quality Index
ASGM	Artisanal and Small-scale Gold Mining
ASM	Artisanal and Small-scale Miners
ASSP	Agriculture Sector Strategic Plan
BIK	Bulk Illuminating Kerosene
BMCA	Bwindi Mgahinga Conservation Area
BMP	Best Management Practices
BOD	Biological Oxygen Demand
BOU	Bank of Uganda
BSLII	Biosafety Level II
CA	Conservation Area
CAA	Civil Aviation Authority
CBDP	Community-Based Disaster Preparedness
CCD	Climate Change Department
CFR	Central Forest Reserve
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNOOC	China National Offshore Oil Corporation
CO	Carbon monoxide
CO2	Carbon dioxide
COBE	Census of Business Establishment
COD	Chemical Oxygen Demand
CREEC	Centre for Research in Energy and Energy Conservation
CRRF	Comprehensive Refugee Response Framework
DAES	Directorate of Agricultural Extension
DAP	Di-ammonium Phosphate
DDMC	District Disaster Management Committees
DFR	Department of Fisheries Resources
DLG	District Local Government
DO	Dissolved Oxygen
DPSIR	Drivers, Pressures, State, Impact, and Response model of intervention
DRC	Danish Refugee Council/ Democratic Republic of Congo
DRDIP	Development Response to Displacement Impact Project
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DWRM	Directorate of Water Resources Management
EC	Electric Conductivity
ECOTRUST	Environmental Conservation Trust of Uganda
ED	Executive Director
EIA	Environment Impact Assessment
ENR	Environment and Natural Resources
EPA	United States Environment Protection Agency
ERT	Electricity for Rural Transformation
ESIA	Environment and Social Impact Assessment
EU	European Union
EUR	Euros
FAO	Food and Agricultural Organization
FDI	Foreign Direct Investment
FLR	Forest Landscape Restoration
FMD	Foot and Mouth Disease
FPU	Fish Protection Unit
FR	Forest Reserve
FY	Financial Year
GAM	Global Acute Malnutrition
GBIF	Global Biodiversity Information Facility
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEO	Global Environment Outlook
GHG	Green House Gas
GHO	Global Health Observatory
GKMA	Greater Kampala Metropolitan Areas
GOU	Government of Uganda
GW	GigaWatt
GWH	GigaWattHour
HFO	Heavy Fuel Oil
HP	Hydropower
HSRRP	Health Sector Refugee Response Plan
HWC	Human-wildlife conflict
IAS	Invasive Alien Species
ICGLR	International Conference on the Great Lakes Region
IFDC	International Fertilizer Development Center
IPC	Integrated Food Security Phase Classification
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
KAWR	Katonga Wildlife Reserve
KCA	Katonga Conservation Area
KCCA	Kampala Capital City Authority
KCL	Kidepo Critical Landscape
KVCA	Kidepo Valley Conservation Area
KVNP	Kidepo Valley National Park
LDN	Land Degradation Neutrality
LFR	Local Forest Reserves
LMCA	Lake Mburo Conservation Area
LRTAP	Long Range Transboundary Air Pollution
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MCM	Million Cubic Metres
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
MGLSD	Ministry of Gender, Labour, and Social Development
MIA	Minamata Initial Assessments
MLC	Material Living Conditions
MODIS	Moderate Resolution Imaging Spectroradiometer
MoWT	Ministry of Works and Transport
MoFPED	Ministry of Finance, Planning, and Economic Development
MTIC	Ministry of Trade, Industry and Cooperatives

MTWA	Ministry of Tourism, Wildlife, and Antiquities
MW	Megawatt
MWE	Ministry of Water and Environment
NaFFIRI	National Fisheries Resources Research Institute
NAMA	National Action Plans for Adaptation
NAP	National Action Plan/National Agricultural Policy
NASA	National Aeronautics Space Administration
NASECO	Nalweyo Seed Company
NBFP	National Biodiversity Finance Plan
NBSAP	National Biodiversity Strategy and Action Plan
NCA	Natural Capital Accounting
NDP	National Development Plan
NDPII	National Development Plan 2
NDVI	Normalized Difference Vegetation Index
NEA	National Environment Act
NEMA	National Environment Management Authority
NEMP	National Environment Management Policy
NFA	National Forestry Authority
NGO	Non-Governmental Organization
NMT	Non-motorized transport
NO	Nitrogen monoxide
NOAA	National Oceanic and Atmospheric Administration
NPA	National Planning Authority
NSOER	National State of the Environment Report
NUSAF	Northern Uganda Social Action Fund
NUSPA	Northern Uganda shea Processors' Association
NWSC	National Water and Sewerage Corporation
OECD	Organization for Economic Cooperation and Development
OPM	Office of the Prime Minister
PA	Protected Area
PAH	Polycyclic Aromatic Hydrocarbons
PE	Polyethylene
PET	Polyethylene Terephthalate
PM	Particulate Matter
PMS	Premium Motor Spirit
PP	Polypropylene
PV	Photovoltaic
PVC	Polyvinyl chloride
QECA	Queen Elizabeth Conservation Area
QENP	Queen Elizabeth National Park
QOL	Quality of Life
RAP	Resettlement Action Plan
RBINS	Royal Belgian Institute of Natural Sciences
REA	Rural Electrification Agency
REDD	Reducing Emissions from Deforestation and Forest Degradation
RINR	Regional Initiative against the Illegal Exploitation of Natural Resources
SCA	Special Conservation Area
SDG	Sustainable Development Goal
SDGS	Sustainable Development Goals
SLM	Sustainable Land Management
SMMRP	Sustainable Management of Mineral Resources Project
SMP	Sustainable Management Plan
SNA	System of National Accounts
SO2	Sulphur Dioxide
SOC	Soil Organic Carbon
SPGS	Sawlog Production Grant Scheme
SPR	Sector Performance Report
SRP	Soluble reactive phosphorous
THF	Tropical High Forest
TN	Total Nitrogen
TOE	Tonne of Oil Equivalent
TP	Total Phosphorous
TSS	Total Suspended Solids
UBOS	Uganda Bureau of Statistics
UBTF	Uganda Biodiversity Trust Fund
UEPB	Uganda Export Promotions Board
UGGDS	Uganda Green Growth Development Strategy
UGX	Uganda Shilling
UK	United Kingdom
UNBS	Uganda National Bureau of Standards
UNCCD	United Nations Convention on Combatting Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commission for Refugees
UNICEF	United Nations Children Fund
UNISDR	United Nations Office for Disaster Risk Reduction
UNMA	Uganda National Meteorological Authority
UNRA	Uganda National Roads Authority
UNSD	United Nations Statistics Division
UPDF	Uganda People's Defense Force
URA	Uganda Revenue Authority
URC	Uganda Railway Corporation
USAID	United States Agency for International Development
USD	United States Dollar
USDA	United States Department of Agriculture
USGS	United States Geological Society
UWA	Uganda Wildlife Authority
VOC	Volatile Organic Compound
WASH	Water, Sanitation, and Hygiene
WB	World Bank
WCMC	World Conservation Monitoring Centre
WCS	Wildlife Conservation Society
WFP	World Food Programme
WHO	World Health Organization
WWF	Worldwide Fund for Nature

Foreword

Hon. Cheptoris Sam

The Ministry of Water and Environment with pleasure presents the 13th National State of the Environment Report (NSOER) for Uganda. The theme for the 13th NSOER is "managing the environment for climate resilient livelihoods and sustainable economic development". This is a transition from the 12th NSOER theme on "Restoring the environment for livelihood improvement and sustainable economic development". Uganda continues to be a natural resource-based economy and this is likely to persist into to the foreseeable future. With this structure of the economy, the state of environment and natural resources will remain a major determinant of the overall national macroeconomic performance and human wellbeing of its citizens.

The National Environment Authority (NEMA) is mandated to prepare the NSOER. The report is developed periodically after two years and involves a multidisciplinary array of persons, institutions from the Government Ministries, Departments and Agencies (MDAs), regulators, managers, users and/or beneficiaries of the environment and natural resources and stakeholders in the implementation of the provisions of the NEA No. 5, 2019.

NEMA collected data and information against the core environmental indicators that were developed during the 10th NSOER process. The continuous updating of indicator data has allowed for trend analysis, easy identification of emerging issues and a discussion on the future outlook.

The preparation used a thematic approach that involved development of the structure and thematic areas; research and collect data along the key thematic areas, analysis and the linkages between environment, livelihood, economic development and the drivers that impact positively or negatively on the environment and natural resources.

The Ministry of Water and Environment would like to congratulate NEMA on the successful documentation of the 2018-19 National State of the Environment Report for Uganda. I hereby invite all the people of Uganda and partners to implement the actions proposed in this report.

FOR GOD AND MY COUNTRY.

Hon. Cheptoris Sam
MINISTER OF WATER AND ENVIRONMENT

Acknowledgements

The National Environment Management Authority (NEMA), in accordance with the National Environment Act No. 5 of 2019, is obligated to produce the National State of the Environment Report (NSOER) every two years. The NSOER aims to inform the public about the state of the environment in the country; the importance of the environment and natural resources in the development process and their value to society; its trends and projections; the key issues; challenges; and opportunities for improvement.

The NSOER is a key communication tool for information on environmental performance. It utilizes current scientific knowledge to support evidence-based policy for sustainable environment management. The report targets a wide audience, providing information to various stakeholders including policy and decision makers, the private sector, community leaders, academia, libraries, researchers, the media, among others.

NEMA would like to thank the Government of Uganda through the Ministry of Water and Environment for supporting the production of the National State of the Environment Report. Notable contributions of information and data used in the preparation of the NSOER came from the various Ministries, Departments and Agencies (MDAs); particularly institutions that constitute the Environment Information Network (EIN) and District Local Governments. We are grateful to the collaborating institutions and partners who participated in the technical reviews.

NEMA further acknowledges the technical support and coordination from the Senior Geographical Informtion System & Remote Sensing Officer; Julius Muyizzi for effectively coordinating all stakeholders on behalf of Government. NEMA also extends its appreciation to all staff who participated and supported the process of preparation of the 13th NSOER.

Our hope is that the report findings and recommendations will prompt decision makers and duty bearers at all levels to take timely decisions and actions to remedy anthropogenic activities that degrade our environment. It is also our hope that institutions shall undertake rightful planning in order to enhance management of the environment as infrastructure for sustainable livelihoods and development.

Dr. Tom O. Okurut

FOR GOD AND MY COUNTRY.

Dr. Tom O. Okurut
EXECUTIVE DIRECTOR
NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

Executive Summary

PART 1

The state of the environment is closely linked to the quality and productivity of several sectors in Uganda and it is a key determinant of their performance. The environment provides resources to the economy and acts as a sink for emissions and waste. Poor environmental quality in turn affects economic growth and wellbeing by lowering the quantity and quality of resources or through impacts to health.

The agriculture sector employs over 66% of the population, 80% of the women and the 63% of the youths. The average size of arable land holding per household engaged in farming increased from 1.10ha per household in 2008 to about 1.35 ha a per household by 2019 and the crop sub-sector constituted about 15.4% (cash crops, 2.4% and food crops, 13%) of the GDP. This sector has, however, greatly contributed to vegetation change and land degradation through land conversion from natural vegetation e.g. forest and wetland to agricultural fields and through poor land management practices. The major threats to wetlands are conversion to small scale agriculture, establishment of housing settlements in urban areas, illegal industrial developments and public infrastructural developments. The livestock sector contributes between 1% and 1.5% to Uganda's export trade value and Uganda is a net exporter of livestock products and live animals. Livestock exports are dominated by dairy products and eggs (USD 80 million), with meat and meat products (USD 6.2 million) playing a minor role.

Human survival, security and well-being is underpinned by the state of the environment and its ecosystems. The key ecosystems in Uganda that drive the provision of these essential services include: forests, savannah grassland and woodlands that dominate Uganda's vegetation cover, wetlands, rivers and lakes, mountainous and hilly areas. The services, material living conditions (MLC) and quality of Life (QOL) were applied for measuring the human well-being status using the OECD 2014 in the various districts or sub regions in Uganda. Kampala sub-region had good MLC but with poor QOL while the sub-regions of Ankole, Central 1 and Central 2 both good MLC as well as good QOL. Meanwhile sub-regions of Kigezi, Tooro, Bunyoro, Elgon and Busoga had poor MLC but good QOL. However, the regions Teso, Acholi, Karamoja, West Nile and Lango had both poor MLC and poor QOL. Over all human wellbeing shows that 53.3% of people had fair access to material living conditions and fair quality of life while 46.7% had limited access to material living conditions as well as quality of life.

Urbanization and infrastructure development have also significantly impacted the natural resources. Until 2019, Kampala was Uganda's only urban agglomeration classified as a city. The reclassification of nine municipalities as regional cities can promote new opportunities. This will be accompanied with expanding infrastructure such as paved roads, power distribution, water and sanitation services, and waste management. This infrastructure development should be guided by a land use plan segregating location of industrial, commercial and residential land use, even before a city physical plan is developed.

PART 2

Biodiversity: Due to the uniqueness and diversity of ecosystems and variation of climatic conditions in Uganda, the country hosts 53% of the world's mountain gorillas, 11% of the global recorded species of birds, 7.8 % of global mammalian species, 19% of Africa's amphibians and 14% of African reptilians. The country also hosts a high number of globally threatened species i.e. 39 mammals, 25 birds, 12 amphibians, 3 reptiles and 45 plants. At the national level, the number of threatened species is even much higher, underscoring the need for increased species protection in Uganda.

Forest ecosystem: Although all natural forests (Tropical high forest (THF), well stocked; THF, low stocked and woodlands) have experienced a strong decline in the past decades, plantations registered an increment between 2010 and 2017 from 3% to 8%. Overall decline in forest cover has also been halted and, for the first time since 1990, a net forest gain has been recorded. Forest loss has mainly been due to conversion of forest to agriculture. Amuru, Masindi and Hoima forest loss has mainly been due to sugarcane plantations e.g. Atiak subcounty in Amuru district alone, lost over 33.7 KM2 to sugarcane growing. The other significant cause is demand for Charcoal and fuelwood and building materials by refugees e.g. Kyangwali, Bidi bidi and Rwamwanja.

THF, fully stocked host the highest species diversity. They also host a very high number of threatened and restricted range (endemic) species. To ensure conservation of the suite of species in Uganda, most of the protected areas, especially the national parks and the larger forest reserves are critical.

Effort to restore forest cover include the Sawlog Production Grant Scheme (SPGS), focused on forest plantations as a means of reducing pressure on the natural forest estate, the tree fund where District Local Governments annually receive tree seedlings from NFA for planting, interventions by civil society organizations, and eviction of encroachers and allowing natural regeneration. Declaration of Kalagala and Itanda as a special Conservation Area covering an area of 2,835 ha under the National Environment Act No.5 of 2019, section 51 - The Kalagala- Itanda Falls Site Sustainable Management Plan (FIFS-SMP) were developed.

Wetlands: Wetland coverage reduced from 15.5% in 1994 to 13% in 2017. Of the remaining wetland, 8.9% is still intact while 4.1% is degraded. Considering the cover at drainage basin level, wetland degradation was highest in Lake Kyoga and Edward basins (42% and 34% respectively) and lowest in the Kidepo and Aswa basins (1% each). Further analysis showed that Mbale district had the most degraded wetlands with 99% of its wetlands are under threat while Ntoroko had the lowest percentage of degraded wetlands (2%).

The Kyoga basin degradation is mainly attributed to conversion of intact wetlands to subsistence cultivation of mainly rice, sugarcane and maize. In Victoria Nile and Albert Nile, wetland loss is mainly due conversion into built up areas and landfilling. Recovery chances are higher chance for areas converted to agriculture than for built-up areas, if wetland protection is enforced. In 2017/2018, a total wetland area of 487 Ha was restored. This is compounded by pollution due to indiscriminate waste disposal.

This has led to biodiversity and habitats destruction, deterioration of water quality, and have impeded natural drainage patterns leading frequent floods in most urban centres. To maintain wetlands for the future generations, key considerations should be to demarcate and gazette wetland reserves, restoration efforts should be increased and directly work with communities to conserve wetlands within a specific area

Wildlife: Although there was an overall increase in wildlife species in protected areas, species population on private land is steadily declining as a result of conversion of existing habitat for cultivation and grazing.

Between 1995 and 2017, Elephant populations increased from about 2000 to 5,808, Buffaloes increased from about 18,000 to 37,054, and Giraffe increased from 250 to 880. The Kibale National Park Chimpanzee survey conducted in 2019 indicated a population increase from 921 in 2005 to 1001 in 2019 and the gorilla population census conducted in 2018 in the Bwindi-Sarambwe area estimated Gorilla population at 496. The Black rhinos also increased in captivity from 8 in 2004 to 22 in 2017. The Grant's gazelle, however, declined from 100 individuals in 1995 to 57 in 2017.

Fisheries: Generally, fish production in the country remains higher than it was 20 years ago. Total fish production in 2018 was 456,000MT. Although it was slightly less than in 2016 (467.500MT), it was higher than 2017 (451,900MT). Over fishing and use of illegal fishing gears have, however, led to a decline in fish productivity. For example, 4,222 new fishers entered the Lake Albert fishery, increasing the total number of fishers by 17.8% since 2016. Over the same period, illegal gillnets increased by 196.3%. This was compounded by infestation of the Kariba weed (Salvinia molesta). Other threats are cultivation of water body shoreline and aquatic plastic pollution.

Establishment of the Fish Protection Unit in 2017 and promotion of cage aquaculture have led to reduction of illegal fishing activity and fishing pressure on the water bodies. More effort should be towards restoration of forests and wetlands in the water catchments, protection of water body buffer zones and promotion of sustainable agronomic practices in areas adjacent to water bodies.

The main markets for Uganda's fish are European Union (EU), Japan, Hong Kong, Singapore, Australia, Dubai, Israel and the United States. Uganda earned 171.5 million US$ of revenue from the export of fish and fish products. This is the highest ever amount the country has earned from fishery-based exports. On the other hand, fish and related aquatic products import has also continued to increase. Aquatic products import increased from 70 million 2016/2017 financial year US$ to 90.9 million US$ in the 2017/18.

Threats to Biodiversity: Threats to biodiversity include conversion and degradation of the natural ecosystem, invasive species, excessive harvesting of flora and fauna, illegal wildlife trade, poaching, human-wildlife conflict, disease outbreaks, plastic waste and pollution of water bodies. Increase in

human population has also resulted in communities settling close to areas of high wildlife populations resulting in crop raiding, spread of zoonotic diseases, loss of property and attacks on humans often resulting in retaliatory killing of wildlife. The number of reported cases of HWC has increased over the years with Murchison Falls Conservation Area (MFCA) registering the highest number. Species often associated with these conflicts include elephants, lions, hippopotamus, baboons and monkeys. These conflicts have cross cutting impacts on human livelihoods, biodiversity conservation and the economy.

Responses: Efforts to combat loss of wildlife include the establishment of the National Wildlife Crime Coordination Taskforce in 2019 and training the Taskforce members in CITES nomination criteria, training of the judicial officers in wildlife crime, recruitment and passing out of 480 rangers in 2018, piloting electric fencing in conflict hotspot areas in Queen Elizabeth National Park and Murchison Falls National Park, excavation of trenches along park boundaries, placing bee hives along trenches to increase the trench effectiveness, translocation of problem animals from conflict areas and sharing revenue from protected area gate collections with communities around the respective protected areas. In 2019 alone, a total of UGX 7,148,195,741 was shared with communities around QENP, MFNP and MENP.

NBSAP II implementation has attracted various funding opportunities including Uganda Biodiversity Trust Fund (UBTF), an independent conservation fund, UGGDS which has drawn financing for the five focus areas of agriculture, green cities, sustainable transport, sustainable energy and natural capital management, and Support from the European Union office in Uganda to mobilize at least EUR 207.35 million for implementation of biodiversity conservation and management related activities. Also under the National Environment Act No.5 (2019), a new environmental audit charge was proposed, which will raise an expected UGX 6 billion.

Recommendations: Future funding and biodiversity conservation actions should focus on control of IAS, including addressing their ecological and socio-economic impacts, strengthening enforcement to control illegal wildlife trade, implementing the financing solutions in the National Biodiversity Finance Plan, increasing investment in restoration and value addition, and strengthening protection of biodiversity outside protected areas.

Oil & Gas and Mineral Resources

Oil and gas: The country is known to have six (06) sedimentary basins namely the Albertine Graben, the Hoima basin, the Lake Kyoga basin, the Lake Wamala basin, the Kadam-Moroto basin, and the Lake Victoria basin. Three (3) exploration licenses were issued in 2018 and the ESIA for the EAST African Crude Oil Pipeline (EACOP), aimed at transporting oil from Hoima (Uganda) to Tanga (Tanzania), was completed in 2019.

Impact of the oil and gas development on environment has mainly been through vegetation clearing for infrastructure construction e.g. roads, electric power lines and the airport. The Masindi-Paara and the Kabaale-Kiziranfumbi roads have further opened up areas that are highly biodiverse, which also host threatened and endemic species. These developments have, however, also created employment opportunities, and led to increase in income and business opportunities in the areas where they occur.

Mineral and Extractives: The mineral resources sector contributes 0.3% percent to Gross Domestic Product (GDP) per annum. By 2019, the value of mineral resources produced was worth UGX 158.75 billion. The increased mining activities have, however, impacted the environment e.g. through excessive release of mercury into the air, water and land by artisanal and small-scale gold mining and leaving large burrow pits that collect water resulting in increased malaria cases. To counter these negative impacts and also improve control of the mining sector, in 2018 the president accented to a new mining and mineral policy for Uganda, 2018.

Air quality: Initiatives to study air quality, particularly in urban areas in Uganda, indicate that particulate matter and nitrogen dioxide are above the WHO recommended levels. Particulate matter (PM2.5) in the central business district of Kampala Capital City ranges from 36µgm-3 to above 80 µgm-3 (24-hour mean) which is above the WHO recommended 25 µgm-3. The collated monthly datasets in 2019 reflect seasonal variations with higher pollutant levels recorded during the months of June, July, August, September, and lower pollutant levels during the wet season months of March, April and May, while October reflected the lowest pollution levels, possibly as a result of precipitation and particulate suppression. The diurnal observations reflect that higher pollution levels occur in the early mornings (from 05:00 to 09:00) and late evenings (from 17:30 to 00:30) and much lower levels after morning hours (09:30 to 17:00). The characteristic diurnal profiles can be partly traced to the atmospheric conditions. For instance, daytime conditions being characterized by turbulent conditions that lead to higher pollution dispersion rates, whereas nighttime conditions largely hinder pollution dispersion.

In 2017/2018 no pneumonia (cough and cold) came second to malaria at 26.9% of all Out-Patient department attendances in the country, while pneumonia came 8th at 2.6% (MoH, 2018). The national records of reported air pollution-related illnesses reflect that no pneumonia (cough and cold) remains the most prevalent among such illness and could be indicative of the prevailing associated health burdens of deteriorating air quality. There is urgent need for putting in place the legal framework e.g. Air Quality regulations and strategy to provide national-level guidance on implementation of the new policy. Strict zoning during land use planning, especially of upcoming cities, needs to segregate location of industrial, commercial and residential land use to reduce air concentrations and pollution exposure to people.

Water quality: The data obtained during the monitoring of the water quality for the various major rivers indicated that River Mobuku had the highest pH while River Rwizi had the lowest. The high pH levels recorded by river Mobuku is attributed to the geological chemical formation of the area. Lake George had the lowest pH while Lake Albert had the highest pH, it was noted that pH and electrical conductivity of Lake Victoria for the year 2016 were higher than that of 2018. However, for dissolved oxygen, concentrations in the various points of the lake showed high dissolved oxygen levels of DO in 2016 than there was in 2018. Dissolved oxygen is necessary to many forms of life including fish, invertebrates, bacteria and plants.

Other rivers whose pollution level is steadily increasing yet water demand is also increasing are River Rwizi, River Mpanga and River Nyamwamba. Pollution load in River Rwizi is expected to continue growing if no intervention is undertaken. There is projected gradual increase in the concentration of BOD and COD which represents concentration of organic matter in the water.

Kilembe mining area adds Cu to Nyarusenghe stream which consequently pollutes Nyamwamba River. The water in the section of Nyarusenghe stream is polluted by Cu and Fe. The concentration of Co, Cu, Zn and Pb in vegetables (Amaranthus) grown in Kilembe catchment were higher than the recommended levels for human consumption. Wetlands at the mouth of River Nyamwamba discharge point to Lake George are critical for water filtration and ought to be well protected.

There is increased BOD and COD along River Mpanga at the point where the river receives effluent from an abattoir and the hospital wastewater, therefore, the main pollution sources upstream include: Kabundaire abattoir; where waste is directly deposited in the river untreated; Kabarole main referral hospital; The sewage treatment ponds and Mpanga market area where there is high risk of waste from the market entering the river.

Interventions to control water pollution should include containment of tailings erosion, demarcation, isolation and treatment of underground mine water and leachate, mapping highly contaminated soils and prohibition of cultivation or grazing animals on such soils, enforcement of waste management regulations and protocols, strengthening enforcement of the existing legal frameworks and expansion of the Integrated Water Resources Management (IWRM) framework to include other aspects like poverty eradication and disaster preparedness.

Soil Condition: In Uganda, soil organic matter is low to medium in most places, and is declining due to increased erosion and poor land management practices. Soil organic carbon and soil pH are key indicators of the status of soil health, the pH of Uganda's soils vary, owing to a climate gradient, but has a narrow range between 4.8 and 6.3. High soil pH is mainly in the Karamoja region, where conditions are generally dry; otherwise the rest is low because of wet conditions .

Soil degradation is a major threat to food security in Uganda and is responsible for siltation and pollution of lakes, rivers and open water sources, which has affected livelihoods. Major causes of soil degradation in Uganda are nutrient depletion and soil erosion. The degradation of the soil resource in Uganda is attributed to population growth and the attendant effect on land ownership and fragmentation, land tenure, adoption of inappropriate land and soil management practices, and the low use of fertilizers and organic manure. The population explosion seems to out-match farmer's ability to find arable land and 50% of the land have soils of medium productivity. This means encroachment of protected

land in places s' ability to find arable land.

Interventions should include revision of the legal framework e.g. the National Environment (Minimum Standards for Management of Soil Quality) Regulations and the National Environment (Hilly and Mountainous Area Management) Regulations, mapping of erosion risk and soil nutrient deficiency, enforcing the adoption of appropriate soil and water conservation strategies.

Hazards and Disasters: The districts that were most affected by drought were Karenga, Kaabong, Arua, Madi-Okollo, Nebbi, Packwach, Zombo, Mbarara, Kiboga and Lira. Those most affected by floods were Kasese, Kabale, Kisoro, Nebbi, Katakwi, Amuria, Butaleja, Tororo and Sironko. Districts most affected by landslides were Bududa, Sironko, Bulambuli, Kasese and Bundibugyo. In 2018, a total of 48 drought incidences, 113 flood incidences, 30 landslide incidences, 74 hailstorm incidences and 11 windstorms were reported. Other reported incidences include lightening, earthquakes and fire hazards. Some of the anthropogenic causes of disasters and hazards were land degradation, deforestation of fragile ecosystems, wetland encroachment and use of inappropriate farming methods.

Interventions included relocation of affected families, continuous media sensitization and awareness creation in disaster prone districts, operationalization of disaster management committees and catchment management plans, provision of humanitarian relief and non-food items, compilation and dissemination of early warning materials, and establishment of small/large scale irrigation schemes and water reservoirs in drought and flood prone regions. Future action should aim at strengthening weather monitoring, forecasting systems and dissemination, strengthening the enforcement mechanisms of environmental laws and regulations, and integration of Disaster Risk Reduction measures in development planning processes. Unfortunately, more disasters are likely to occur, if the rate at which land-use systems are expanding is not closely monitored and the different uses strictly regulated.

Refugees: Uganda is the largest refugee-hosting country in Africa with over 1.29 million refugees and asylum seekers. The largest number is from South Sudan (66%) followed by DRC (28%). Other countries of refugee origin are Burundi, Rwanda and Somalia. Although on average refugee-host community ratio is 18%, districts like Ajumani and Moyo have a ratio of 47% to 53% and 44% to 56% respectively. Kampala and Koboko have the lowest refugee to host population ratio of 4% to 96% and 2% to 98% respectively.

Currently, a household in the refugee settlement has an average of 6 people while the size of allocated land is mostly 30 by 30 meters, which is inadequate for supporting household livelihood and agricultural needs. The refugees have thus encroached on protected areas and fragile ecosystems (forests, wetlands/ river banks/ lake shores) for both food production and other livelihood and economic activities including sand mining, stone quarrying, timber and charcoal production. Other challenges in refugee camps include inadequate water supply, poor waste disposal and management, low latrine coverage, pollution and health impacts.

To counter these challenges, a Refugee and Host Population Empowerment (ReHoPE) strategy was developed in 2017. The Development Response to Displacement Impact Project (DRDIP) and Northern Uganda Social Action Fund (NUSAF) have implemented Infrastructure, Environment, Livelihoods and Project Management activities. DRDIP has attracted an additional USD 150 million to finance its second phase. It is also important to mainstream environment and natural resources management across all settlements and refugee programmes.

PART 3

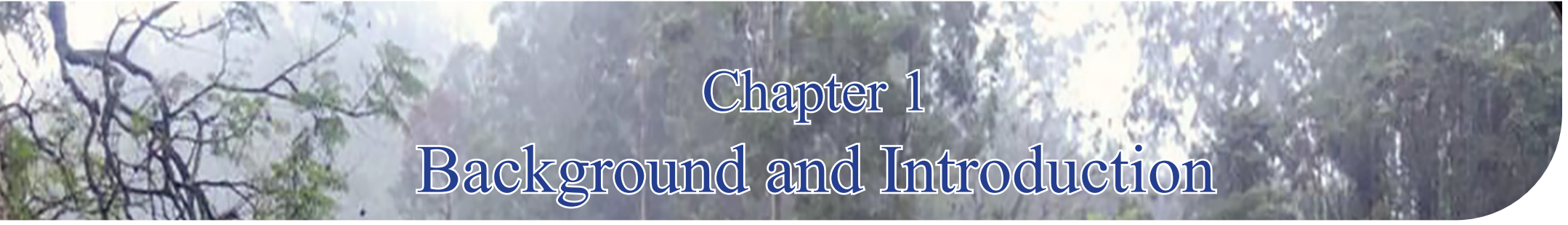
Policy and Action Responses: The NEA No.5 of 2019, which come into force on 27th June 2019 introduced the Right of Nature, Special Conservation Areas, Payment for Ecosystem services, Biodiversity and other Offsets, sound management of chemicals, pollution control and liability, management of impacts arising from Oil and Gas developments, e-waste management, strategic environmental assessments, management of plastics and plastic products, enhanced role and functions of lead agencies, and establishment of the Environment Protection Force, and the mandate to develop guidelines and tools for management of the different aspects of the environment. These provisions should be made use of e.g. for ensuring protection of biodiversity outside protected areas through establishment of Special Conservation Areas.

Other instruments put in place include the Wildlife Act (2019), the National Biodiversity Strategy and Action Plan (NBSAP) 2015-2025, the national biodiversity and offset strategy (MWE, 2019), the mining and mineral policy for Uganda, 2018, and the National Biodiversity Finance Plan (NBFP), 2019, which identified eight biodiversity financing solutions.

Although little effort has been made to assess the ecosystem services of the natural resources in Uganda, the Government is in the process of integrating Natural Capital Accounting (NCA) into the System of National Accounts (SNA), and into the macroeconomic indicators. The focus is on developing accounts for Water, Wetlands, Forest, Tourism and Biodiversity, Fisheries, and Land (soil) and land degradation (soil). This is to ensure that natural wealth of the country is managed and used sustainably.

Recommendations indicated in this report, if implemented based on the now available legal framework, will ensure nature sustainability for future generations, climate resilient livelihoods and sustainable economic development.

PART 1



Chapter 1
Background and Introduction

Production of the National State of the Environment Report (NSOER's) is a statutory requirement of the National Environment Management Authority under section 46 of the National Environment Act (NEA), No. 5, 2019. The NSOER is published every two years..

This is the 13th National State of Environment Report (NSOER) for Uganda. The theme for the 13th NSOER is ***"Managing the environment for climate resilient livelihoods and sustainable economic development"***. This is a transition from the theme of the 12th NSOER "Restoring the environment for livelihood improvement and sustainable economic development". Uganda continues to be a natural resource-based economy and this is likely to persist into to the foreseeable future. With this structure of the economy, the state of environment and natural resources will remain a major determinant of the overall national macroeconomic development (performance) and human wellbeing of its citizens.

The development of NSOER involves a multidisciplinary array of persons, institutions, regulators, managers, users and/or beneficiaries of the environment and natural resources and stakeholders in the implementation of the provisions of the NEA No. 5, 2019.

The country's social-economic transformation and human wellbeing is hinged on effective and efficient utilization of its diverse environment and natural resources. Indeed, the strategic focus of ending the National Development Plan (NDP II) and commencing the National Development Plan (NDP III) is on harnessing the immense opportunities in Agriculture, Tourism, Minerals, Oil and Gas sectors all of which are natural resources-based. These are the key priority investment areas for driving the country towards the middle-income status. The extent however, of availability of the resource values and benefits from these sectors shall be dependent on the state of the environment.

Environment is categorized as a crosscutting issue in the national planning and budgeting processes and as such deliberate efforts must be put in place to mainstream environment actions in sectoral plans with budget allocations as necessary and sufficient conditions for sustaining the environment. Mainstreaming environment has extensive backward and forward linkages to the wider economy and if harnessed it has the potential to contribute to job creation, sustainable economic growth and the transformation of the country. Environmental sustainability is thus a critical determinant of sustainable economic development.

1.1 Purpose of NSOER

The NSOER report aims at informing the general and informed public about the state of the environment in the country; the importance of the environment and natural resources in the development process and their value to society; its trends and projections; the key issues, challenges and opportunities for improvement. It is therefore a method of communicating environmental performance which serves as an accurate and useful reference document to support Environment Management in the country

1.2 Approach for developing the National State of the Environment Report

The preparation of the NSOER was conducted through a participatory process, guided by the Coordinator under the supervision of the NEMA Executive Director. The review was executed in phases: planning, thematic desk review, field visits, analysis, drafting, validation editing and dissemination.

Phase 1: Planning

TThe planning phase involved concept development where a theme (Managing the environment for climate resilient livelihoods and sustainable economic development) was proposed and adopted; identification of key environmental issues; hotspots and hope spots; methodology and the implementation plan. It also involved inception planning; development of the structure and thematic areas; formation of thematic teams to research and collect data along the key thematic areas of: environment, economy and human wellbeing, Biodiversity (Forest, Wetlands, Wildlife, Fisheries,), Oil and gas, energy resources and mineral and extractives; water quality; soil condition; hazards and disasters and refugees.

The team at this stage involved sector ministries, departments and agencies (MDAs) with a direct responsibility of implementing sections or parts of the National Environment Act NEA No. 5 2019 plus other representation of civil society and private sector.

Phase 2: Thematic desk review meetings

The key tasks performed under this phase by the team above included: literature review, assessment and evaluation of information and data collected and assembled by the thematic teams including data obtained from the institutions policy and sectoral reports including published and unpublished research reports. All the collected information was discussed in several general and sectoral review meetings to determine its usefulness and value to the NSOER theme and content correctness. Data outcomes from review meetings was used to develop a trends analysis for identified environmental issues.

Phase 3: Field Visits

Field Visits were conducted to collect environment information and "evidence" in specific places experiencing noticeable environmental change (Hotspots and Hopespots) for analysis.
Time-series satellite imagery of identified hotspots and hopespots were analyzed to monitor the environment's resource and visually document the extent to which humans and natural processes have had an impact on the specific environment components over the review period.

Phase 4: Analysis

The Drivers, Pressures, Status, Impacts and Responses (DPSIR) framework was the analytical tool used to link processes in terms of human behavior to their consequences for the environment (outcomes/impacts). DPSIR provides a proven basis for describing elements of the chain that link human activities to their impacts on the environment and the effectiveness of responses (Patricio et al. 2016). The status and trend on environmental and natural resources were analyzed using this framework on the data validated. The framework helped to order the data and information in such a way as to tell the story of environmental change in an integrated fashion, linking causes and effects including identification of hotspots and hopespots.

A significant area of the Earth's surface that is susceptible to slow-onset or rapid environmental change is referred to here as a "hotspot" and is explained through the use of two or more satellite images showing the change over time. A positive outlook for the future is captured through the concept of a "hopespot", which refers to areas where actions have led to, or are leading to, positive changes, such as restoration and rehabilitation (UNEP, 2013). Time-series satellite imagery of identified hotspots and hopespots were analyzed to monitor the environment's resource and visually document the extent to which humans and natural processes have had an impact on the environment.

Phase 5: Technical Review and Validation

A series of technical review and validation meetings were held in the course of preparing this document and this involved Ministries, Departments and Agencies (MDA's), Civil Society Organisations (CSOs) and Private Sector Organisations' (PSO) experts in addition to the thematic group authors. The various thematic review chapters were progressively assessed, refined and edited to ensure relevance, content correctness, and national outlook picture.

The thematic teams later integrated the comments in the draft reports of NSEOR produced in each session.

Phase 6: Copy Editing Layout Design and Publishing

Copy editing and layout design of the final draft of the National State of the Environment Report 2018-19 was undertaken by a team of editors. This involved reviewing and correcting written material to improve accuracy, readability, and fitness for its purpose, and to ensure that it is free of error, omission, inconsistency, and repetition. The Top Management of NEMA re-validated the final product just to be sure of the final content before publishing.

Phase 7: dissemination

The National State of the Environment Report is a very valued product and on high demand by its large and varied array of users. It is disseminated to stakeholders in the public, research institutions, Districts, Libraries, government agencies, development partners and can be accessed in the NEMA Library and online.

1.3 Structure of the Report

The NSOER is divided into four parts, Part I comprises of; Chapter 1: Background and Introduction, which provides the background to state of environment reporting, the purpose of the NSOER, and the approach used for developing the National State of the Environment Report; Chapter 2: Environment, Economy and Human wellbeing provides information on the relationship between the Environment, and the Economy, and the Environment and Human Wellbeing. Part II covers the State of the Environment and it is composed of seven chapters: Chapter 3: Biodiversity (Forest, Wetlands, Fisheries, Wildlife), Chapter 4: Oil and Gas, and Mineral Resources, Chapter 5: Air Quality, Chapter 6: Water Quality, Chapter 7: Soil Condition, Chapter 8: Environmental Disasters and Hazards, Chapter 9: Refugees and Environment. Part III of the NSOER looks at policy responses, describes the different types of policy responses and actions that are being used to address environmental issues; and also tries, where possible, to assess their success or failure as well as ongoing reviews and amendments. Part IV attempts to look into the future, since, present day actions also have consequences that reach far into the future and there is a need to look at the environmental issues that are likely to require priority attention in the future.

Bibliography

National Environment Act No 5 2019; Republic of Uganda

National Development Plan II, National Planning Authority, July 2015

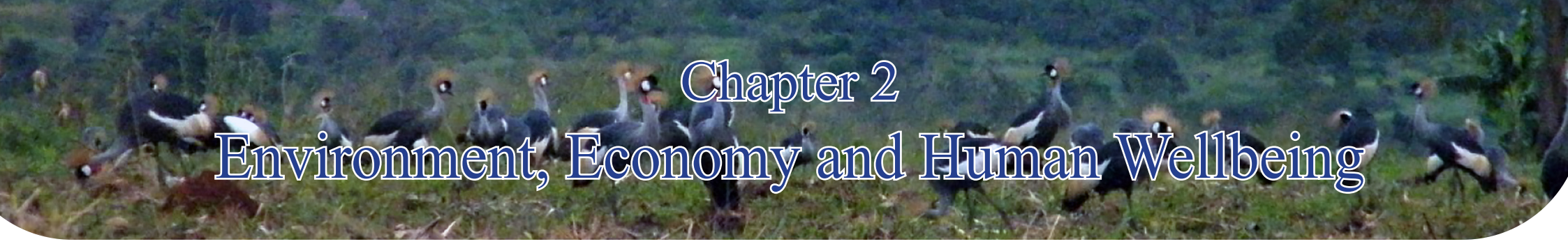
National Development Plan III, National Planning Authority, July 2020

National State of the Environment Report No 12, National Environment Management Authority 2016

Patrício J, Elliott M, Mazik K, Papadopoulou K-N and Smith CJ (2016) DPSIR—Two Decades of Trying to Develop a Unifying Framework for Marine Environmental Management? Front.

Mar. Sci. 3:177. doi: 10.3389/fmars.2016.00177

UNEP 2013



Chapter 2
Environment, Economy and Human Wellbeing

2.1. Introduction

The Environment and natural resources in Uganda are the foundations of the economy, these include; soils, lakes and river banks, rangelands, flora and fauna among others. It is estimated that gross returns to national economy from bio-diversity alone can be as high as US$ 63.9 billion per year (*Moyini, etal, 2002*). The economy leverages the environment and natural resources for livelihoods improvement and general economic wellbeing. Effective utilization of the environment and the natural resources in the regions endowed with the same has led to reduction in poverty levels and improving livelihoods and wellbeing.

The Uganda National Household Survey (2017) by the Uganda Bureau of Statistics (2017) indicated a reversal performance on poverty levels. The results of mid-term review of the NDPII (2015/16-2019/20) also reveal slow progress towards national targets such as economic growth and per capita income among others. The report depicts poverty and big regional income inequalities with the eastern and northern regions ranking as the poorest regions in comparison to the central and western regions. For example, around 43 percent of Ugandans were insecure non-poor in 2013, defined as those living above the national poverty line but living on less than twice the national poverty line (World Bank 2015). This section presents the implications of the state of the environment on the overall performance of the economy and human wellbeing. The section therefore explores the state of environment, the economy and human wellbeing nexus. This generates key issues for consideration to enhance environmental sustainability, the performance of the economy and improved human wellbeing.

2.2. Environment and the economy

2.2.1. Macroeconomic performance and outlook

The Ugandan economy estimated growth rate of 6.3% in 2018/19, was still below the NDPII targets of 6.8 percent and was largely driven by the expansion of services. Services growth averaged at 7.6% in 2019 driven by trade and repair, financial and insurance, information and communication, public administration, education and health activities. Industrial growth 6.2%, driven by increased manufacturing activities, construction and mining. Agriculture grew by 3.8% mainly attributed to an increase in food and cash crop growing activities. Retail, construction, and telecommunications were key economic drivers. While inflation remained below 5 %,(African Development Bank Group, 2019: Uganda Economic Outlook). Exports were majorly primary products and did not match up with imports widening the trade deficit to an estimated 9.4% of GDP in 2019 from 8.3% in 2018 (World Bank, 2019). The service sector, however, was expected to decrease during 2019 mainly due to due to slower growth in the trade, transportation and storage, accommodation, and food sub-sectors.

Furthermore, according to the African Development Bank Group economic outlook for Uganda, retail, construction, and telecommunications drive the economy, with mining, transport, and hospitality expected to grow as oil and gas investments are made. Also urban development with rapid urbanization, rising population density, increasing market size and access, clustering of skills and technology, and proximity to financial institutions, offers opportunities for business development, firm creation, and new jobs.

Kampala was, until 2019, Uganda's only urban agglomeration classified as a city. The reclassification of nine municipalities as regional cities can promote new opportunities. The new cities will be phased in over three years, expanding infrastructure such as paved roads, power distribution, water and sanitation services, and waste management (African Development Bank Group, 2019).

Uganda is transitioning to a service economy but faces low productivity and low job creation. The economy has become more productive, but productivity differences across industry, services, and agriculture are large. Industrial productivity is seven to eight times higher than in the services and agriculture sectors (African Development Bank Group, 2019).

2.2.2. Implications of socio-economic developments on the environment

Through Lead Agencies, NEMA continues to regulate projects and/or development activities which are likely to impact on human health and the environment. Different categories of proposed projects over the years are reviewed and guidance given through issuance of certificates and conditions to be followed to avoid, reduce or minimize project impacts on communities. The number of projects approved by NEMA has continued to increase year after year, a positive sign of awareness amongst the regulated communities about issues pertaining to environment conservation and management, and the requirements under various environmental laws and standards. The Authority approves on average a total of more than 1,200 projects in each financial year. In FY2018/19, 1,125 were approved by the Authority (Figure 2.1 and Figure 2.2.), compared to a total of 807 projects approved during the FY2017/18

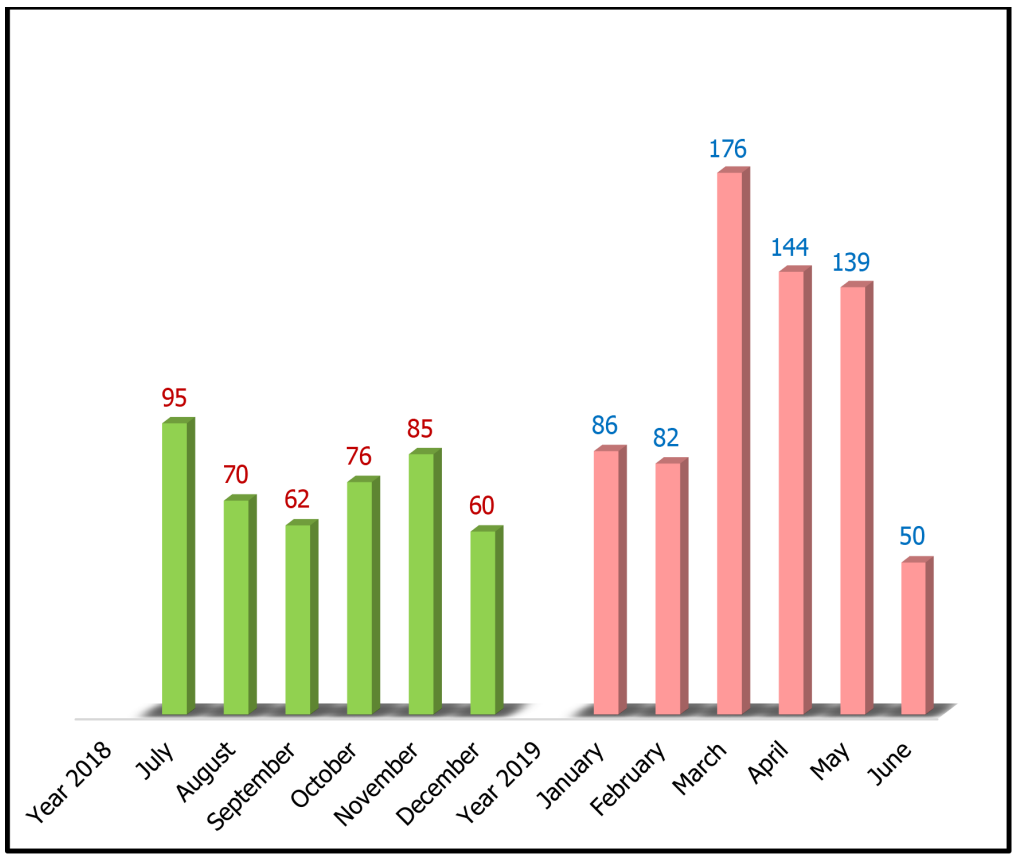


Figure 2.1: Total number of projects approved and certificates issued during July, 2018 - July, 2019 period

Figure 2.2 illustrates categories of projects approved by NEMA with Fuel Stations (22.8%), Information Communication Technology (22.0%), Infrastructure (21.1%), Industry (14.7%), and Mining (6.2%) being categories with the highest number of approved projects. These five categories of projects constituted 86.8% of the total projects approved by NEMA during the July, 2018 to June, 2019 period. These sectors were as noted earlier contributed immensely to GDP growth.

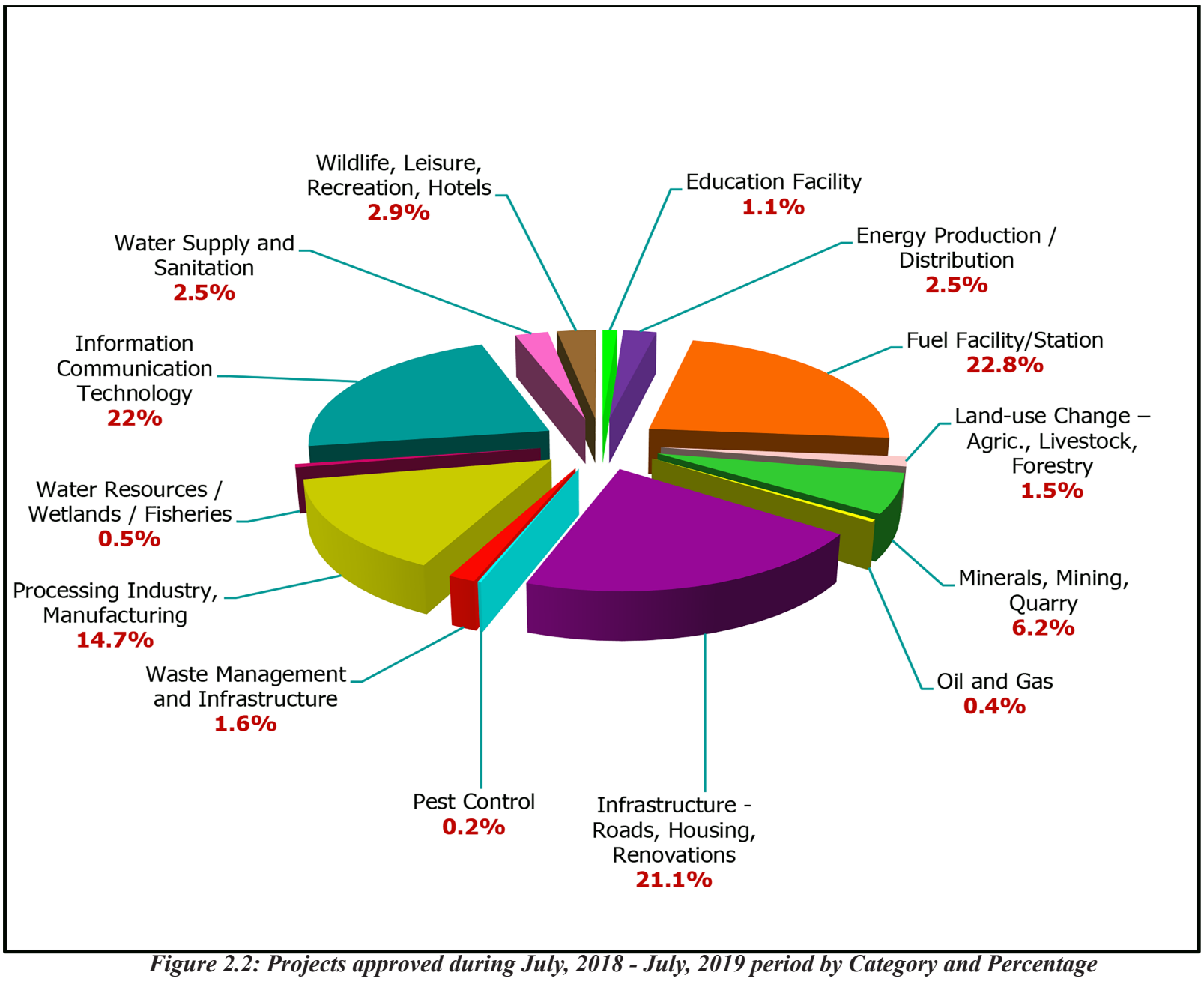


Figure 2.2: Projects approved during July, 2018 - July, 2019 period by Category and Percentage

Whereas the projects provide opportunities for employment and sources of income for a cross-section of people, among other benefits to the economy and the country, there are also some associated negative impacts on human health and the environment. For instance, establishment of infrastructural projects and industries, create a big demand for supply of construction materials which are sourced from the environment. The rate of extraction of gravel/ murram, rock/ stone, water, sand, clay and wood, among others to meet the infrastructural demand is directly proportional to the number of approved projects. Extraction of these materials often leads to land degradation, conversion of swamps/ wetlands, deforestation/depletion of wood sources both for construction and as sources of fuel, soil erosion, disruption of the local hydrology which may affect the water catchment systems, borrow pits that are often not restored, among other negative impacts.

In addition, noxious gases are emitted from different kinds of small-scale and large-scale industries, though the motorized transport sector is the biggest contributor to the continued deterioration of the quality of air and associated negative impact on human health and other vulnerable receptors. Information, Communication and Telecommunication (ICT) projects continue to have a direct positive impact on society and the country's economy, by improving national communication interconnectivity.

Projects approved can show the rate of investment in the economy. This contributes to the economic wellbeing of the persons and communities involved. Project developments promote business growth especially Small and Medium Enterprises (SMEs) and encourage migration of labour to mining areas, construction sites and promote trade. Such developments also inevitably exert pressure on the available social services (water supply, sanitary facilities, and medical services) in the affected localities.

2.2.3. Economic sectors and environment

The state of the environment is closely linked to the quality and productivity of several sectors in Uganda, and is indeed a key determinant of their performance. It is for this reason that environment is considered as one of the crosscutting issues that influences many sectors.

The term or phrase "economic sectors" is variously defined. The different definitions, however, portray the same categories of economic sectors in relation to the environment. That is, economic sectors can be simply defined as categories of the economy grouped according to their place in the production chain, and by their role or kind of work (product or service) or ownership.

Generally, the main sectors of the economy are grouped as follows: primary sector which is largely extraction of raw materials; secondary / manufacturing sector which is concerned with producing finished goods, construction activities, and utilities; tertiary (service) sector that is concerned with offering intangible goods and services to consumers, and includes tourism and information technology; and, quaternary sector which encompasses knowledge economy, education, research and development (*Table 2.1 below.*).

Table 2.1: Sectors of the economy and their role of work

Sectors of the Economy	**Components / Activities**
Primary sector (raw materials)	Extraction of raw materials
	Farming / fishing / forestry
Secondary sector (processing of raw materials / finished goods)	Manufacturing
	Utilities – electricity, water supply
	Construction
Tertiary sector (service)	Retail
	Financial services
	Communication
	Hospitality and leisure
	Real estate
	Information technology
Quatenary sector	Education
	Public sector
	Research and development

The said sectors depend on natural resources base directly or indirectly. Hence, the relationship between environment and economic sectors is largely considered as the natural environment providing the raw materials (land/soil, water, air, plants, animals, minerals) for production of goods and services. Many writers and researchers have provided various insights into what constitutes economic sectors and what constitutes the natural environment, in order to provide a holistic view of the relationship or linkage between economic sectors and the environment.

The links between the economy and the environment are manifold. The environment provides resources to the economy and acts as a sink for emissions and waste. The natural resources are essential inputs for production in many sectors, while production and consumption also lead to pollution and other pressures on the environment. Poor environmental quality in turn affects economic growth and wellbeing by lowering the quantity and quality of resources or due to health impacts, (*OECD, October 2016*)[1] .

1. The OECD Global Forum on Environment on "Towards Quantifying the Links Between Environment and Economic Growth" held 24-25 October, in Paris

In addition, the economic sectors mentioned can be impacted upon or influenced by land-use systems planning processes, land-use practices, environment management practices, and performance of the national economy in general.

Distribution of total area of Uganda by type of cover / use

The total area of Uganda is about 241,555 square kilometres (sq.km). The last updated landuse/cover type is of the year 2017 which shows shares of the total area of Uganda under different uses as illustrated in Table 2.2(a) (comparison between the years 2015 and 2017), Table 2.2(b) (landuse cover as percentage of total area of Uganda), and Figure 1 below. There have been significant changes in certain categories of land-use especially between the year 2015 and 2017.

For instance, the combined coverage under forests comprising broad-leaved plantations, coniferous plantations, and woodland, increased from a total of 1,938,990ha (19,389.90sq.km) in the year 2015 to 2,505,266ha. (25,052.66sq. km) in 2017 – constituting an increase of 29.2%. The largest share of increase in forest cover was primarily contributed by increase in area under broad-leaved plantations as shown in Table 2.2(a).

Overall, the largest proportion of total land-use cover, however, is under subsistence and commercial farmlands. There was also a small increase was witnessed in the area built-up area during the 2015 – 2017 period, increase of 2.3%; while the area under bushlands decreased from a total of 1,970,692ha (19,706.92sq.km) in 2015 to 1,664,429ha. (16,644.29sq.km) in 2017, accounting for 15% decrease in area.
Table 2.2(a) and Figure 2.3).

Table 2.2(a): Comparison between the years 2015 and 2017 on the distribution of the total area (ha) of Uganda by type of cover / uses.

LAND COVER TYPE	YEAR 2015	YEAR 2017
Broadleaved plantations	43,733	336,548
Coniferous plantations	63,546	303,204
THF high stocked	525,134	524,189
THF low stocked	104,592	102,150
Woodlands	1,201,985	1,239,176
Bushland	1,970,692	1,664,429
Grassland	5,103,796	5,121,004
Wetland	716,721	785,703
Subsistence farmland	10,275,557	10,003,444
Commercial farmland	255,934	182,396
Built up	135,593	138,722
Water bodies	3,750,237	3,746,221
Impediment	7,828	8,162
Total	**24,155,346.98**	**24,155,346.66**

Table 2.2(b): Percent distribution of the total area of Uganda by type of cover / uses, in the year 2017

LAND COVER TYPE	PERCENT OF TOTAL AREA OF UGANDA
Impediments	0.03
Build up areas	0.6
Wetlands	3.2
Bushland	6.9
Forests (Tropical high forests + woodlands + plantations)	10.4
Open water bodies	15.5
Grassland	21.2
Agriculture (subsistence + commercial)	42.17
Total	100.0

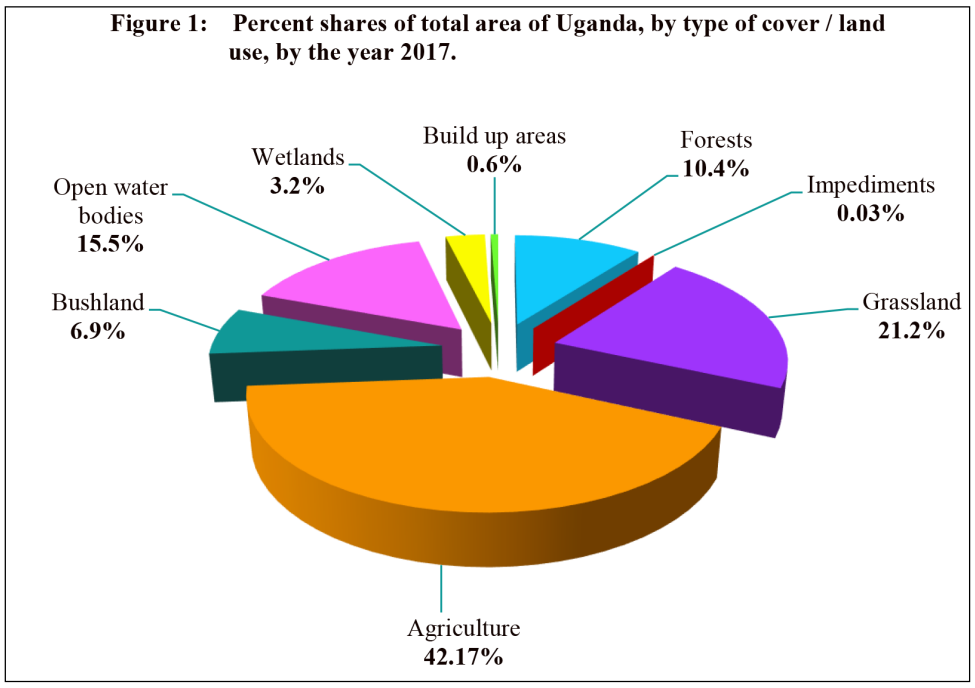


Figure 2.3: Percent shares of total area of Uganda, by type of cover / use, by the year 2017

It is evident that largest share of the total area of Uganda is under agriculture. The bushland, grassland and wetland areas also have extensive areas constituting pastures or grazing areas for livestock, wild animals, among others.

In addition, according to Majaliwa Gilbert Jackson Mwanjalolo et al, 2018 presently the diversity of conversions of natural ecosystems for different land-use systems is a critical challenge in Uganda. This is mainly driven by the need to meet the livelihoods of different communities including the business community, high demand for forest products, urban expansions, and infrastructural developments (e.g., construction of roads/highways, hydropower dams, airports, industrial parks, housing estates).

As a result, the country has witnessed massive losses of natural vegetation and intensification of human activities. This situation is further aggravated by the overexploitation of natural resources, use of unsustainable harvesting and agronomic practices, and effects of climate change. Uganda has witnessed many environmental problems including frequent occurrences of landslides and floods causing deaths and loss of property, loss of biodiversity, low agricultural output, and reduced forest and wetland goods and services.

Agriculture Sector and the Environment

In terms of the economy the agricultural sector falls under the primary sector (raw materials), which is the main source of agricultural raw materials, and supports activities associated with crop, livestock, fishing and forestry sub-sectors. Agriculture constitutes about 44% of the share of the total area of Uganda, and it contributed about 25% to the total GDP in the FY 2016/17, 22.8% of the GDP in 2017/18 and slightly reduced to 21.9% in 2018/19 (UBOS, 2019). It is also the major employer of over 66 percent of the population, 80 percent of the women and the 63 percent of the youths[3] . Despite contributing to the GDP and population wellbeing, the sector has had a major impact on the environment in terms of land degradation, deforestation as well as biodiversity loss.

Agricultural land refers to the share (the proportion) of land area that is arable including land that is under permanent or perennial crops and permanent pasture. Arable land is generally referred to as land that is cultivable. Land under permanent/perennial crops (e.g., coffee, cocoa, rubber, and tea, and fruit trees), however, need not to be replanted after each harvest, but excludes trees grown for wood or timber.

Agricultural land per capita

According to the World Bank (World Bank, June, 2016: World Development Indicators – Economy) the total arable land area is about 6,900,000 hectares (ha). Hence, the available arable land per person (hectares per person) – per capita arable as of the year 2016, stood at 0.174%. Considering the estimated population size of Uganda of about 40 million by the year 2019 the per capita-arable land is about 0.17ha (about half an acre per person).

Overall, due to increasing population size, trends in per capita arable land for Uganda has been steadily decreasing as depicted in Table 2.3, over a period of 55 years. The highest per capita arable land figure was registered in the year 1964 – 0.490 ha (1.2 acres) per person.

Despite the decreasing trend of per capita arable land depicted in Table 2.3,

2. Uganda Bureau of Statistics: 2019 Statistical Abstract.
3 2015/16-2020/21 NDP II, NPA

the recent agriculture survey of 2018, however shows that average size of arable land holding per household engaged in farming, has increased in the last decade (2008 – 2017) from 1.10ha per household in 2008 to about 1.35 ha per household by 2019 (UBOS, 2019).

Table 2.3: Per capita arable land trends for Uganda in selected years, in the period 1964 – 2019.

Year	*Per capita arable land (ha)*
1964	0.490
1975	0.375
1985	0.337
1995	0.248
2005	0.215
2015	0.181
2019	0.170

Source: FAO, 2019: Uganda - Arable land (hectares per person).

Generally, on average each household uses two parcels of land amounting to about 1.5ha (3.7 acres). Only 13% of the household use 5 parcels of land totaling 3.9ha (equivalent to18 acres).

Also Majaliwa Gilbert Jackson Mwanjalolo et al, 2018 indicates that the highest gains in usage of land area were experienced in subsistence agricultural land and protected grasslands, while the highest losses were seen in grasslands that are unprotected and woodland/forest with low livestock densities. In the same vein, it is predicted that by the year 2040, subsistence agricultural land is likely to increase by about 1% while tropical high forest with livestock activities is expected to decrease by 0.2%, and woodland/forest that is unprotected, by 0.07%. This implies that as the population increases there is more demand for agricultural produce/products and in turn demand for more land for farming purposes.

The study referred to indicates that the high demand for agricultural land and land for establishment of settlements, are mainly responsible for land-use systems patchiness or distortion, and land degradation. Also more disasters including landslides, floods, droughts, are likely to occur in Uganda, and consequently causing more deaths and loss of property, if the rate at which land-use systems are expanding is not closely monitored and the different uses strictly regulated.

The Annual Agriculture Census Survey (AACS) of 2018 (UBOS, 2018)[4] also confirms that although agriculture is predominately rain-fed, only less than 3% of households (out of a total of 7 million households surveyed) irrigate their farmlands. This implies that there is potential to transform areas that experience frequent dry spells or prolonged dry seasons into productive areas, if irrigation systems are established in such areas. Hence, the agricultural sector susceptibility to adverse weather conditions will always remain a major risk to the economy.

Beyond impacts on immediate income, environmental shocks and climatic risks also become an important constraint to productivity growth. When individuals are not covered for such risks, they are less willing to invest in inputs and skills (e.g. investing in irrigation systems, modernizing agriculture production and practices) that help improve productivity. In addition, the drought and Pest infestations observed in 2016 and 2017 largely explained the increase in poverty incidence up to 21.4% percent (World Bank, 2019)[5] .

Crop Sub-sector

The 2018 (UBOS) agriculture survey indicates that the total number of household involved in farming at the time of the survey was about 7.4 million (seven million four hundred thousand). The survey revealed that despite the relatively wide range of crops in Uganda, four food crops dominated (ranked highest) in the crop sub-sector, namely, maize, bananas for food (matooke), cassava, and beans.

In terms of total area under the four major crops and the proportion of total households involved, the following were realized: for maize crop – 55% of the total households engaged in farming activities grew maize on 2.5 million hectares of land in both the first and second seasons, which amounted to 3.4 million metric tonnes of maize; for banana crop (matooke) – 47% of households had bananas planted on total of 579,000 hectares resulting in production of 6.5 metric tonnes; for cassava crop – 941,000 hectares was under cassava crop and involved 29% of the households, resulting in production of 4.4 million metric tonnes of cassava; and, for beans – 54% of the households were involved with a total of 728,000 hectares under beans, resulting in production of 1.2 million metric tonnes.

The survey stated above also showed that the main cash (perennial) crop which have ranked highest and is considered a strategic crop for Uganda, is coffee. The 2018 survey indicates that 428,000 ha was under coffee, out of which Arabica coffee was grown by 17% of the total households surveyed and Robusta coffee was grown by 8% of the households. Overall, the crop sub-sector constituted about 15.4% (cash crops, 2.4% and food crops, 13%) of the GDP (UBOS, 2019) .

In terms of crop yields, the decline was mainly due to low adoption of appropriate soil management practices an indicator of poor soil health, and hence unsustainable production practices. According to the Uganda Bureau of Statistics (UBOS) Annual Agriculture Census Survey (AACS) of 2018 (UBOS, 2018) , `Uganda's soil fertility has declined and hence, it needs enhancements; however, households utilizing fertilizers are a minority in the country. That is, only about 24% of the 7 million households surveyed in 2018, use fertilizers, while the majority (40%) do not apply fertilizers because they are too expensive, and 25% believe that the soils are fertile enough.

It was indicated in the 2018 AACS Report that the majority of households use organic fertilizers while 32% of the households use inorganic fertilizers. The AACS also revealed that in the country, Mbarara District ranked highest in the percentage (64.8%) of household using fertilizers, followed by Kachwekano in Kabale with 39.6%, while Nabuin in Moroto had the lowest percentage (3%) of households using fertilizers. These are areas which are experiencing negative impacts of land degradation (e.g., cause by soil erosion, removal of vegetation cover, poor farming practices) and drought.

Five major crops were analyzed as shown in Figure 2.4.

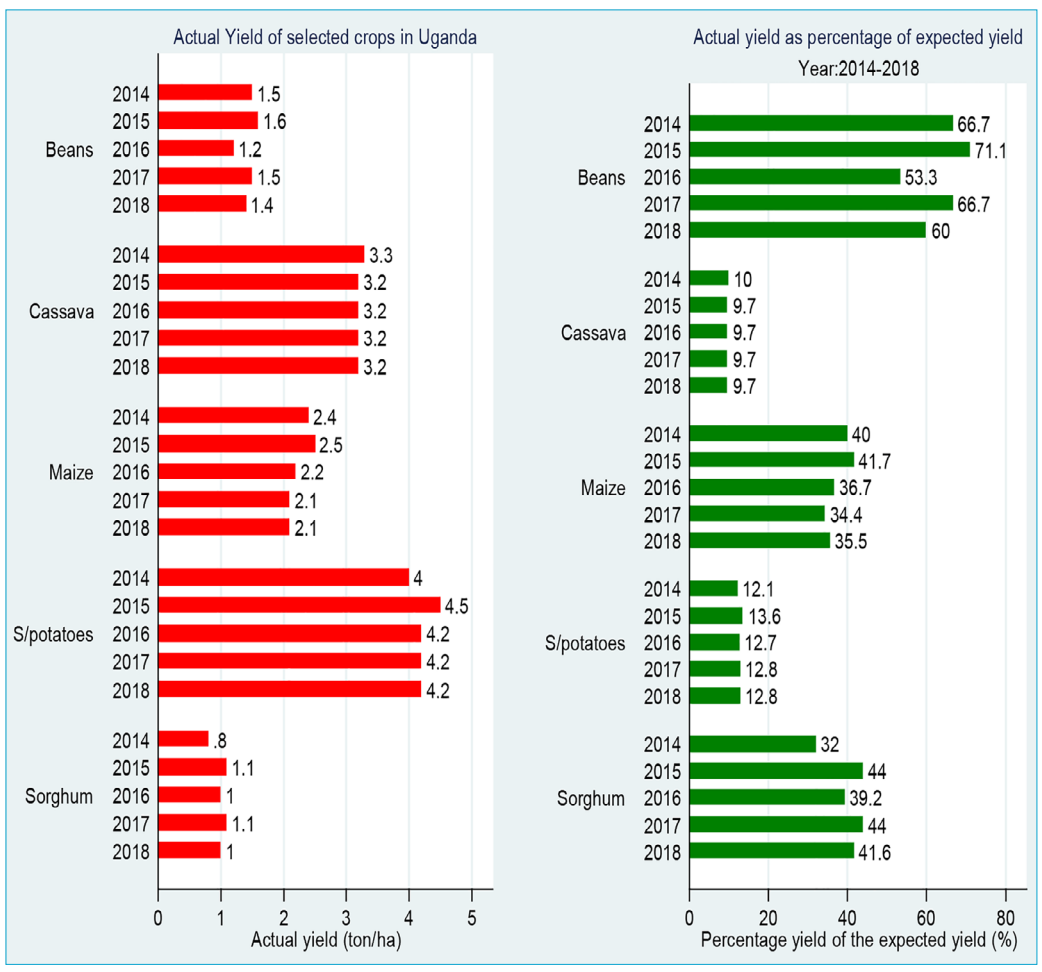


Figure 2.4: Crop yields and land degradation

Figure 2.4 shows the actual yields of selected food and the percentage of the expected yield from the area planted. The actual yield of beans per hectare has been decreasing yet the area under the crop is increasing. For example, in 2017 the yield was estimated at 1.5 ton/ha which reduced to 1.4 ton/ha in 2018. The reduction in the yield could partly be attributed to loss of soil fertility. This implies that the current level of production would require only 66.7% of the land in 2017 and 60% of land in 2018.
Furthermore, the yield of maize was estimated at 2.1 ton/ha in both 2017 and 2018 which required only 34.4% and 35.5% of the total area planted under maize in 2017 and 2018 respectively. The situation is not any different for cassava, sweet potatoes, and sorghum where most of the land under the crop would have not been necessary had the soils not been degraded.

Livestock Sub-sector

The Government of Uganda is implementing a variety of policies and strategies to ensure a sustainable growth and transformation of the livestock sector. These are guided by the Agriculture Sector Strategic Plan (ASSP) 2015/16 – 2019/20, which prioritises investments in beef, dairy cattle, poultry and goats as well as

4. Uganda Bureau of Statistics, 2018: Annual Agriculture Census Survey, 2018 – Statistical Release.
5 World Bank Group (2019): Uganda Economic Update – Strengthening Social Protection to Reduce Vulnerability and Promote Inclusive Growth
6 Uganda Bureau of Statistics, 2018: Annual Agriculture Census Survey, 2018 – Statistical Release.

in other agricultural commodities. According to the FAO, 2019 report on Uganda's livestock sub-sector, the transformation of the livestock sector, however, is expected to be so rapid that existing policies and strategies might become inadequate in few years' time to steer a sustainable growth of livestock .

Livestock productions systems

There are four cattle production systems in Uganda: the commercial ranching; pastoral; agro-pastoral; and, semi-intensive production systems. The agro-pastoral system is predominant in the eastern, central, western, north and West Nile sub-regions of Uganda. Commercial and semi-intensive production system is prevalent in the southwest and parts of central sub-regions of the country.

There are three major chicken production systems in Uganda, namely, the free-range, the semi-intensive and the intensive production systems; however, about 40% percent of all households keep chickens, largely in free-range systems. The semi- and intensive systems are predominant in the central and eastern sub-regions of Uganda.

The indigenous breeds continue to be dominant over the exotic ones for both cattle and poultry. Out of about 14.6 million cattle in Uganda, 13.6 million (93%) of total cattle are indigenous. While for poultry, 42.9 million (87.7%) were indigenous and the rest exotic.

It is estimated that about 3.9 million households own livestock and accounting for about 58% of the total population of Uganda as at 2019, and the majority (92%) of who are subsistence farmers. Beyond providing food and other goods and services to the population, the livestock sector contributes between 1% and 1.5% to Uganda's export trade value. Uganda is a net exporter of livestock products and live animals, and only few live animals are exported. Livestock exports are dominated by dairy products and eggs (USD 80 million), with meat and meat products (USD 6.2 million) playing a minor role.

Livestock productivity

There has been gradual increase in livestock productivity, with average annual growth of 4% in the recent years, for all categories of livestock (cattle, goats, sheep, pigs and poultry) as well as different livestock products, notably, meat, milk and eggs. Livestock productivity during the 2018 – 2019 period is shown in Table 2.4.

By the year 2019, the per capita consumption per year for the three main livestock products was as follows: meat, 14 kilogrammes; milk, 35 litres; and, eggs, 22 pieces.

Recent trends show that the number of cattle increased by 2.7% (from 14.2 million in 2017 to 14.6 million in 2018); goat, sheep, pigs and poultry numbers increased by 2.4%, 3.1%, 3.3%, and 2.8% (compared to 2017 increase of 1.97%, 3.2%, 0.54% and 2.8%, respectively).

The production of beef in 2018 was estimated to be 217,065 metric tonnes (MT) and this was a 2.7% increase from 211,358 MT registered in 2017. In 2018, there was an increase in the production of milk to 2,040 million litres from the 1,614 million litres compared to that produced in 2017. There was a 2.6% increase in egg production in 2018 from 907.1 million observed in 2017 to 930.7 million in 2018. The poultry sector contributes 4.3% to the total value of agricultural production.

Table 2.4: Livestock productivity levels as at 2019.

Commodity	Production volume (Metric tonnes)	Current Productivity	Potential yields as at research stations
Dairy (milk in million litres)	2,500	Zero grazing; 1.5litres/ day for indigenous cows and 30 litres for exotic	24 litres/day indigenous
		Free range; 1ltre/day for indigenous and 12.5litres for exotic.	
Beef	221,746	150kg/ adult animal	855kg/adult animal
Poultry meat	62,000	0.8kg per bird at 1-month live weight 2.5kg per bird at 1.5 months live weight	
Poultry- egg production	36,000	230 eggs/bird/ year exotic birds 49 eggs/bird/year local chicken	egg/bird/year

Source: Ministry of Agriculture, Animal Industry and Fisheries, 2019.

Tourism sector and environment

Uganda is one of the tourist destinations in the world and Africa. Uganda offers a combination of nature-based, adventure and cultural activities to tourists. The nature-based tourism is hinged on the diverse species of flora and fauna such as mammals, including gorillas, birds, and the scenery and water resources such as falls, rivers and lakes. National Parks and wildlife reserves register the highest tourist arrivals. In the last two decades, the country has registered increased number of tourists. For example, in 2001, about 0.205 million tourists visited, and that has systematically increased to 1.4 million tourists in 2017 (UBOS, 2018). This implies that the number of tourists traveling to the country has been growing at an average rate of 80,530 tourists per year. The number of visitors to National Parks has been growing exponentially at an average rate of about 7.1 persons per year from 90,000 thousand visitors in 2002 to 285,671 visitors in 2017 as shown in Figure 2.5. Although there has been growth in the number of visitors to the national parks in the period 2002-2017, the share of visitors of the total tourists that visit the country has drastically reduced from 35.4% in 2002 to 19.1% in 2017 as shown in Figure 2.5. This implies that Uganda has a high potential to attract more tourists based on nature if well preserved.

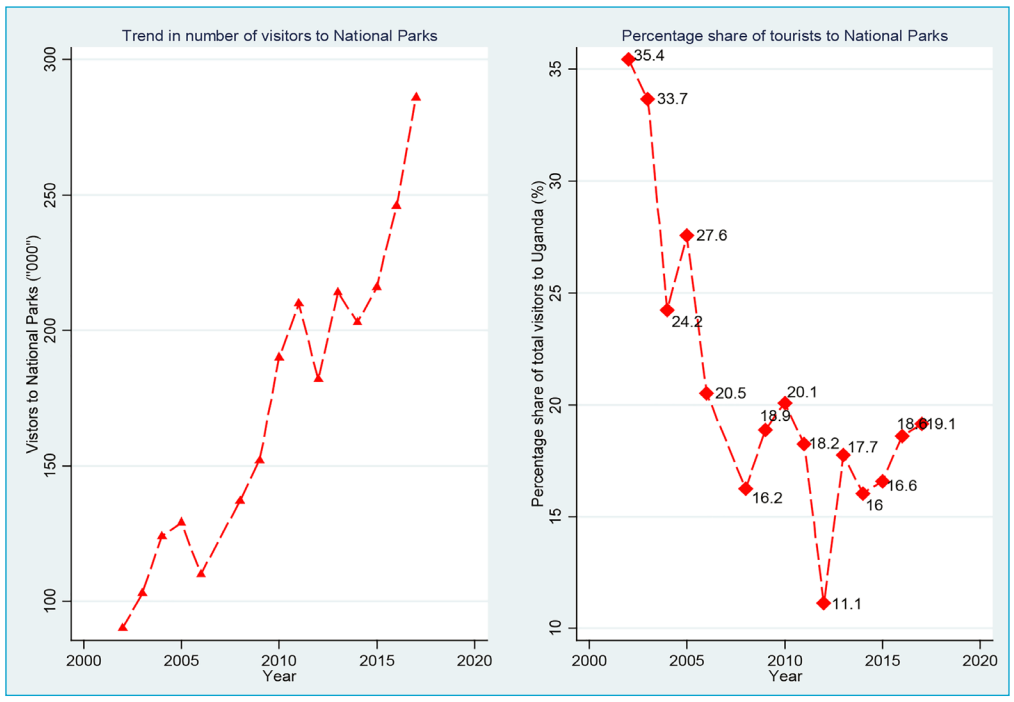


Figure 2.5: Trend in number of tourists to National Parks in Uganda 2002-2017

Energy Sector and the environment

The energy situation in Uganda as of 2018 shows that Uganda meets more than 93% of its energy demand with biomass, 6% with fossil fueled combustion, and only 1% with electricity from hydropower and fossil fuelled thermal power plants. By the end of the year 2019, the per capita of energy in Uganda stood at 215kWh per capita, however, this is rated as one of the lowest per capita electricity consumption in the world (World average is 2,975 per capita), and compared to the per capita per year for Sub-Saharan Africa's average of 552 kWh per capita.

In addition, the Global Energy Transfer for Feed-in Tariff (GET FiT) Programme (2012 – 2019) has left its mark on the Ugandan power sector. By the end of 2019, approximately 50% of all energy generation projects in the country were procured and supported by the GET FiT Programme, contributing to a greatly diversified power sector – institutionally, technologically and geographically (GET FiT Uganda, 2019) . The GET FiT Programme was developed in 2012 by the Electricity Regulatory Authority on be-half of Government, and the German development bank – KfW.

Current power generation capacity

According to the Electricity Regulatory Authority (ERA), the total installed capacity as at end of December 2019 was 1,252.4MW of which 1,246.5MW supplies the main grid and 5.9MW is off the main grid. By end of 2018 stood installed capacity was at 984.02 MW, indicating a 21% increase by end 2019. Uganda is presently benefitting from a mix of energy sources as follows: hydro amounting to 744.34MW; thermal, 101.60MW; Cogeneration, 96.2MW; solar, 40.83MW; hybrid, 10.83MW; diesel, 1 MW; and, biomass, 0.043MW. The annual installed capacity trends are shown in Table 2.5.

Table 2.5: Annual installed electricity Generation Capacity trend (in MW) during the 2014 – 2019 period.

Fuel Type / Year	2014	2015	2016	2017	2018	2019
Large Hydro	630.0	630.0	630.0	630.0	630.0	855
Small Hydro	65.3	65.3	65.3	82.3	114.0	149.3
Co-Generation	75.1	96.2	96.2	96.2	96.2	96.2
Thermal	101.6	101.6	101.6	101.6	101.6	101.6
Solar	0	0.6	10.8	20.8	40.8	50.8
Hybrid (Solar + Thermal)	0	2	2	2	1.04	1.04
Total Capacity	**921**	**923**	**940**	**975**	**984.01**	**1253.94**

Source: Ministry of Energy and Mineral Development, and Electricity Regulatory Authority Database, 2019.

Other 8 (eight) proposed power generation projects with total proposed capacity of 1,010.96MW include the following: Achwa-3 Hydropower Plant on Achwa River in Gulu District; Agbinika Hydropower Plant on River Kochi in Yumbe District; Ayago Hydropower Plant on River Nile in Nwoya District; Muzizi Hydropower Planton River Muzizi in Hoima District; Nengo Bridge Hydropower Planton River Mirera in Rukungiri District; Nyagak-2 Hydropower Plant on River Nyagak in Zombo District; Nyagak–3 Hydropower Plant on River Nyagak in Zombo District; and, Nshungyezi Hydropower Plant on River Kagera in Isingiro District.

Large Hydropower Plants

Uganda has considerable number of hydropower resource potential estimated to be over 2,000 MW. A number of hydropower plants have already been constructed, others are currently under construction, and some are proposed (see Tables below). The large-scale hydropower potential is along the White Nile, which originates in Lake Victoria. The flow of the White Nile River is controlled by the Owen Falls Dam. The Isimba Power Station with a capacity of 183.2MW was commissioned and became operational in 2019. The Karuma Power Station with 600MW installed capacity and expected to be operational in 2020.

Table 2.6: Large Hydropower Category - for Grid Supply

NAME	RIVER	DISTRICT	YEAR COMMISSIONED / TO BE COMPLETED
1.Nalubaale Hydropower Plant	River Nile	Buikwe	1954
2.Kiira Hydropower Plant	River Nile	Jinja	2000
3.Bujagali Hydropower Plant	River Nile	Buikwe	2012
4.Isimba Hydropower Plant	River Nile	Kayunga	2019
5.Achwa–II Hydropower Plant	River Acwa	Bundibugyo	2019

Source: Electricity Regulatory Authority, 2019: April 2019 Statistics – Installed Plants by Technology

Solar energy

The level of solar energy utilization (consumption) in Uganda is still rated as very low, even though there is considerable potential to develop solar energy sub-sector. The solar power plants now installed are listed below. With regard to solar power potential and distribution, the average solar radiation is 5.1 kWh/m2/day. In addition, existing solar data clearly indicate that the solar energy resource in Uganda is high throughout the year. The data sets indicate a yearly variation (max month / min month) of only about maximum 20% (from 4.5 to 5.5 W/m2), which is due to the location near the equator. The insolation is highest in the dryer area in the north-east and very low in the mountains in the east and south-west.

The solar power plants which are now installed, are listed in Table 2.7. The Soroti Solar Power Plant with installed capacity of 10MW (13,000 hp) is said to be the largest grid-connected, and privately-funded solar power plant in Sub-Saharan Africa, outside of South Africa. It has potential to power approximately 40,000 homes located near the Plant, thereby minimizing transmission losses.

Table 2.7: Solar Power Category / Technology

NAME	PURPOSE	LOCATION / DISTRICT	YEAR COMMISSIONED
1.Kalangala Infrastructure Services Power Plant	Off Grid generation	Kalangala	2015
2.Access Uganda Solar Power Plant	Grid supply	Soroti	2016
3.Absolute-Kitobo Power Plant	Off Grid generation	Kalangala	2016
4.Tororo Solar North Solar Power Plant	Grid supply	Tororo	2017
5. Kabulasoke Grid Connected Solar P.V Power Plant – MSS Xsabo Power Solar Power Plant	Grid supply	Kabulasoke	2018
6. Emerging Power U Ltd (Mayuge/Bufulubi) Solar Power Plant	Grid supply	Mayuge	2019

Source: Electricity Regulatory Authority, 2019: April 2019 Statistics – Installed Plants by Technology.

Energy demand

According to ERA as at April, 2019, the system peak demand (including exports to Kenya and Tanzania) in the year 2019 was 723.76 MW signifying a 12% increase compared to a 3% growth in 2018. This growth is mainly attributed to growth in domestic demand. Below is a summary of the trend during the 2015 – 2019 period. It should also be noted that the 220kV came on (integrated into) the power transmission network after the year 2011.

Table 2.8: Annual Demand and Growth Rate

Year	2015	2016	2017	2018	2019
Demand					
Peak demand	560.09	579.28	625.27	645.4	723.76
Domestic Peak demand (MW)	520.68	534.11	562.45	596.2	629.46
Max system demand (Domestic + exports)	560.09	579.28	625.27	645.4	723.76
Installed capacity (Grid)	887.5	897.5	924.54	976.24	1246.49
Growth rate (percent)					
Domestic	2%	3%	5%	6%	6%
Domestic + exports	2%	3%	8%	3%	12%

Source: Electricity Regulatory Authority, 2019.

2.3 Environment and Human Wellbeing

2.3.1. Introduction

Human survival, security and well-being is underpinned by the state of the environment and its ecosystems. Our natural environment provides us with essential life support services of air, water and food. Air is an atmospheric resource for human well-being which key factor is air quality that is adversely affected by environmental pollution. The key contributors of air pollution in Uganda are particulate matter (PM 2.5), emission of gases like Nitrogen Oxides (NOx), Sulphur Oxides (SOX), Methane (CH4) and others like black carbon (BC). Beside the key sources of air pollution in Uganda include emission from motor vehicles, unpaved roads, burning of waste, industries, domestic emission and construction activities. Air pollution contributes to poor human health which is characterised by respiratory diseases and morbidity. The national air quality monitoring network is yet being set up but presently NEMA has two stations where it collects data. The air quality data so far got is within the acceptable World Health Organisation (WHO) guideline limits.

Maintenance of water quantity and quality is one of the regulatory functions of forests and wetlands ecosystems. By 2018, Uganda's urban and rural water coverage was estimated at 77% and 70% respectively while safe national water is 70% (MWE 2018), showing the importance of water as being critical in supporting health and human well-being. Therefore, protecting and restoring water related ecosystems such as forests, mountains, wetlands, lakes and rivers are essential to mitigate against water scarcity. Besides universal access to safe and affordable drinking water by 2030 requires more investments in infrastructure, providing sanitation facilities and encouraging hygiene at every level in society.

Food is basic human need that is provided by ecosystems. It is therefore important to recognise that sustainable management of ecosystems is critical for food security and society well-being in Uganda. Notably, 86% of the world's rural population depend on agro- biodiversity which remains a primary source of livelihood assets for poverty reduction, ending hunger, provision of jobs and social protection, among others. More importantly it should be noted that food security is key in fostering progress towards ending hunger and alleviating poverty by promoting income security and access to better nutrition (SDGs 1 and 2), (FAO,2015). According to IPC report 69% of Ugandan's population are minimally food secure while 26% of total population are facing stressed food insecurity and thus the need for more efforts in the sustainable management of the natural capital (ecosystems and climate) that is the back-borne of agricultural productivity and production.

It is also critical to consider climate which is an atmospheric resource that is greatly affected by weather variability and climate change that subsequently impact on human well-being. Extreme weather conditions and climate events like floods and droughts have adverse effects on human livelihood capitals like food and income and thus affecting human well-being. Furthermore, rise in temperatures affects ecosystem functions and services such as loss of biodiversity species, increase in invasive species and total species extinction. Besides rise in temperature is a major cause of drought which hinder the regulating functions of ecosystems for environmental integrity, climate resilience, disaster risk reduction and human livelihoods. For instance, according to UNICEF 2017 report, Uganda has one of the fastest changing climates in the world and temperatures are predicted to rise by an unprecedented 1.5 degrees in the next 20 years. Extreme climate events like floods and drought and weather variability such as rise in temperatures and rain storms do not only affect the environment but also have adverse impacts on agriculture and other livelihood assets.

2.3.2. Ecosystem services

The key ecosystems in Uganda that drive the provision of these essential services include: forests that cover 8% of the land area, savannah grassland and woodlands that dominate Uganda's vegetation cover, wetlands which account for 11% of the land area, rivers and lakes, mountainous and hilly areas. The Millennium Assessment (MA) report (2006) categorized services of the ecosystems into three types, namely; provisioning, regulating/supporting and cultural services. The provisioning services that are the most known, provide basic needs for human survival such as food, freshwater, wood, fiber and fuel, among others. The regulating services on the other hand are responsible for functions such as water purification, climate regulation, flood control, carbon sequestration and control of disease. The supporting services are the basis for the function and the maintenance of other services such as nutrient cycling, soil formation, and primary production. Whereas cultural services consist of aesthetic, spiritual, educational, and recreational service. As may be noted all the three services combined define the status of the human well-being. A well-functioning ecosystem, sustainably being exploited, sustains livelihoods and communities. Sustainable Development Goals (SDGS) 1, 2, 6, 12, 13, 14, 15 among others measure the human wellbeing in relation to the environment.

Ecosystem services are the benefits people obtain from ecosystems and as stated above these services include provisioning, regulating, and cultural services that directly affect people and supporting services needed to maintain the other services. Any ecosystem may be evaluated to determine the well-being status of the living community. To illustrate this point, the Nabugabo Wetland ecosystem in central Uganda was evaluated to determine in details the types of derivatives from each of service as shown below:

(a) <u>Provisioning services:</u>
- (i) Agricultural production (crop and livestock farming)
- (ii) Water supply for human consumption, crop production/ irrigation and livestock
- (iii) Capture fishery (fish)
- (iv) Wood-based energy and timber (fire wood and charcoal)
- (v) Non-wood and non-fish wetlands products

(b) <u>Regulating/supporting services:</u>
- (i) Regulation of water flow and quality (water storage and re-charge, waste processing and sediment trapping, and flood attenuation)
- (ii) Support to crop productivity (pollination, soil fertility and moisture)
- (iii) Breeding/nursery habitats for fish species and habitats.
- (iv) Climate change mitigation (carbon storage and sequestration, and avoided emissions)

(c) <u>Cultural services:</u>
- (i) Recreation and education (nature-based tourism, trophy hunting, research and education)
- (ii) Biodiversity and conservation (species of special conservation values like the crested crane (*Balearica Regulorum*)
- (iii) Cultural, aesthetic and emblematic values like landscapes and species with spiritual heritage)

All the mentioned services can be quantified into monetary terms for purpose of appreciation and be applied for measuring the human well-being status using the OECD 2014 in the various districts or sub regions in Uganda. This framework defines human well-being to be dependent on the Quality of Life and Material conditions (possession) of each individual. These are but also dependent on the sustainability of future resources clustered as economic, social, human and natural capital. ***Figure 2.6 pictorially illustrates this framework.***

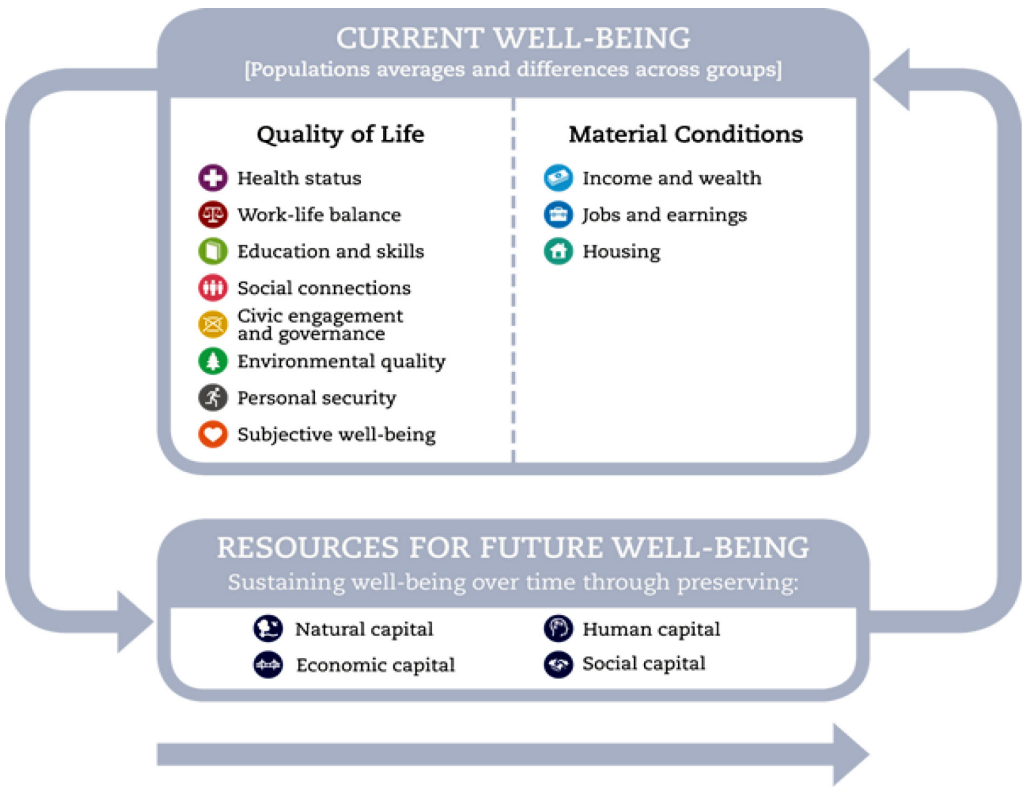


Figure 2.6. OECD Framework for measuring well-being and progress. Source: OECD, 2014

2.3.3. Status of Human well-being in sub-regions of Uganda

The status of human well-being in Uganda was assessed based on indices that were developed using multivariate methods more specifically factor analysis. Indices were developed for both material living conditions and quality of life. The indices were then combined to derive the human well-being index that was used to understand the status in Uganda. Statistical macroeconomic data was collected from each of the districts in the region.

Material Living Conditions and Quality of Life

Human well-being was assessed in two dimensions namely material living conditions (MLC) and Quality of Life (QOL). The material living conditions constituted elements like poverty, income, house ownership and nature of house among other material things. On the other hand, the quality of life index was constructed considering elements like education level, health of the people, participation in community activities, and access to other public goods. The results of the analysis are summarized in Figure 2.7.

Material Living Conditions (MLC) and sub-region

The MLC were assessed using derived constituent index values for all districts clustered into two sub-regions. Cluster 1 comprising of four sub-regions of Kampala, central 1(Bukomansimbi, Butambala,Gomba, Kalangala, Kalungu, Lwengo, Lyantonde, Masaka, Mpigi, Rakai, SsembabuleandWakiso) central 2 (Buikwe, Buvuma, Kayunga, Kiboga, Kyankwanzi, Luwero, Mityana, Mubende, Mukono, Nakaseke and Nakasongola), and Ankole, had better Material Living Conditions (MLC) as compared to Cluster 2 comprising of eleven sub-regions of Kigezi, Tooro, Bunyoro,Elgon, Busoga, Bukedi, West Nile, Lango, Acholi, Teso and Karamoja.

On Quality of Life (QOL), Cluster 3 comprising of seven sub-regions (Kampala, Karamoja, Teso, Acholi, West Nile, Lango and Bukedi) had poor quality of life as compared to Cluster 4 comprising of eight sub-regions (Central 1, central 2, Ankole, Kigezi, Tooro, Bunyoro, Elgon and Busoga) that had better Quality of Life (QOL).

From the data, its Kampala sub-region that had good MLC but with poor QOL while the sub-regions of Ankole, Central 1 and Central 2 had both good MLC as well as good QOL. Meanwhile six sub-regions of Kigezi, Tooro, Bunyoro, Elgon,Ankole and Busoga had poor MLC but good QOL. However, 5 of the regions Teso, Acholi, Karamoja, West Nile and Lango had both poor MLC and poor QOL. Figure 2.7 illustrates these results.

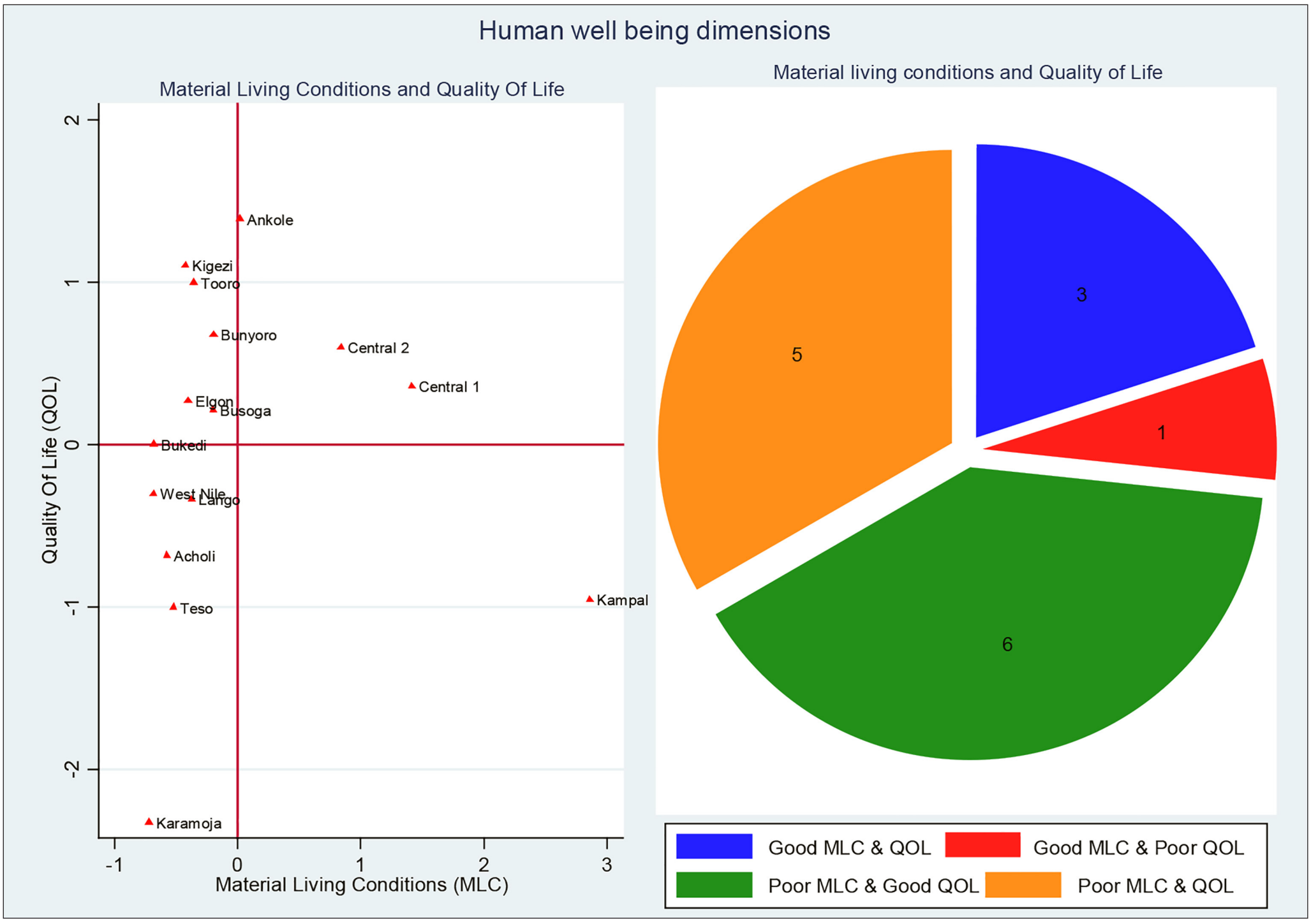


Figure 2.7 Material Living Conditions & Quality of Life in sub-regions of Uganda

Over all human well being

Results show that out of the 15 sub-regions, people in 8 (53.3%) had fair access to material living conditions and fair quality of life while people residing in the remaining 7(46.7%) sub regions had limited access to material living conditions as well as quality of life. This is illustrated in Figure 2.8

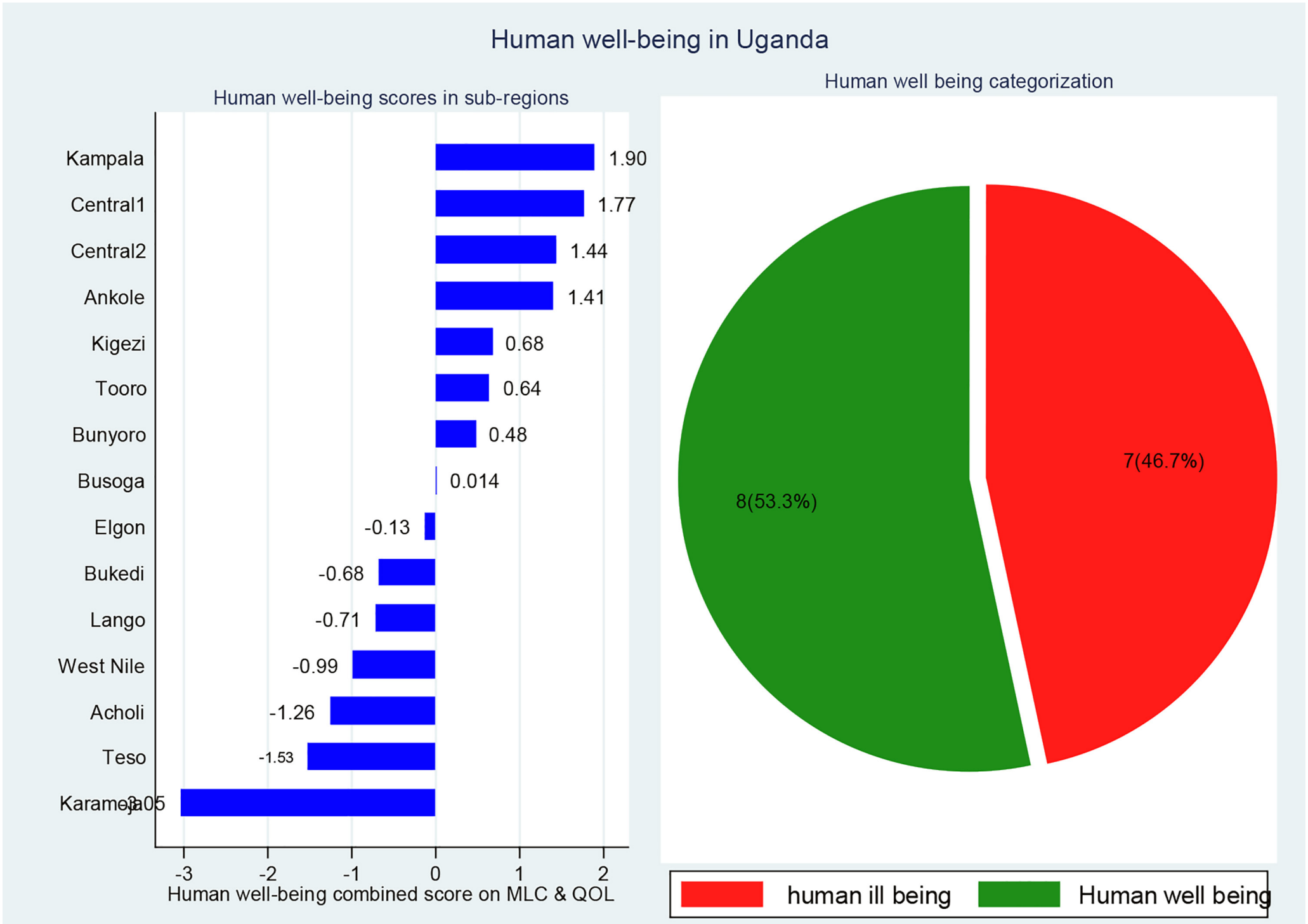


Figure 2.8: Human well being

Ecosystem services

Factor analysis was used to assess the relationship between the different functions of the ecosystem. Results suggest that the first factor could be called provision/regulating function of the ecosystem. The second factor seems to be indicating pollution levels of the different agricultural inputs.

Provisioning/regulating services

Findings; crop farming, biomass extraction, and grass for thatching houses, soil/clay for the floor load highly on this factor. These demonstrate some of the materials/products the population derive from the ecosystem in Uganda. These directly define the provisioning function of the ecosystem. Furthermore, prevention of drought, livestock diseases and human epidemic diseases also load highly on this factor. Results show that increased utilization of biomass, grass, and clays is associated with increased occurrence of droughts, livestock diseases and human epidemic diseases.

There was increased utilization of biomass, clay, and grass in the sub-regions of Busoga, Bukedi, Teso, Karamoja, Acholi, Lango and Tooro which lead to increased occurrence of droughts, livestock diseases as well as human epidemic diseases.
Furthermore, in two regions (Bukedi and Busoga) there was increased utilization of natural resources and application of agricultural inputs with subsequent increase in occurrence in droughts, and livestock diseases. Five sub-regions (Central 2, Elgon, Ankole, West Nile and Kigezi) had increased utilization of agricultural inputs associated with reduced extraction of natural resources like biomass, grass among others. In the sub-regions of Bunyoro, central 1 and Kampala, there was reduced utilization of agricultural inputs as well as reduced extraction of natural resources with the region. Finally, in the regions of Karamoja, Acholi, Teso, Lango and Tooro, there was reduced utilization of agricultural inputs with an increased utilization of natural resources with the regions (Figure 2.4).

The increased utilization of organic and inorganic fertilizers, pesticides and herbicides load highly on the second factor. This factor could be interpreted as pollution or ability of the ecosystem to absorb the pollutants and still regulate the effects. This further implies that there is increased pollution originating from increased use of agricultural inputs. Figure 2.9 shows the variation between the two ecosystem functions across the sub-regions of Uganda.

Results show that there was increased utilization of agricultural inputs in the sub-regions of Bukedi, Busoga, central 2, Elgon, Ankole, Kigezi, and West Nile while the sub-regions of Kampala, central 1, Bunyoro, Tooro, Lango, Teso, Acholi and Karamoja registered a reduction in application of agricultural inputs.

Increased exploitation of natural resources from the environment reduces the capacity of the ecosystems to regulate occurrence of natural hazards and subsequently reduces the likelihood of human well-being by about 92.2%. Furthermore, increased application of fertilizers, pesticides, and herbicides reduces the likelihood of human well-being by about 19.7%.

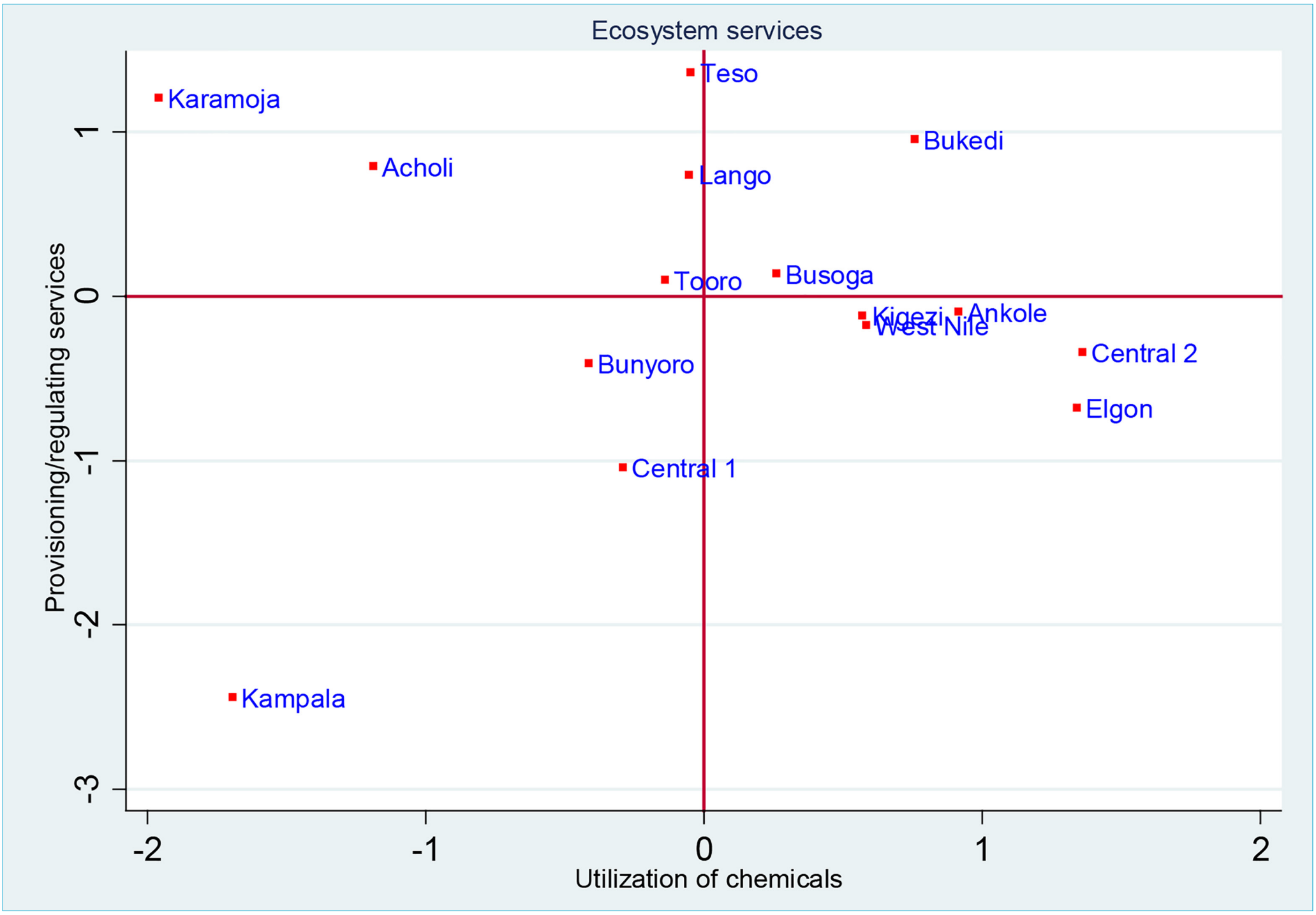


Figure 2.9. Ecosystem Services and the Environment

2.4. Policy recommendations

The following are the proposed policy options for improving on human well-being (QOL and MLC)) through the promotion of clean and healthy environment:

(i) NEMA should carry out a research to establish more reliable information on air quality in Uganda.
(ii) More research is required on ecosystem services in relation (linkages) to human well-being in Uganda.
(iii) NEMA should work with the respective lead agencies to develop green taxes that will promote air quality and climate resilience in Uganda.
(iv) Government of Uganda should expedite the implementation of the existing policy strategies on public transport to improve on air quality and climate change mitigation.
(v) Natural capital accounting should be promoted in order to demonstrate the values of ecosystem services for human well-being in Uganda.

Bibliography

FAO, 2015: The state of food insecurity.

OECD, 2013: Well-being measuring framework.

UNICEF, 2017: Emerging global challenges, climate related hazards and urbanisation, protecting Uganda's children.

MWE, 2018: Water and Environment, Sector Performance Report 2018/19.

Ministry of Water and Environment, 2015, The economic valuation of biodiversity and ecosystem services in lake Nabugabo wetland complex

Uganda Bureau of Statistics: Statistical Abstract (2015, 2016, 2017 and 2018)

Ministry of Finance, Planning and Economic Development: Background to the Budget (Various editions).

World Travel and Tourism Council 2018: Economic Impact Uganda

Water and Environment Sector Performance Reports – Various Editions

Majaliwa Gilbert, Jackson Mwanjalolo 2018: Assessing the Extent of Historical, Current, and Future Land Use Systems in Uganda. Published 8th November, 2018.

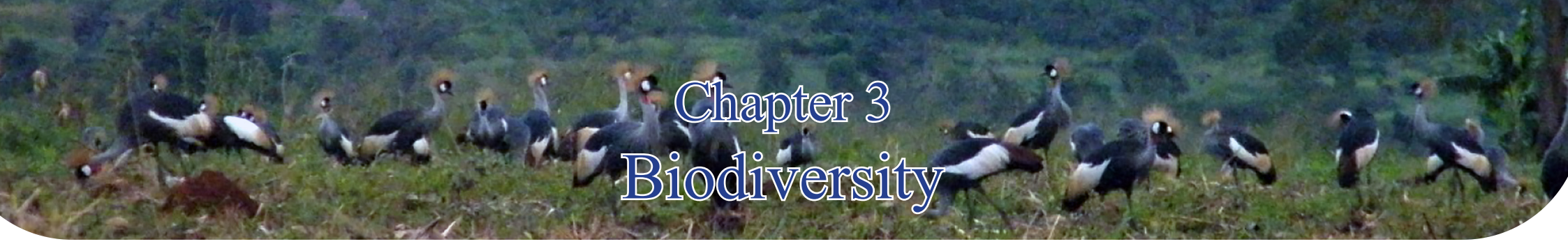
World Bank, (2015, 2016, 2019)

African Development Bank, (2018 and 2019)

Agriculture sector Plan (2015/16, 2019/20)

Moyini, Y., Muramira, E., Emerton, L. and Shechambo, E. 2002. The costs of environmental degradation and loss to Uganda's economy with particular reference to poverty eradication.

PART 2:
STATE OF THE ENVIRONMENT



Chapter 3
Biodiversity

3.1 Introduction

Uganda is one of Africa's richest countries in biodiversity despite its relatively small size. It supports 1,742 terrestrial vertebrate species (with more than half of Africa's birds), and at least 3,662 plant species (Plumptre et al., 2017). Uganda has diverse ecosystems consisting of forests, wetlands, rangelands, lakes and rivers. Uganda is, therefore, an important nation for biodiversity conservation not only in Africa but also globally. There are however a number of threats which is leading to loss of biodiversity including conversion of natural habitats which hosts most species, to agricultural land and infrastructure. With the drive to achieve the middle income status by 2020 (NPA, 2013 and NPA, 2015), there has been a tremendous drive in the infrastructure development and therefore the need to address the negative impacts of infrastructure development on biodiversity especially at ecosystem and species level. Other threats to biodiversity include proliferation of invasive species, human-wildlife conflict, illegal wildlife trade, climate change, pollution (plastics, agrochemicals, effluent discharge, heavy metals among others). This chapter provides information on the status and trends of biodiversity with a focus on forests, wetlands, fish wildlife and protection of threatened plant species outside protected areas.

3.2 Forest ecosystem

A forest ecosystem is a dynamic complex of plant, animal and micro-organism communities and their abiotic environment interacting as a functional unit, where trees are a key component of the system.

3.2.1 Introduction

A Forest is an area covered with vegetation, majority of which are of tree communities, occupying a large extent and in climatic equilibrium with the environment. Forests in Uganda fall under four major categories namely central forest reserves, local forest reserves, community forests and private forests (National Forestry and Tree Planting Act, 2003).

A Forest Reserve is an area of land designated, reserved/gazzetted by Act of Parliament for development of forests or tree growing activities. It can be an open land without forests on it or with forests. Forest reserves are part of the protected areas of Uganda.The forest cover in CFRs represents about 15% of the total forest cover in the Uganda. The other forests that represent about 85% of the forest cover in Uganda are constituted by local forest reserves, community forests and private forests.

Forests are important catchment areas ensuring availability of water for agricultural production, and are habitat for forest biodiversity. Trees also suck up large volumes of carbon dioxide, thus cleaning up the air /atmosphere [important to emphasize benefit to health] and provide forest goods like timber to the people of Uganda. Forests are national assets that add to the natural beauty of the country thereby attracting tourism revenue for the national coffers.

3.2.2 Status and trend of forests

The forest cover in Uganda has been declining, from 23.8% (4.8 million ha) in 1990 to about 9.9 % (2 million ha (Table 3.1). Natural forests have experienced a decline in the past decades while plantation forest has registered an increment between 2010 and 2017 from 3% to 8% (Figure: 3.2 and Figure 3.1).

Forests can broadly be divided into two categories; natural and plantation forests. The highest biodiversity occurs in the natural forests i.e. Tropical High Forest, fully stocked (THF, well stocked), Tropical High Forest, low stocked (THF, low stocked), and woodlands. Although the species diversity may vary between these three categories, the THF, fully stocked is known to host the highest species diversity including threatened and restricted range (endemic) species. Figure 3.2 shows that areas important for biodiversity conservation of the in Uganda are mostly the protected areas and this includes forest reserves (Plumptre et al., 2019 Using forest cover as a proxy for species biodiversity, this rate of forest loss, especially natural forests, highlights the plight of biodiversity in Uganda. Overall decline in forest cover has also been halted and, for the first time since 1990, a net forest gain has been recorded.

Table: 3.1: Forest Cover Trend in Uganda

Class	1990	2000	2005	2010	2015	2017
Broad leaved plantation	18,112.77	10,040.04	15,010.56	21,091.59	44,711.64	84,048.48009
Conifer plantation	15,837.21	11,587.05	17,554.32	43,043.58	61,926.3	75,797.91004
THF well stacked	720,644.67	706,715.73	611,128.53	556,556.85	539,861.67	524,180.7048
THF low stock	229,810.23	209,445.03	195,874.29	116,597.25	121,028.13	102,139.2
Woodland	3,892,853.97	2,997,859.95	2,533,507.92	1,466,134.02	1,175,318.46	1,237,198.093
Total Area	24,154,607.79	24,154,923.15	24,155,337.60	24,155,337.60	24,154,470.90	24,154,655.34
		Forest Cover				
Year	**1990**	**2000**	**2005**	**2010**	**2015**	**2017**
Total Forest Area	4,877,258.85	3,935,647.80	3,373,075.62	2,203,423.29	1,942,846.20	2,023,364.39
Percent of Land Area	**23.8%**	**19.2%**	**16.5%**	**10.8%**	**9.5%**	**9.9%**

Source: National Forest Authority. 2019

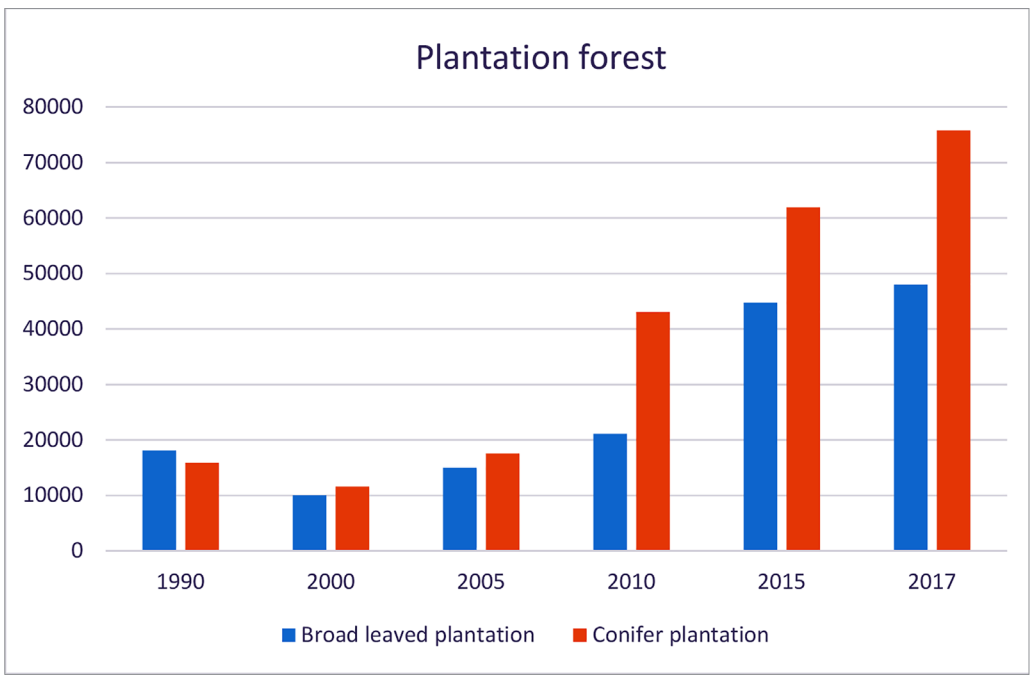


Figure 3.1: Trends of plantation forest cover between 1990 and 2017.

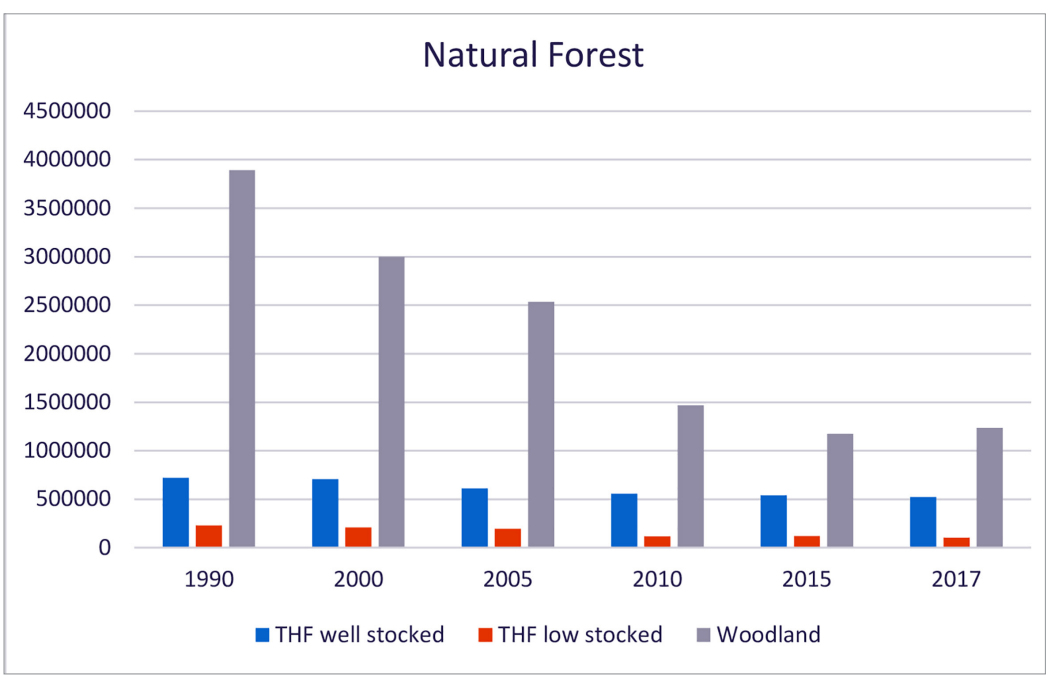


Figure 3.2: Trends in forest cover change between 1990 and 2017.

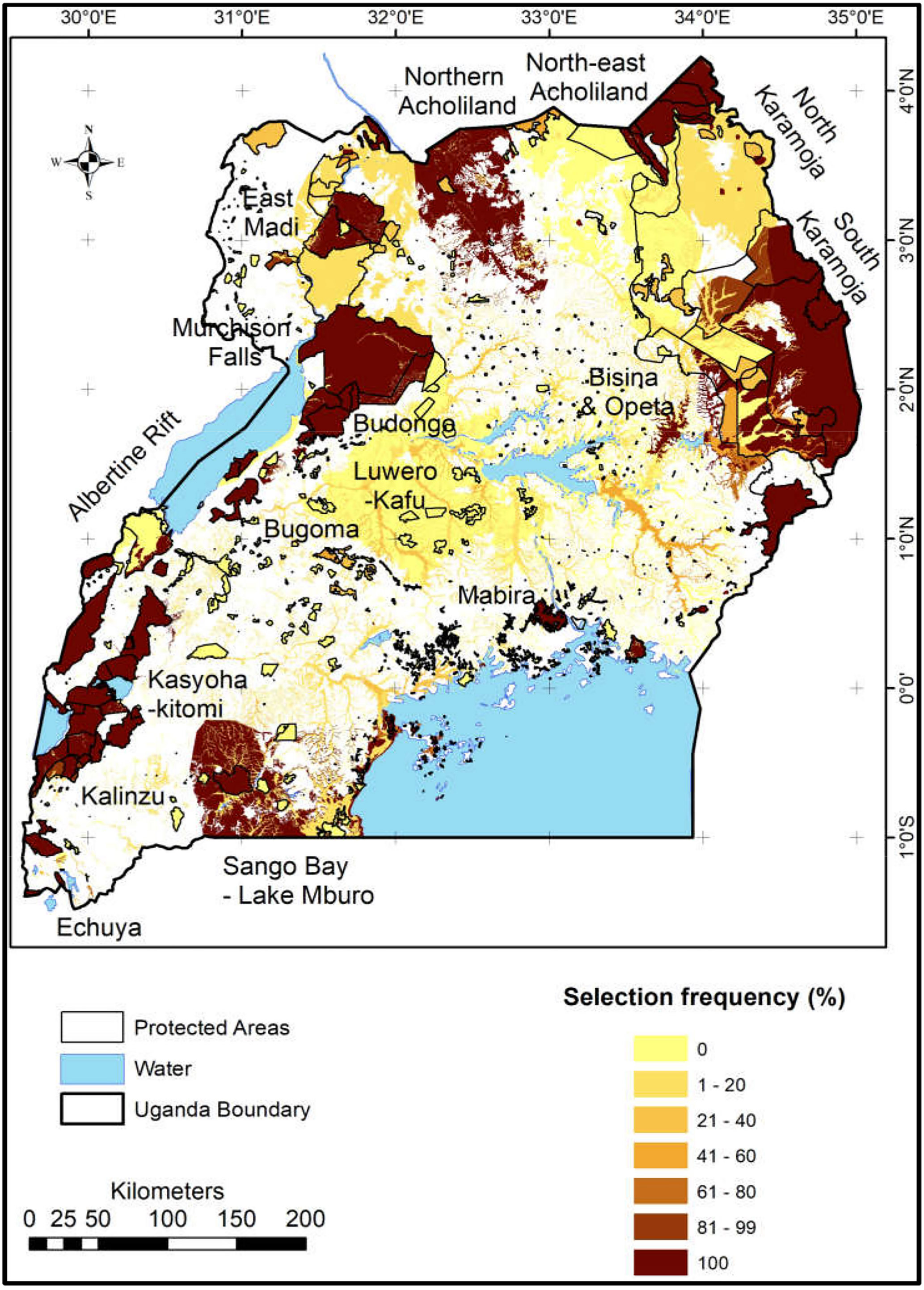


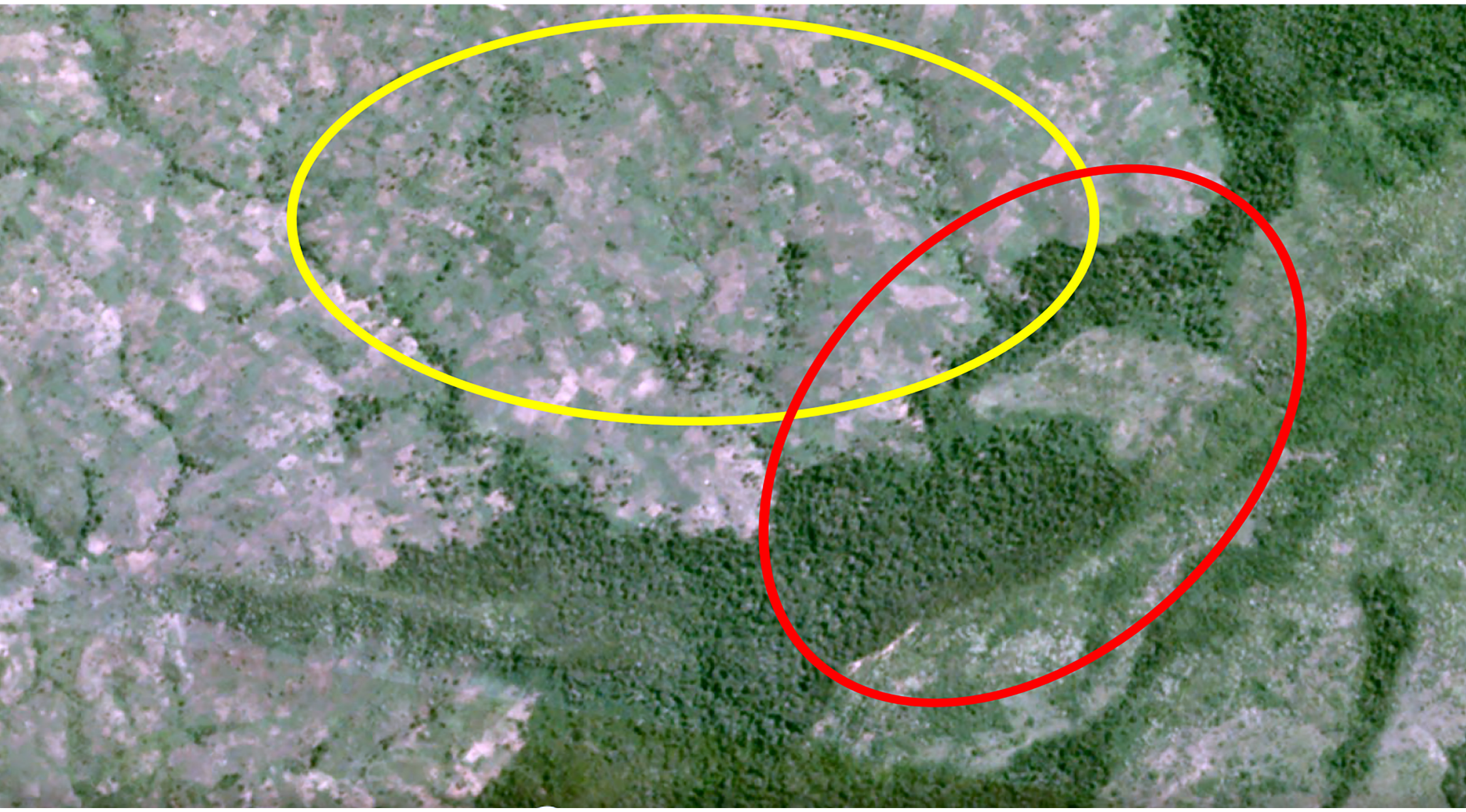
Figure 3.3: Areas important for biodiversity conservation in Uganda (Source: Plumptre et al., 2019)

3.2.3 Pressures and impacts on forests

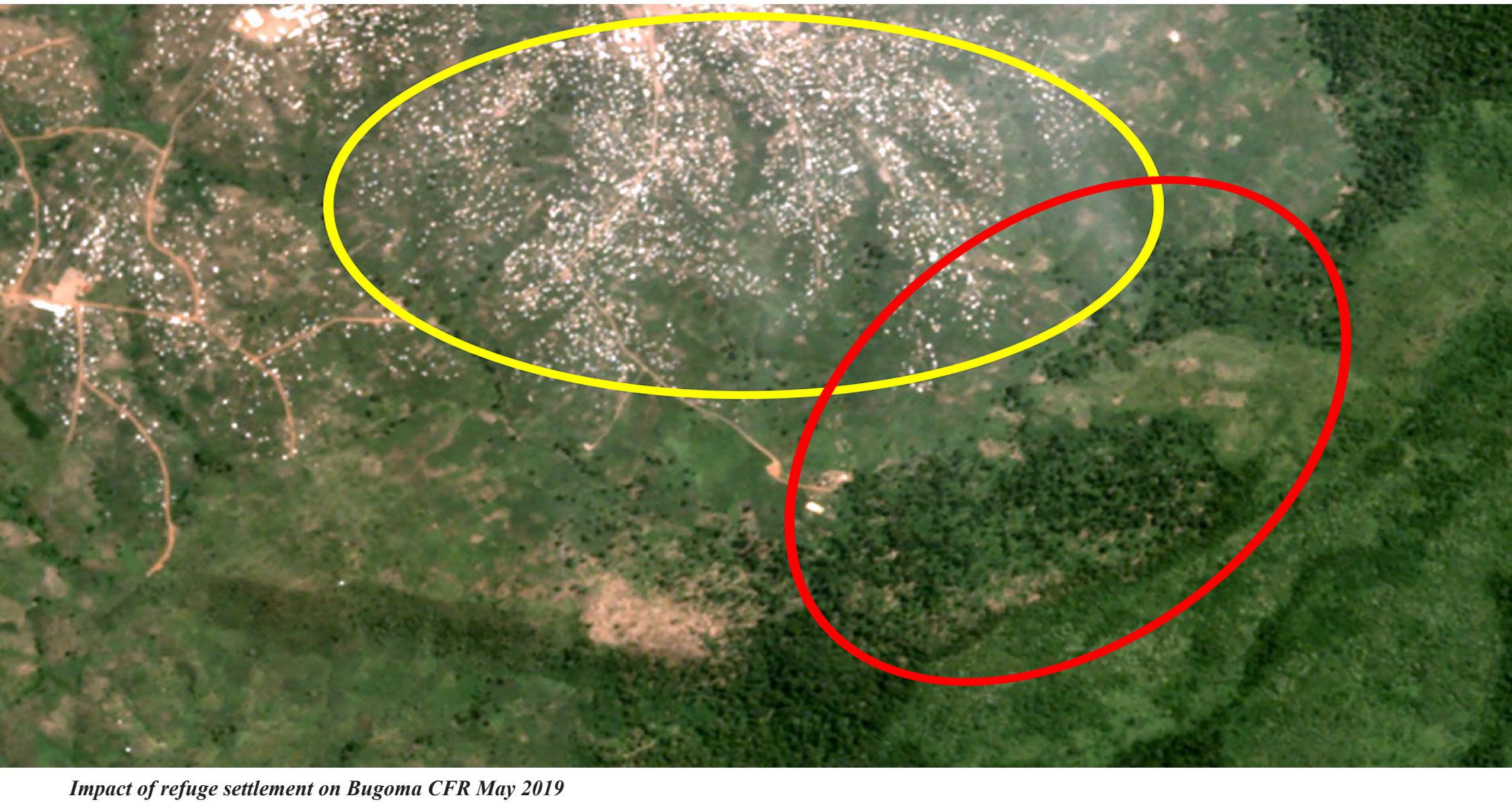
Demand for fuelwood and building materials by refugees

As of February 2019, Uganda is the third largest refugee-hosting country in the world with a total of 1,223,003 refugees. The major source of energy for cooking is fuelwood which is derived from cutting trees in forests or in the landscape. Consequently, all the surrounding areas are depleted of trees or forest cover. This has happened in refugee settlements in Kyangwali in Kikuube district, Bidi bidi in Obongi district and Rwamwanja in Kamwenge district. The same situation has happened in Oruchinga in Isingiro district.

Kyangwali Refugee Settlement is located on the south-western flank of Bugoma Central Forest Reserve (CFR) where woodlands have been cleared by refugees in search for fuelwood and poles for construction as well as illegal logging in the adjacent forests. The illegal activities have extended to Bugoma Central Forest Reserve (CFR) as shown below leading to deforestation.



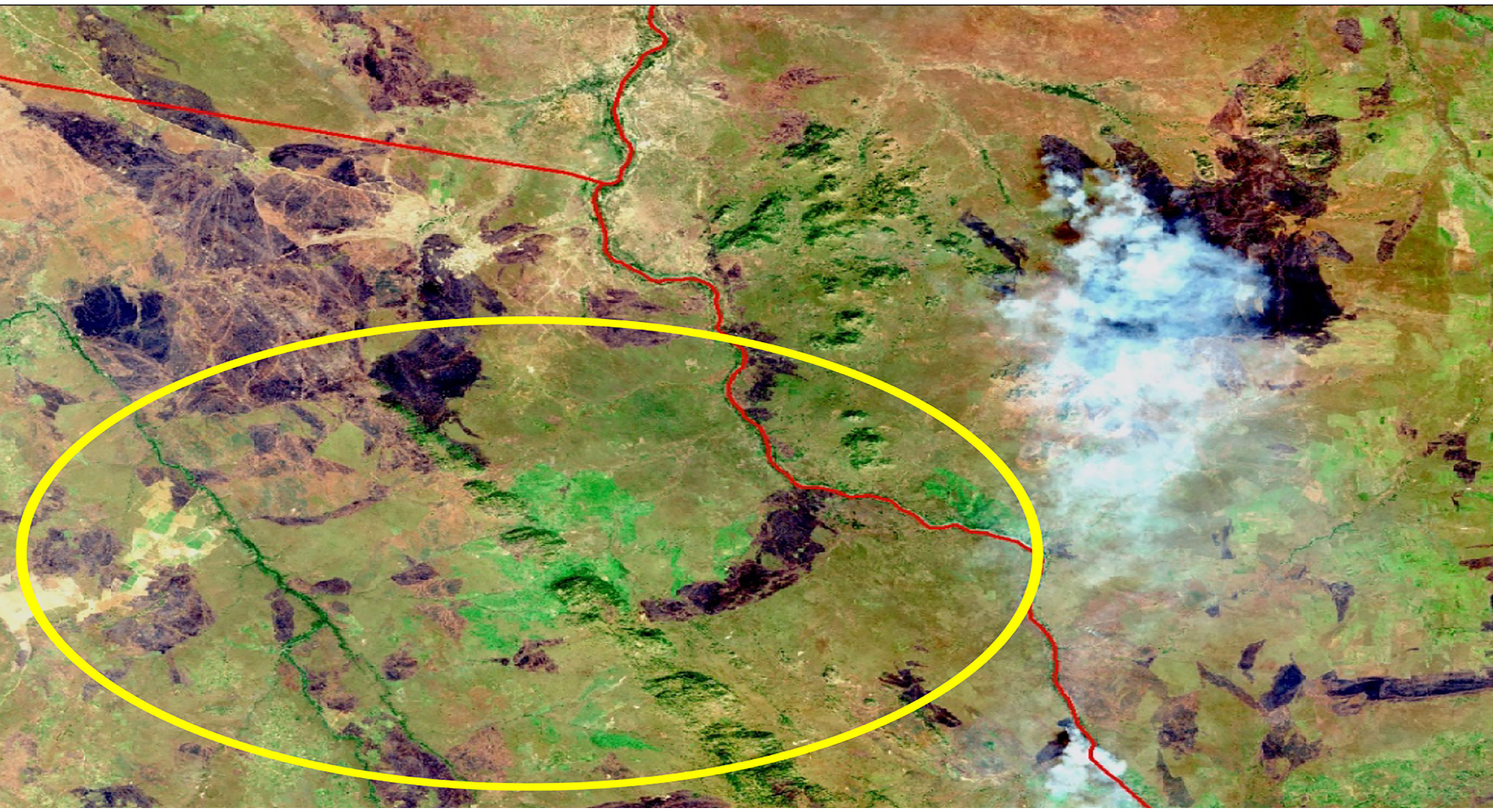
Impact of refuges settlement on Bugoma CFR in May 2017



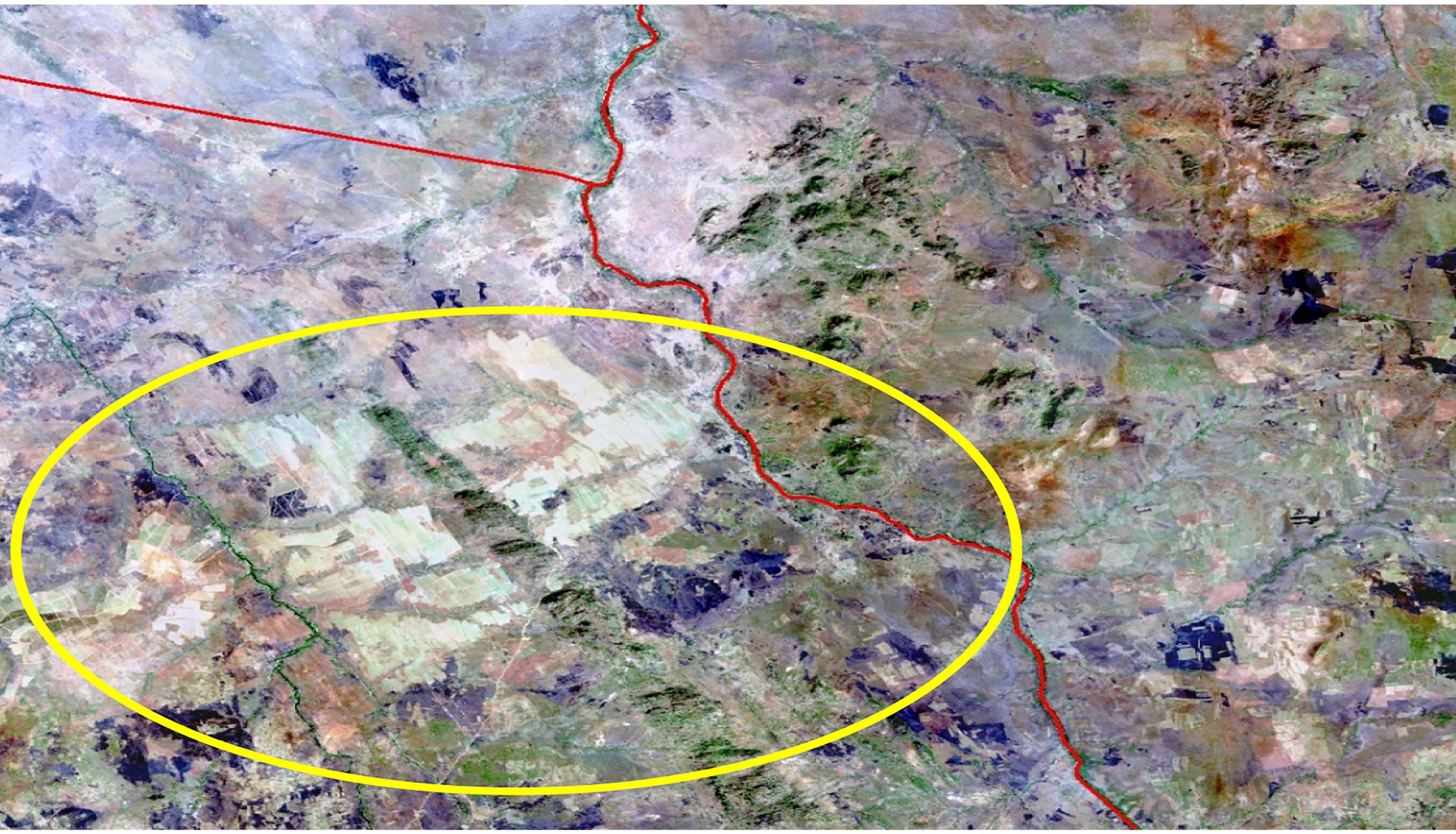
Impact of refuge settlement on Bugoma CFR May 2019

Land-use change

Deforestation and forest degradation, mainly due to conversion to agriculture, has led to loss of large areas of forest cover and degradation of forest land in Uganda. Private forests are some of the most affected areas, as owners have gained more benefits from converting these areas to farmlands than retaining them as forests. Many forests in the central region, Masindi and Hoima districts have been turned to farm lands due to their perceived fertile soils and the lure of high returns from investments in agriculture. where forests have been converted mainly to sugarcane plantations in the districts of Atiak and Amuru districts Large scale farming is good for economic development, but it also contributes to tree loss and around 33.7 sq.km in Atiak has been converted for sugarcane growing as shown below.



Atiak in 2016 before sugarcane plantation



Atiak in 2019 after sugarcane plantation

3.2.4 Responses

Forest cover restoration: Under the Forest Landscape Restoration (FLR) Program, part of contribution to the Bonn challenge, the Ministry of Water and Environment and the International Union for Conservation of Nature (IUCN) identified about 8.08 million hectares for restoration, which is larger than the Bonn challenge commitment of 2.5 million hectares restored by 2020 (Table 3.2). This informed the allocation of areas for tree planting in the sow log scheme and has been used to guide on restoration priorities for NFA.

Table 3.2: Area available for restoration within the different vegetation cover categories in Uganda

Landscape zonation	Deforested land (ha)	Degraded land (ha)	Area for restoration opportunity (ha)
1. Afro-montane	133,613	8,997	691,161
2 .Lake Victoria crescent	706,376	205,640	394,491
3 .Northern moist	4,553,045	932	2,631,315
4 .South East Lake Kyoga flood plain	193,094	9,002	393,640
5 .Southwest rangeland	1,506,253	347,428	1,154,340
6 .Western mid-altitude	1,890,117	554,055	1,039,520
7 .Karamoja	684,161	0	1,775,156
Total restoration opportunity			**8,079,622**

Source: MWE and IUCN 2016

The interventions include the Sawlog Production Grant Scheme (SPGS), which has largely focused on forest plantations as a means of reducing pressure on the natural forest estate. Other interventions include actions through the tree fund where District Local Governments receive tree seedlings from the National Forestry Authority (NFA) for planting annually, interventions by civil society organizations such as the Environment Conservation Trust of Uganda (ECOTRUST), Little Hands Go Green, Tree Talk, and the World Wide Fund for Nature (WWF), among others (MWE 2018).

In the early 2000s it was estimated that 70% of the forest in the Albertine Rift was on private land. However, estimates of deforestation rates made in 2010 indicate that all such private forests will have been cleared by 2025. In order to address this problem, government has, as part of strategic planning, identified forests and woodland savannah connections (corridors) in the landscape to retain migration routes (corridors) and support gene flow among populations of vulnerable species. The result of this has been identification of at least 20 riverine forests and wetlands that could serve as wildlife corridors between central forest reserves, wildlife reserves and community wildlife areas in the Murchison-Semliki landscape (Figure 3.4). Notable species of conservation concern using these corridors included both threatened species such as Chimpanzee.

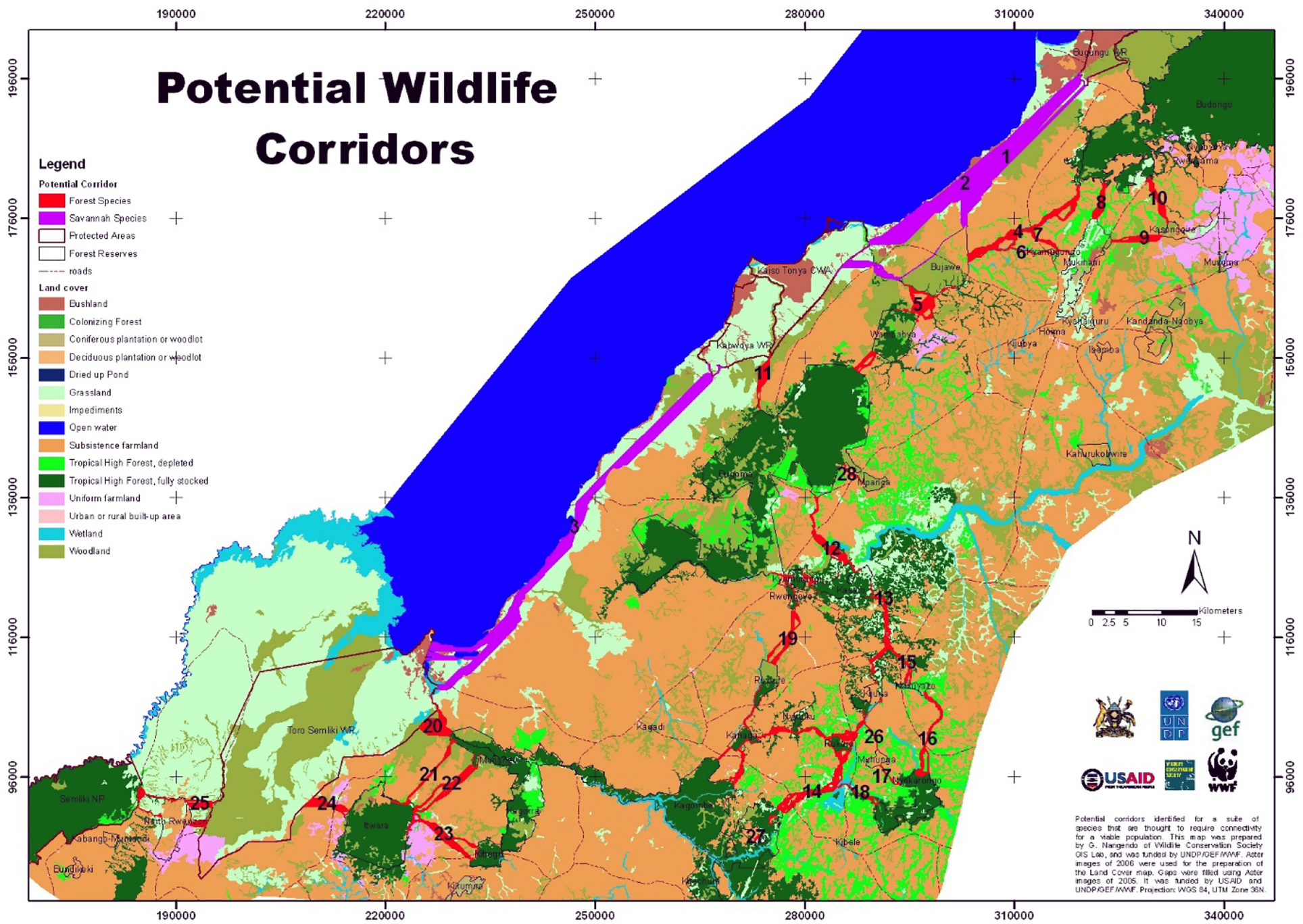


Figure 3.4: Potential animal corridors in the Murchison-Semliki landscape

The wildlife corridors in the Kidepo Critical Landscape (KCL) are also important migratory routes for wildlife, especially the big mammals such as elephants and buffaloes. This is particularly critical during the dry seasons when there is shortage of both food and water in Kidepo Valley National Park (KVNP). This forces the animals to move southwards to Karenga Community Wildlife Area and sometimes further down south to areas as far as Otuke and Abim districts. Other elephants move south-westwards to Kitgum and Agago districts (Figure 3.5). In addition to the big mammals, other mammals that use the corridors include monkeys, warthogs, wild pigs, antelopes, duikers, wild rabbits, baboons, edible rats, bats and squirrels. There are also different types of birds including the rare ones such as ostriches that have been encountered in the corridors. Whereas some of these animals return to the park (seasonally) when rains return, others are permanently resident in these areas. It is estimated that about 150 elephants permanently live within this corridor and also northwards into South Sudan. In Figure 3.9, each colour represents a collared individual. Each collared individual was associated with specific/separate herd of elephants.

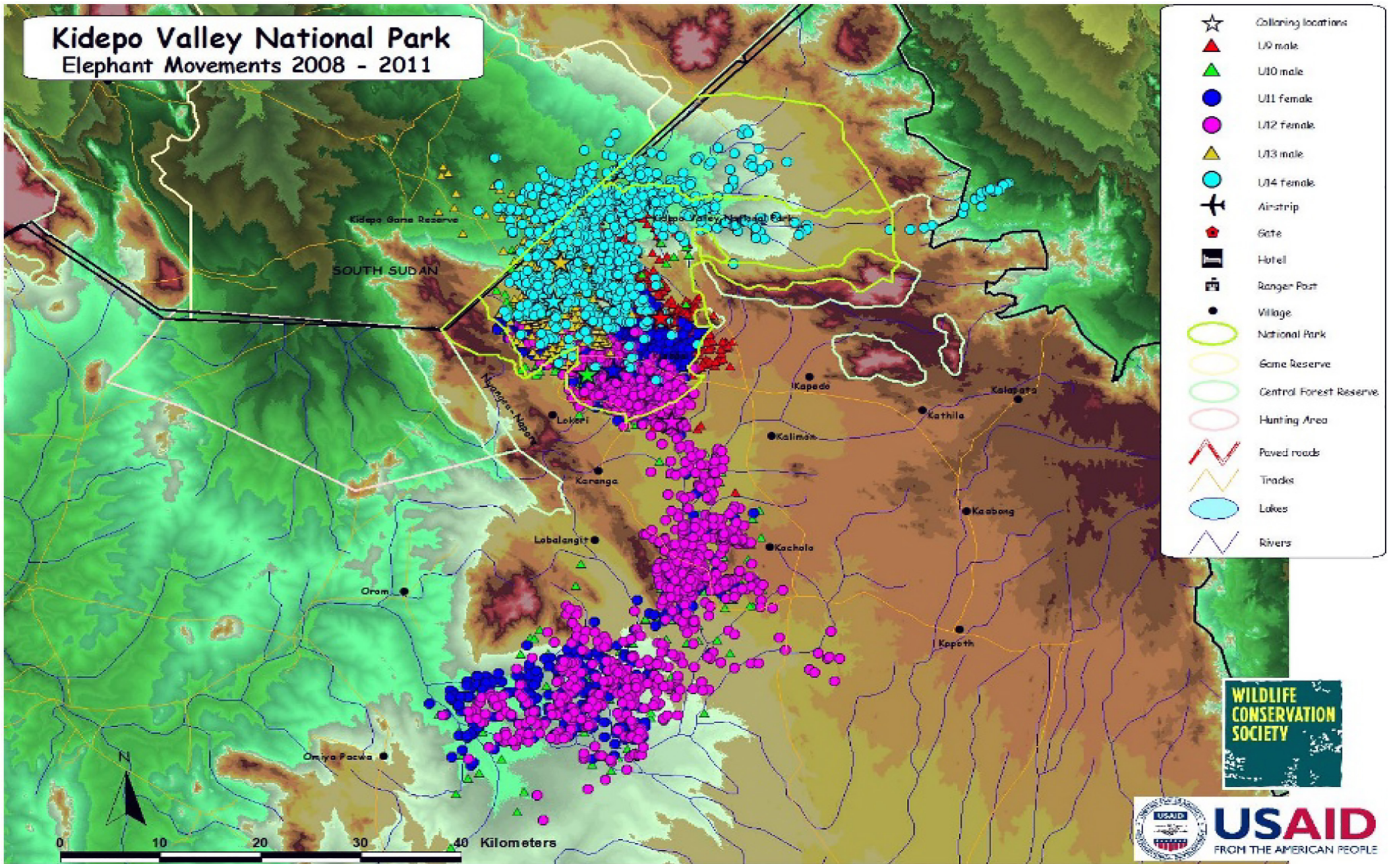


Figure 3.5: Elephant movement from Kidepo southwards to Karenga Community Wildlife Area.

The corridors also consist of one of the biggest belts of the shea butter tree (Vitellaria paradoxa) in Uganda, especially in the districts of Agago, Abim, Kitgum, Pader and Otuke. This belt supports other forms of wildlife that depend on shea for food and other purposes. In itself, the shea tree and its products, especially the fruits and oil have significant economic potential for improvement of the livelihoods of the local people. Apart from the income earned from the sale of shea oil extracted from the seeds, the fruits have enormous nutritional value hence making this shea belt a safety net during times of famine. However, the shea trees are threatened mainly due to the destruction for charcoal production.

With the support from the Global Environment Facility (GEF) through the United Nations Development Programnme (UNDP) government developed a management plan for the wildlife dispersal corridors for the KCL in Figure 3.6. This is the first of its kind in Uganda to support management of biodiversity outside protected areas. Lessons learnt from its implementation will be used for upscaling to other parts of the country.

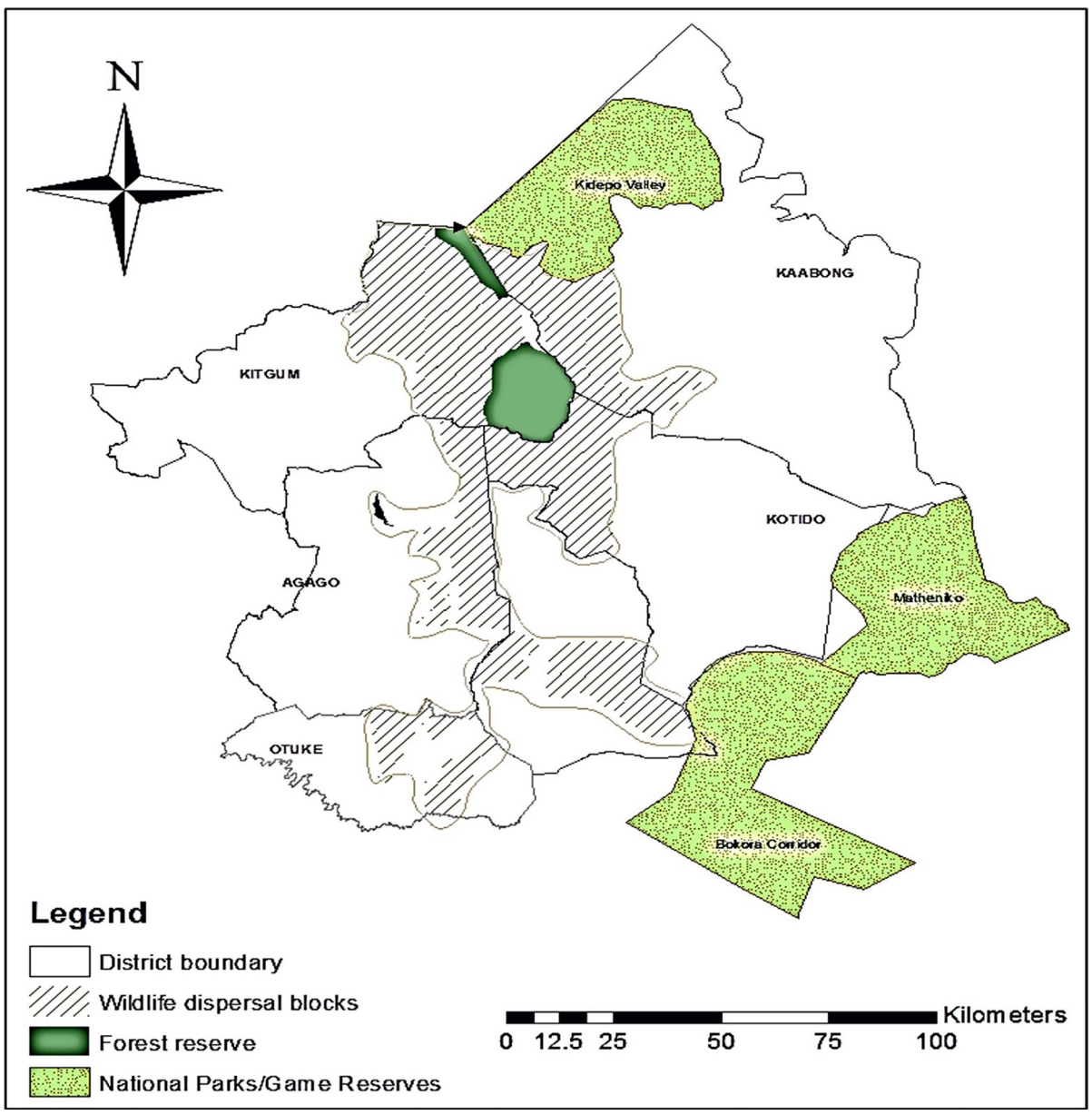


Figure 3.6: Extent of wildlife dispersal blocks/corridors in Kidepo Critical Landscape Source: NEMA (2018)

Kagombe CFR Recovery

Kagombe CFR in Kibaale District was at the peak of encroachment for agriculture in early 2018 and eviction of encroachers was carried out as a measure to restore and protect the forest

Kagombe CFR was at the peak of encroachment in early March 2018

Kagombe CFR on the path to recovery after eviction of encroachers November 2018

Furthermore, the National Environment Act No.5 of 2019 under section 51 provides for declaration of special conservation areas for protection of ecosystems and conservation of biological diversity by prohibiting certain activities. The first special conservation area is the Kalagala and Itanda Special Conservation Area covering an area of 2,835 ha was gazette by Parliament in December 2019. The Kalagala-Itanda Falls Special Conservation Area includes Nile bank, central forest reserve (CFR), Namavundu CFR, Kalagala CFR and the 100-meter river bank from the highest water mark on either side of river Nile, including the islands within river Nile from 2.5 km North of Bujagali dam along 15.7km between Bujagali and Isimba dams to the most Northern part of Nile Bank Central Forest Reserve. Kalagala-Itanda Falls Special Conservation Area lies on both the Western and Eastern side of River Nile in the sub counties of Kangulumira in Kayunga district, Kisozi in Kamuli district, Wakisi in Buikwe district and Butagaya and Budondo in Jinja district as shown on Figure. 3.7

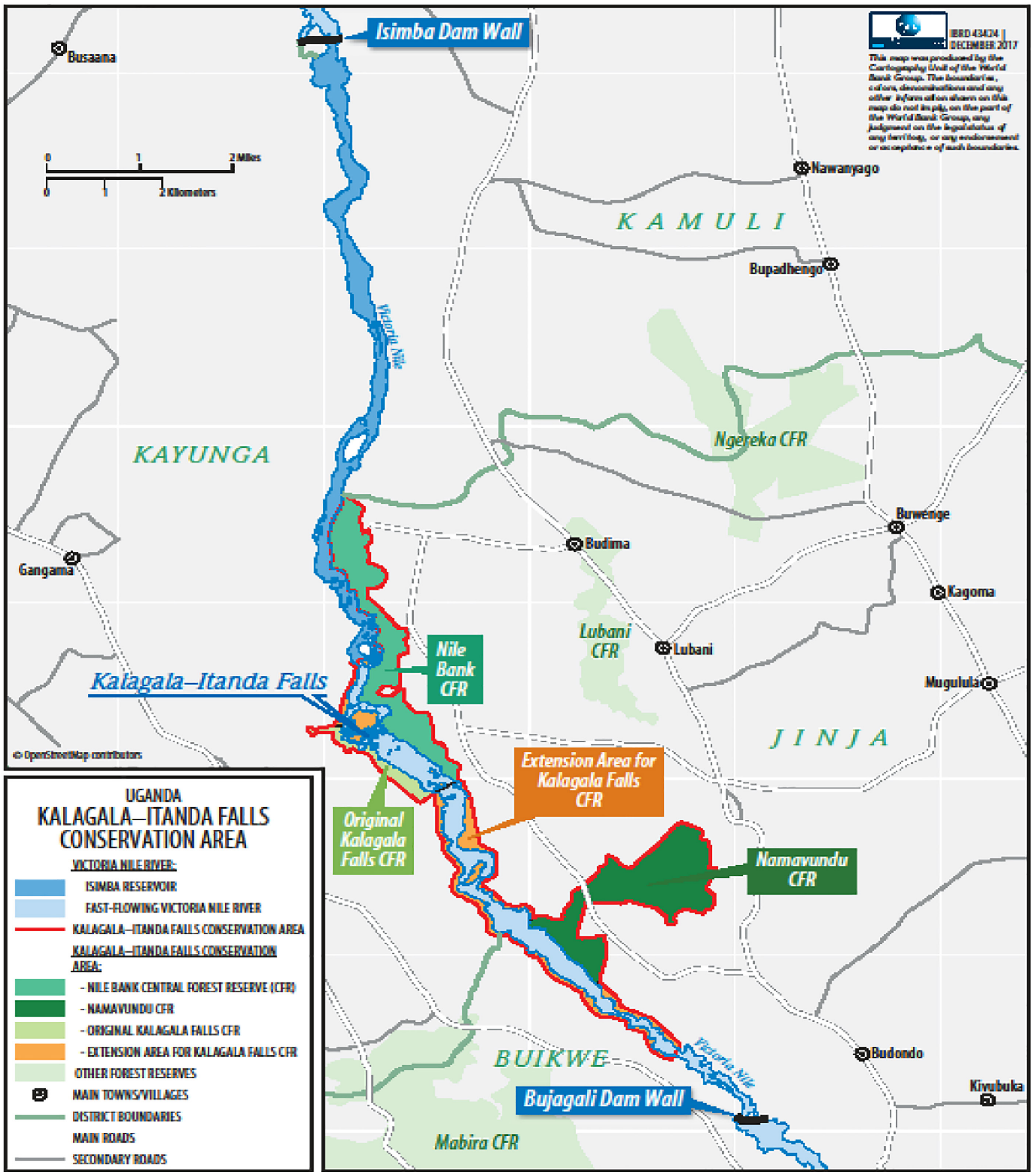


Figure 3.7: Kalagala and Itanda Falls Special Conservation Area (Source: Ministry of Energy record, 2018)

The Kalagala- Itanda Falls Site Sustainable Management Plan (FIFS-SMP) was developed under the auspices of Amended Indemnity Agreement for Kalagala Offset between Government of Uganda and IDA/World bank (2018). The Kalagala-Itanda Falls Site SMP is a framework for promoting sustainable development in Kalagala-Itanda Falls Site. The Plan provides information on the strategies and actions that will be implemented as means to achieve the obligations stated in the amendment and comprise of the Management Plan for Kalagala-Itanda Falls Central Forest Reserve; The Ecotourism Development; Management Plan for the Fragile Ecosystems; Environmental and Social Management Framework; and, Monitoring Plan for Aquatic Biodiversity.

Plate 3.1.Kalagala-Itanda falls site

The Special Conservation Area is to be managed and conserved for the purpose of-

(a) restoring and protecting the ecological zones along the banks of the river Nile and the associated wetlands and islands within the area specified in the Schedule to this Instrument;
(b) sustaining the ecological services of the Kalagala- Itanda Falls Special Conservation Area and to protect the associated wetlands and islands and stabilize the banks of the river Nile;
(c) maintaining the potential for ecotourism and recreation activities within the Kalagala - Itanda Falls Special Conservation Area: including the natural beauty of the waterfalls and rapids;
(d) protecting and enhancing aquatic biodiversity and natural habitats, including endemic fish species of global and national conservation concern;
(e) preserving the cultural heritage sites, assets and social economic values within the Kalagala - Itanda Falls Special Conservation Area;
(f) upgrading the conservation status of the area specified in the Schedule to this Instrument to enable it to be managed as a Special Conservation Area and to prohibit activities; such as infrastructure developments that could adversely affect and alter the ecological functionality, biodiversity and aquatic ecosystem of the river Nile;
(g) promoting research to enhance ecological functionality and values; and
(h) enhancing sustainable livelihoods for local communities in accordance with the Kalagala-Itanda Falls Special Conservation Area Sustainable Management Plan

Activities in the Special Conservation Area

(1) All activities in the Special Conservation Area shall be undertaken in accordance with the Kalagala-Itanda Falls Special Conservation Area Sustainable Management Plan and in accordance with a licence or permit issued under the applicable law regulating the activity.
(2) Construction of new roads, railways, dams or hydroelectric facilities, or other permanent infrastructure is prohibited in the Kalagala-Itanda Falls Special Conservation Area.
(3) Existing activities in the Special Conservation Area authorized under any applicable law, prior to the issuance of this Instrument, shall continue, subject to this Instrument, the applicable law, the approved Kalagala-Itanda Falls Special Conservation Area Sustainable Management Plan and, as applicable, the Resettlement Action Plan or the Livelihood Restoration Plan.

Development of land and soil degradation accounts

Natural capital accounts are a set of objective data on the stocks of natural resources, including ecosystems and species, and the flows of benefits they provide. They aim to provide detailed integrated statistics on how natural resources contribute to the economy and how the economy affects natural resources. In recent years, natural capital accounting (NCA) has become a prominent tool for providing more evidence-based approaches in support of sustainable development, green economy transition and climate change adaptation.

NEMA in collaboration with UNEP-WCMC is implementing a project on Natural Capital Accounts which is supported by the Darwin Initiative. One of the accounts that is being developed is the land and soil degradation accounts. The project support delivery of the National Development Plan, Green Growth Development Strategy and NBSAP through integration of the value of biodiversity into national reporting, poverty reduction, and planning processes. This will enable decision-makers to implement integrated environmental-economic planning for green growth, poverty alleviation and attaining the Sustainable Development Goals (SDGs) and national biodiversity targets contained in the NBSAP. The capacity of account compilers and users will be developed to institutionalize the accounting approach.

The objective of developing land and soil degradation accounts is to provide information on land and soils which is the driver for agriculture. The land (soils) accounts and land (soils) degradation accounts will support UBOS; Ministry of Agriculture, Animal Industries and Fisheries (MAAIF); National Planning Authority (NPA) and Ministry of Finance, Planning and Economic Development (MFPED) in integrating natural capital accounts in national accounts and reporting systems. The land and soil degradation accounts is finalized and the next National State of Environment Report will provide more detail information.

3.3 Wetlands

A wetland is an area of land that is seasonally or permanently flooded. In Uganda these include marshes, swamps and bogs. Wetlands occur all over Uganda covering 11% of the total land area of Uganda of which 7.7% are seasonal wetlands, 3.4% are permanent wetlands and less the 0.1% swamp forest (Government of Uganda, 2016).

3.3.1 Introduction

Wetlands are important for the role they play in society providing a range of ecological and socio-economic functions. Ecological and regulating services include erosion prevention, moderation of extreme flows, sediment traps, climate modification, soil formation, maintenance of water tables in surrounding lands, and as centres of biodiversity and wildlife habitat. Socio-economic or provisioning services include food, medicines, water supply, fisheries, dry-season grazing for livestock, nutrient and toxin retention, tourism, and so on. They are also important for aesthetic, recreational and spiritual reasons.

Wetlands host a wide range of biodiversity including threatened fauna and flora. In addition to hosting a number of threatened species e.g. Diospyros katendei, Afrocarpus usambaresis, Uvariodendron magnificum, Khaya gradifoliola and Lijndenia bequaertii, wetlands are a key breeding and roosting areas for fish and birds e.g. the grey-crowned crane and the shoe bill.

3.3.2 Status and trends

Wetland coverage has reduced from 15.5% in 1994 to 13% (31,411.4 km2) of the total land cover of Uganda based on the 2015-2017 land cover change assessment, 8.9% (21,526.3 km2) still intact and 4.1% (9,885.1 km2) is degraded. Uganda has therefore lost 42.4% (15,820 km2) of its wetlands over the last 20 years, that is, from 37346.3 Km2 to 21526.3 km2. This means that each year Uganda has on average been losing 791 km2 of wetlands (2.12% per year). With this trend, it is estimated that all wetlands in Uganda will be degraded by 2046 if no stringent measures and enforcement is made to conserve and manage wetlands.

Analysis of wetland drainage by basin shows that Lake Albert drainage basin accounts for the largest percentage loss of 32% with over 903 km2 lost between 1994 and 2015. The wetland loss is attributed to the increasing population in the basin, in addition to refugees in the region who have taken up wetlands for agriculture and settlement.

Using wetland cover as a proxy for the biodiversity they host, we analyzed changes in wetland cover between 2015 and 2018. Considering the cover at drainage basin level, wetland degradation was highest in Lake Kyoga and Edward basins (42% and 34% respectively) and lowest in the Kidepo and Aswa basins (1% each) (Table 3.3) and Figures 3.7 to 3.14.

Table 3.3: Showing analysis by drainage basin between 2015 and 2018

Drainage Basin	Intact wetlands (Km2)	Degraded Wetlands (Km2)	Total Wetland coverage (Km2)	% degraded
L.Kyoga	7,701	5,481.1	13,182.1	42%
L.Edward	954.3	493.5	1,447.8	34%
L.Victoria	4,284.4	1,738.3	6,022.7	29%
L.Albert	1,399.4	536.2	1,935.6	28%
Victoria Nile	3,534.1	1,339.4	4,873.5	27%
Albert Nile	1,140.1	280.9	1,421	20%
Aswa	2,333.1	14.7	2,347.8	1%
Kidepo	179.9	1	180.9	1%

The high degradation in the Kyoga basin is attributed to the ever increasing conversion of intact wetlands for subsistence cultivation of mainly rice, sugarcane and maize. The Edward drainage basin wetlands have also been converted to farm lands. In Victoria Nile and Albert Nile, wetland loss is mainly due to increased conversion of wetlands into built up areas and landfilling. For most of these areas, there is total clearance of the wetland cover and thus loss of both flora and fauna species the wetlands host. There is, however, her chance of recovery for areas converted to agriculture than for built-up areas if wetland protection is enforced.

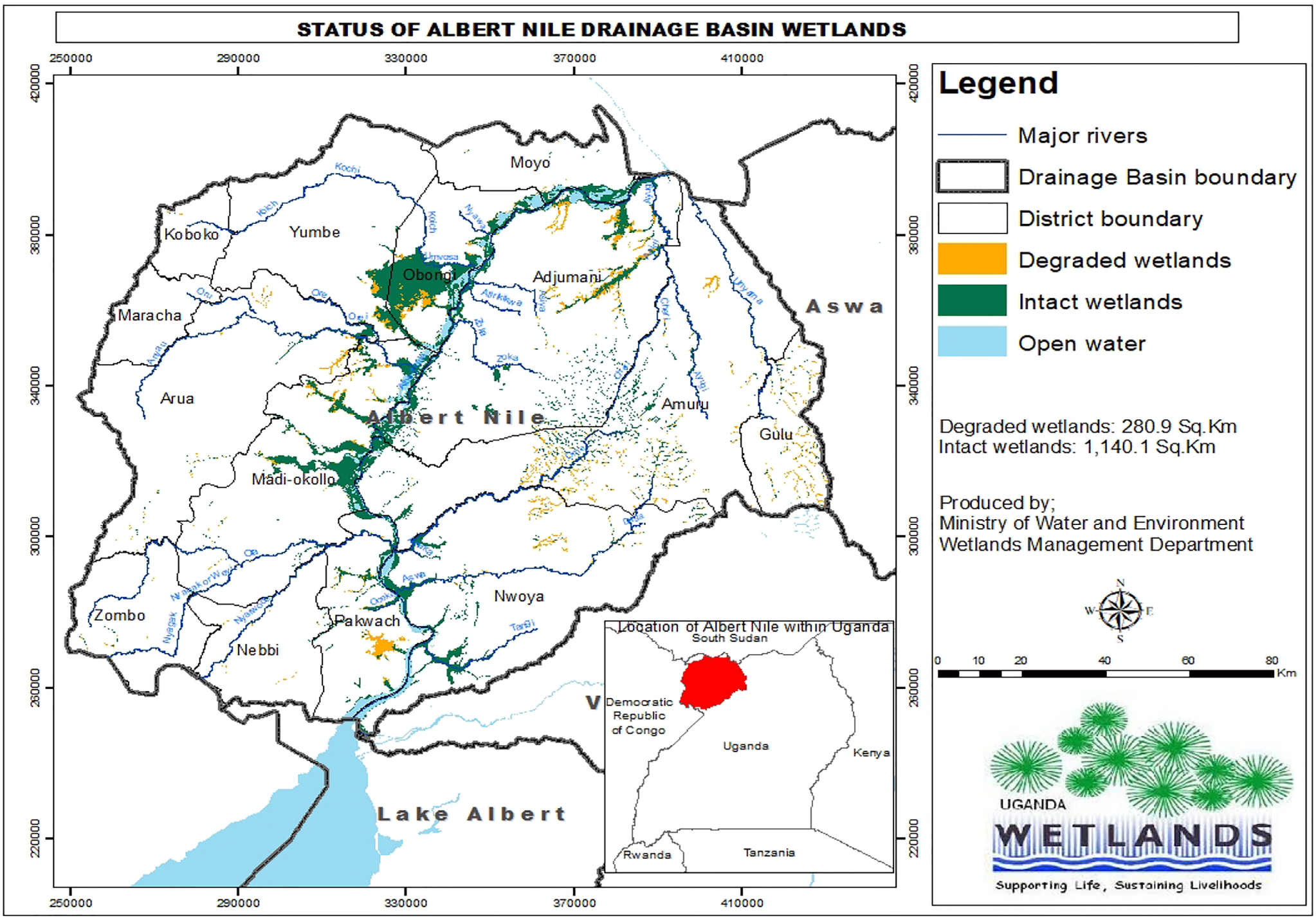


Figure 3.8: Showing Degraded Wetland Areas in Albert Nile Drainage Basin in 2018

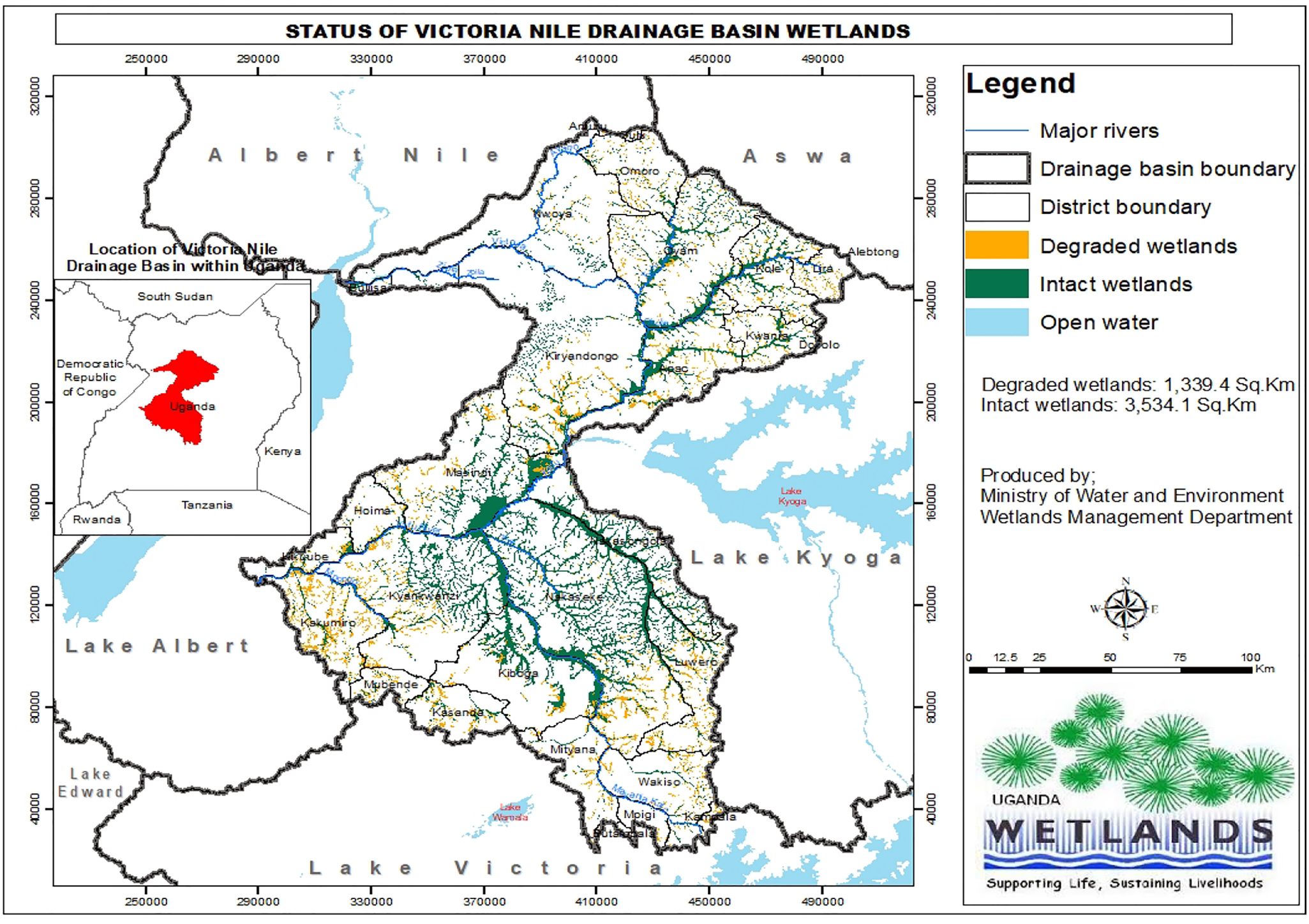


Figure 3.9: Showing Degraded Wetland Areas in Nile Drainage Basin in 2018

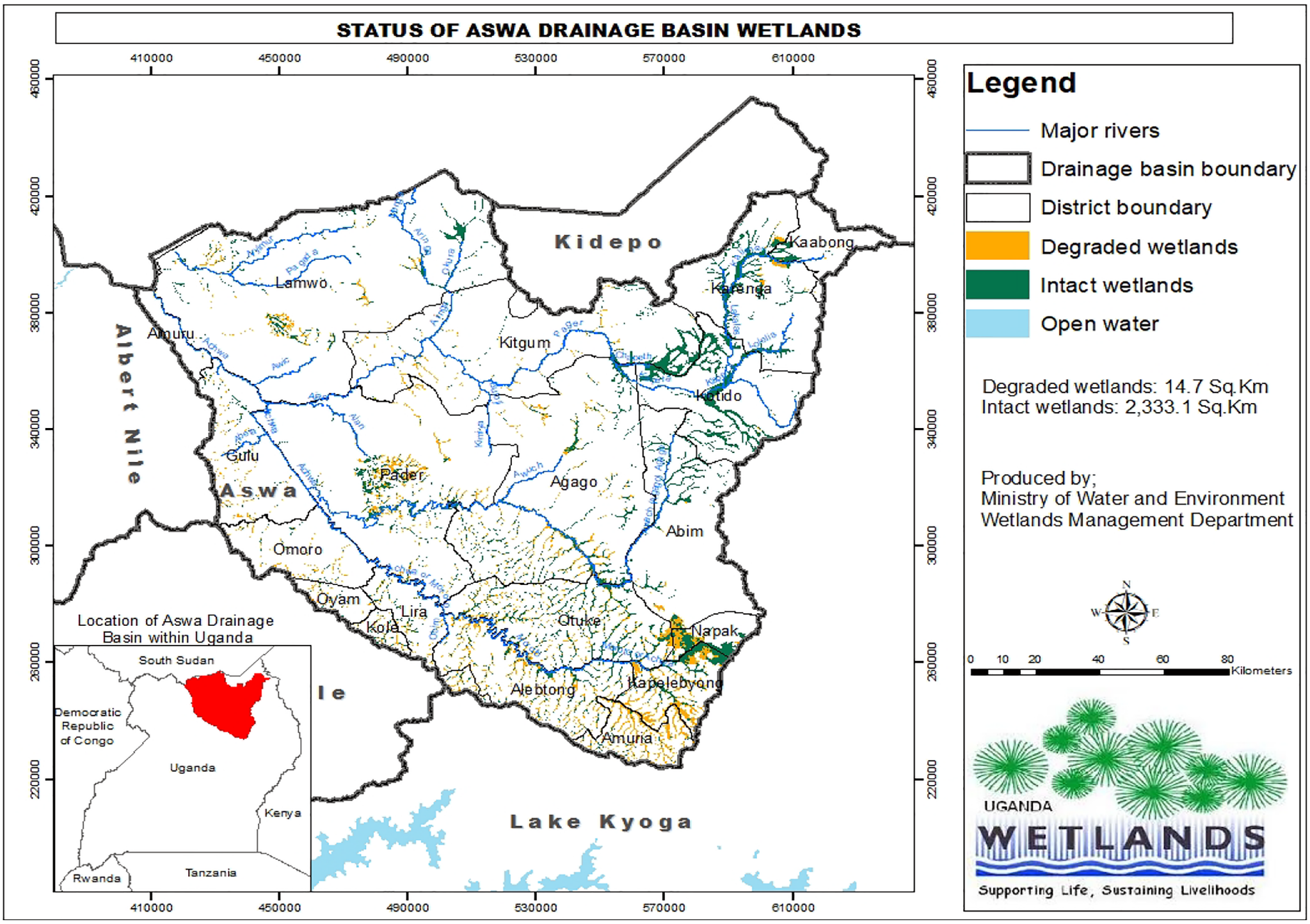


Figure 3.10: Showing Degrade Wetland Areas in Aswa Drainage Basin in 2018

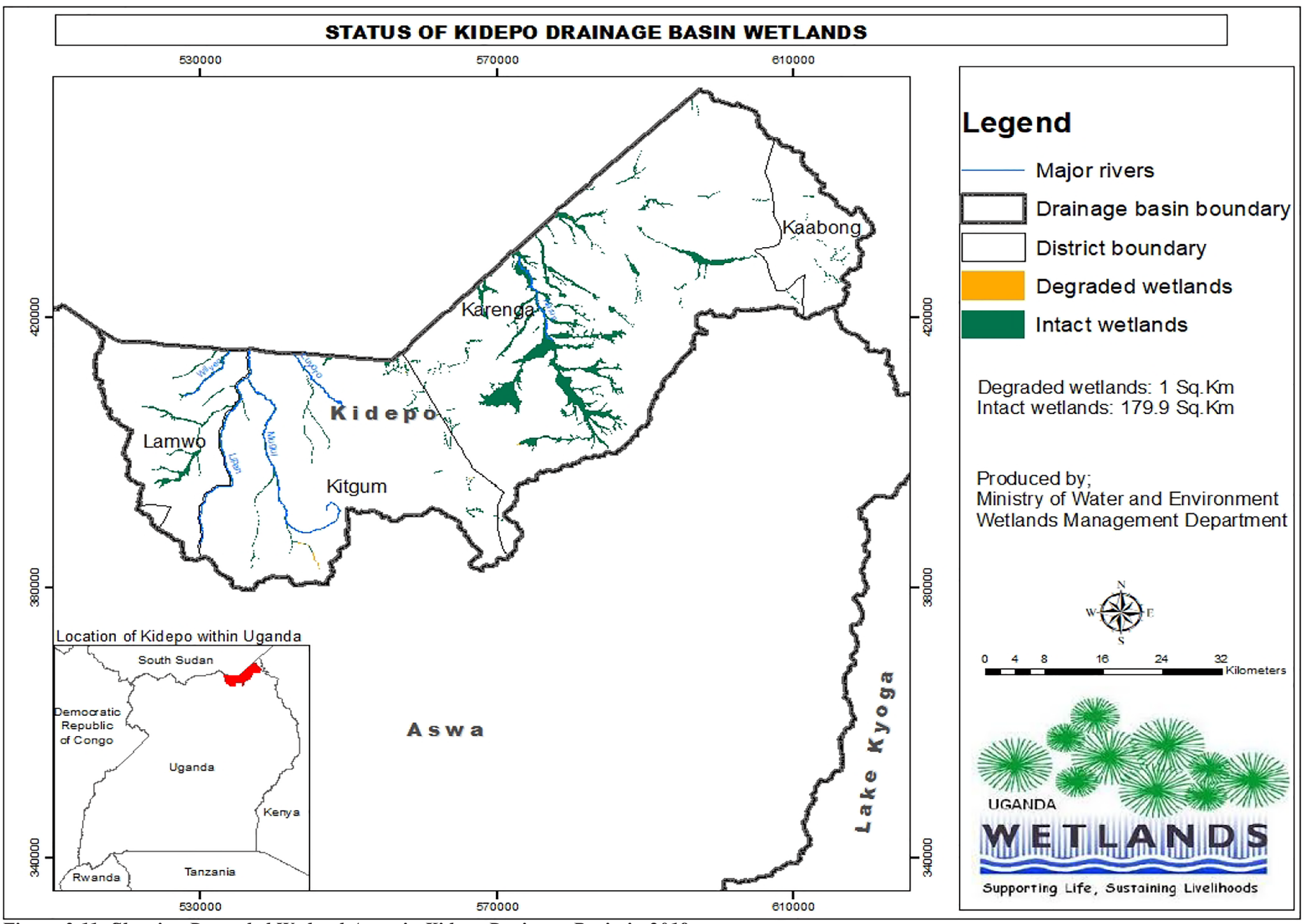


Figure 3.11: Showing Degraded Wetland Areas in Kidepo Drainage Basin in 2018

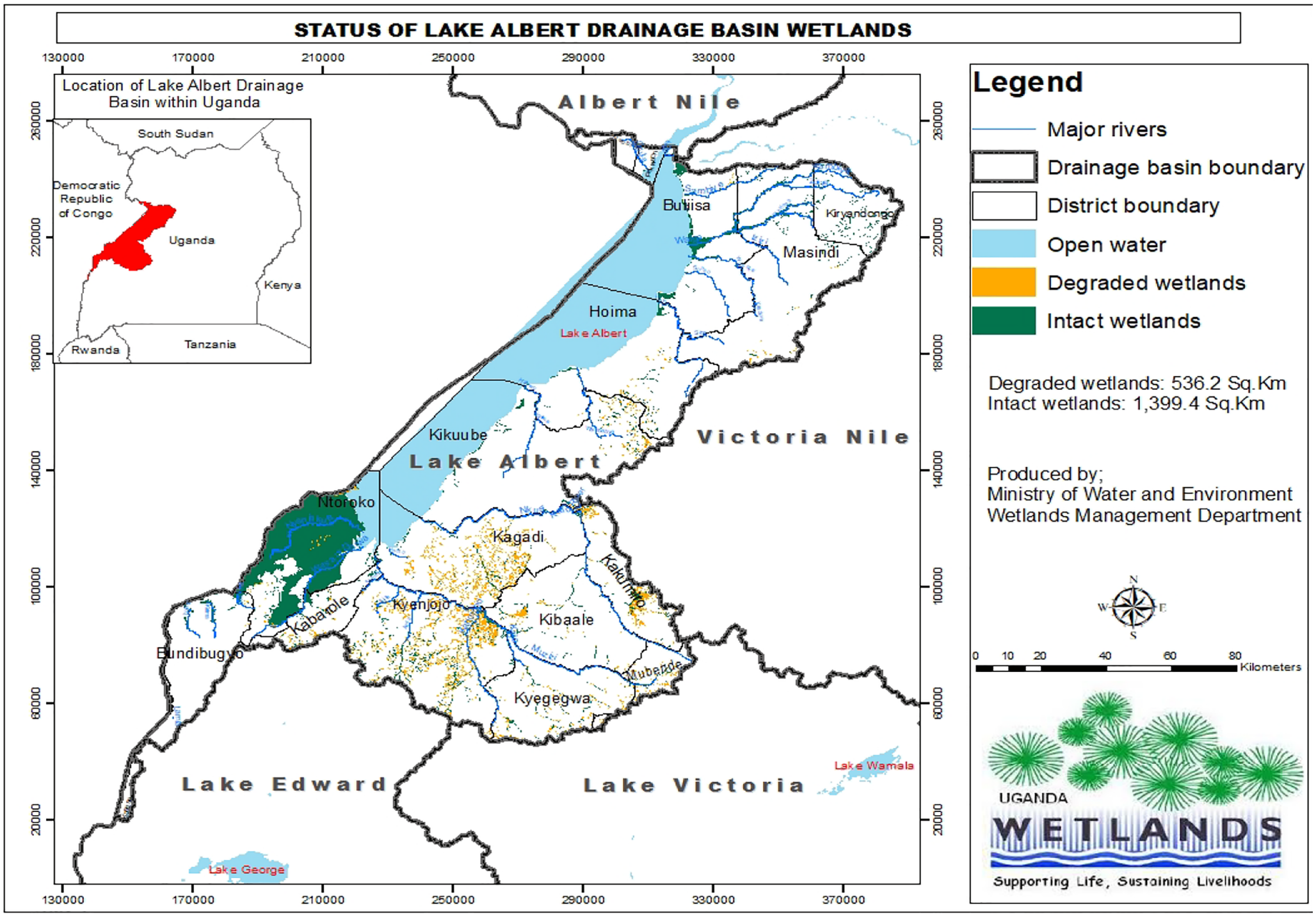


Figure 3.12: Showing Degraded Wetland Areas in Lake Albert Drainage Basin in 2018

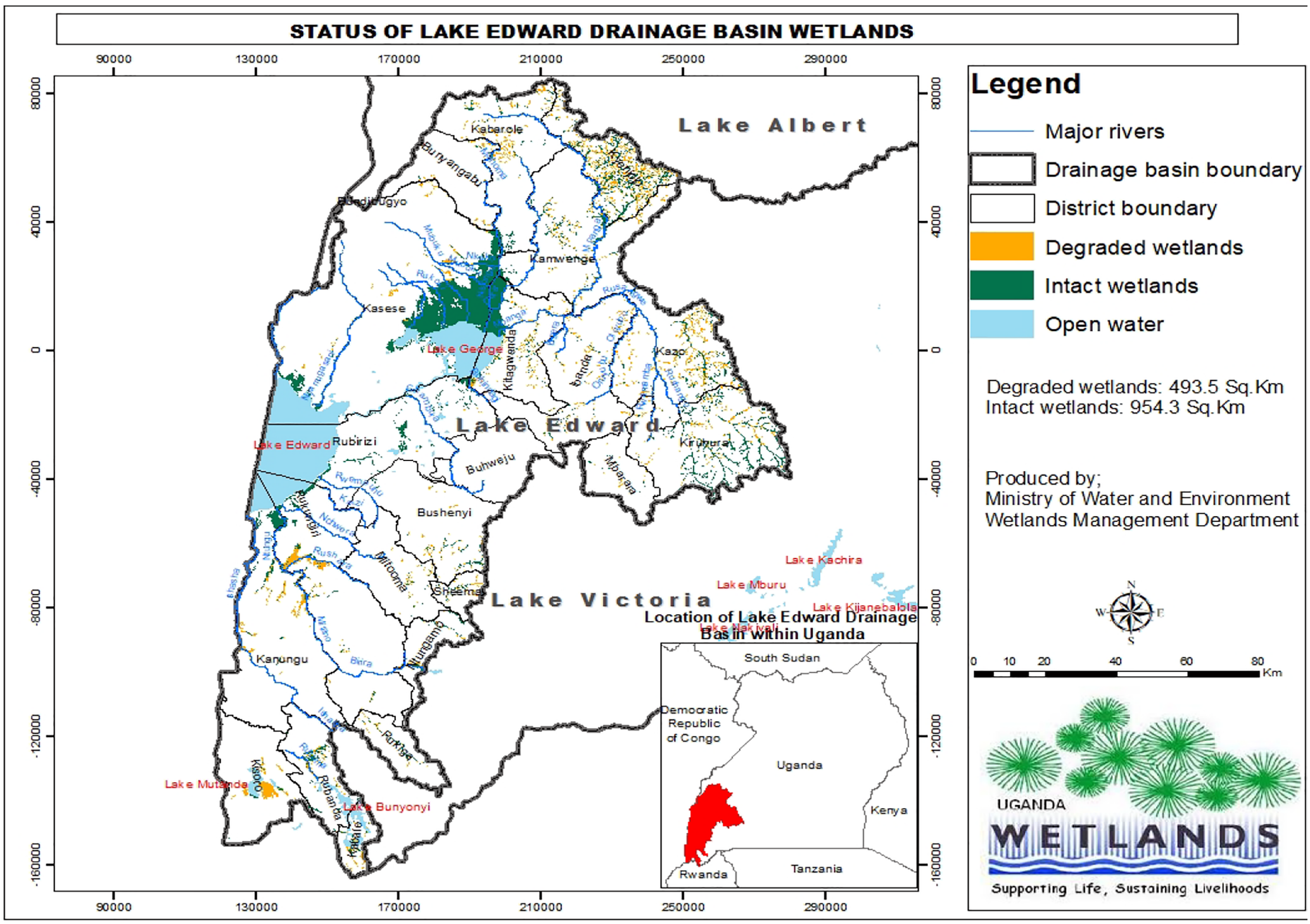


Figure 3.13: Showing Degraded Wetland Areas in Lake Edward Drainage Basin in 2018

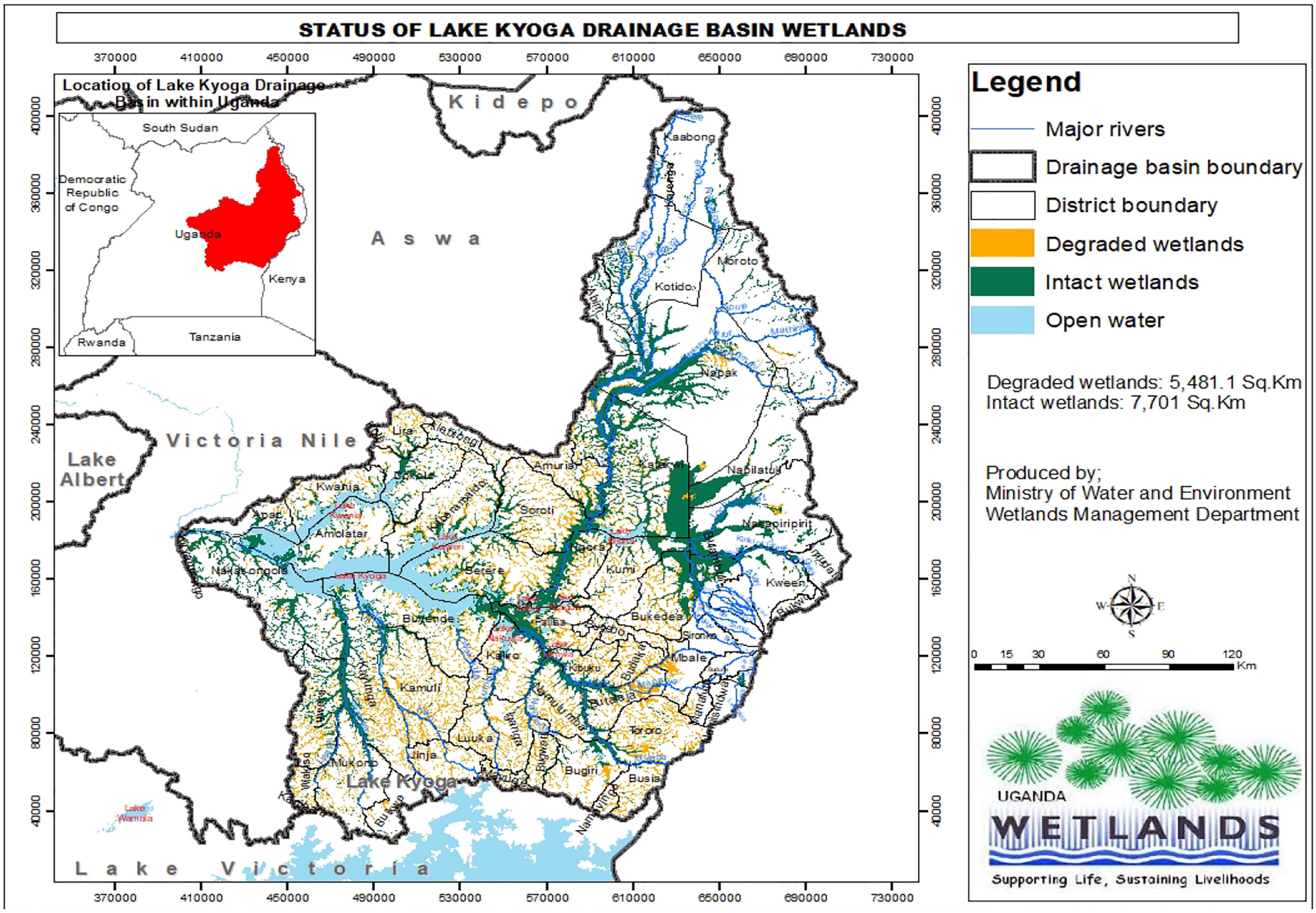


Figure 3.14: Showing Degraded Wetland Areas in Lake Kyoga Drainage Basin in 2018

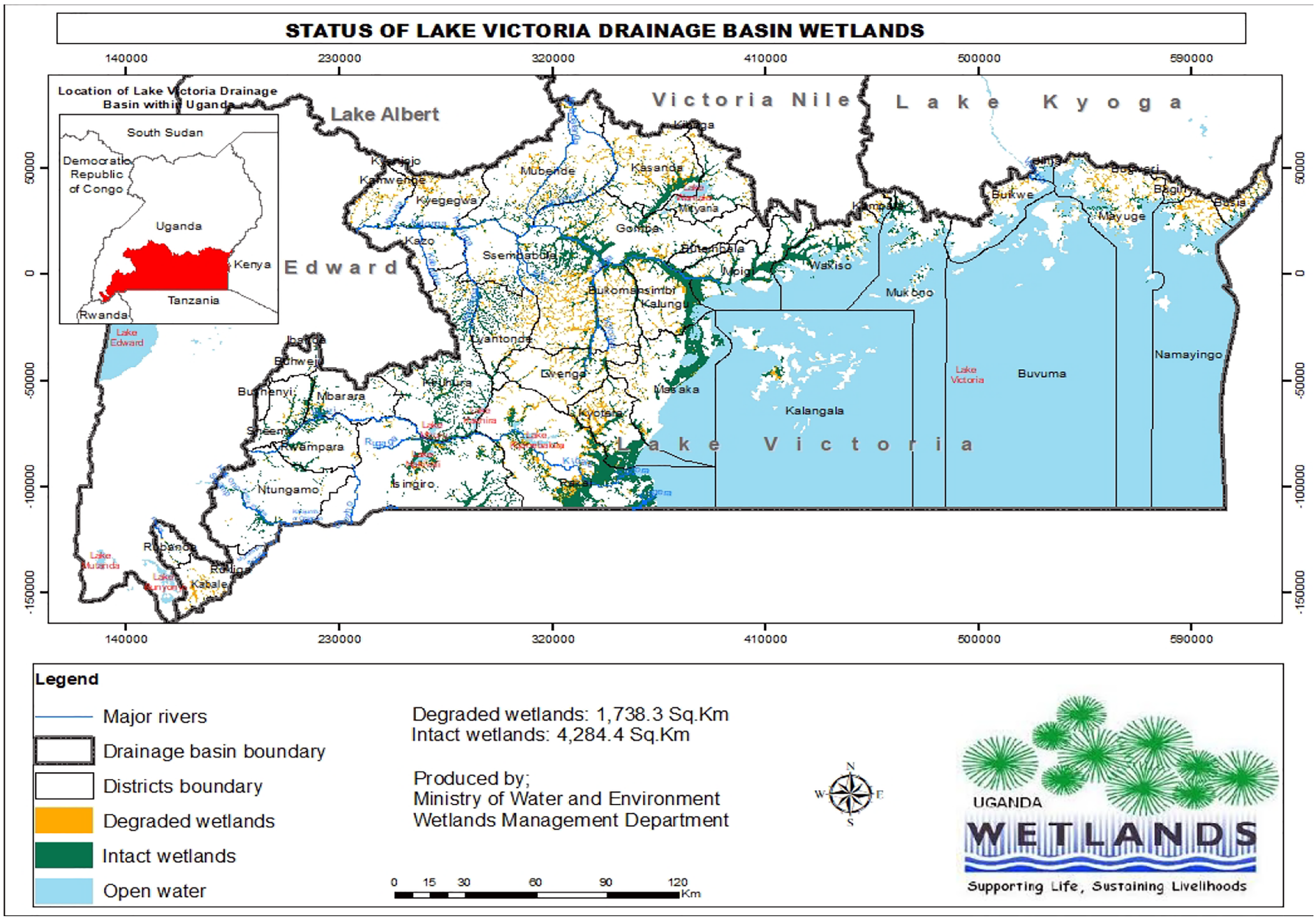


Figure 3.15: Showing Degraded Wetland Areas in Lake Victoria Drainage Basin in 2018

In terms of loss of wetlands by regions, out of the 31,411.4 km2of wetlands left country wide, 21,526.3 km2 (69%) were intact while 9,885.1 km2 (31%) were degraded (Figure 3.15). Figure 3.15 also shows that Eastern region had the highest coverage of degraded wetlands, and the degraded wetlands were almost half (46%) of all wetland in the region Northern Uganda registered the lowest coverage of degraded wetlands (21%).

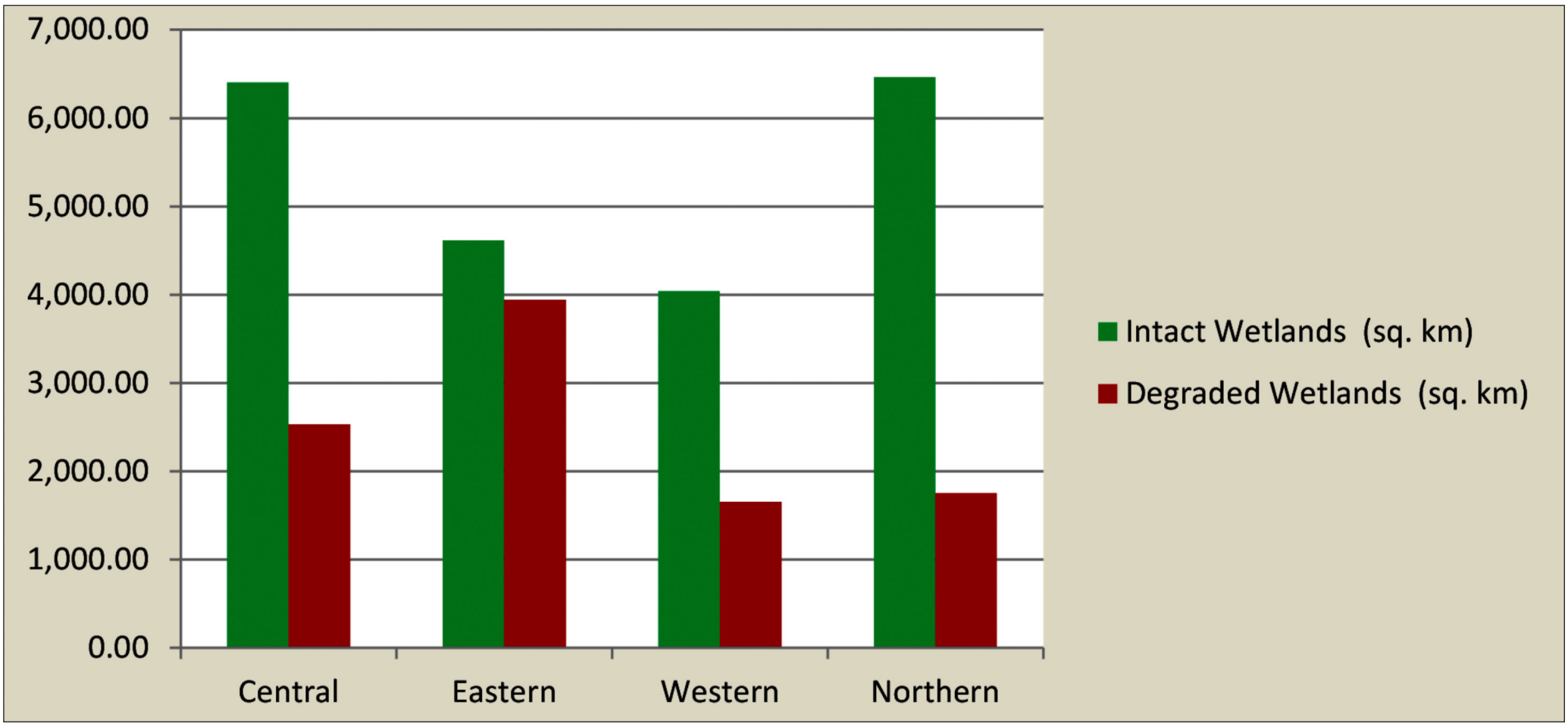


Figure 3.16: Wetlands coverage and degradation by region

3.3.3 Pressures and impacts

The major threat to wetlands in L. Victoria basin is the ever increasing demand for land for urbanization. And the biggest degradation pressure in urban centers is the establishment of housing settlements, illegal industries and public infrastructural developments. Pollution pressure is due to indiscriminate waste disposal and discharge of effluent. The other pressure is the degradation or is by in-filling wetlands with soil/marram or dumping with solid waste and debris.

These developments have led to loss of wetland biodiversity, destruction of habitats, deterioration of water quality, and have largely impeded natural drainage patterns of the landscape leading to frequent floods in most urban centres especially in Kampala (Nakivubo), Gulu (Pece), Mukono (Mbalala) and Jinja (Kirinya).

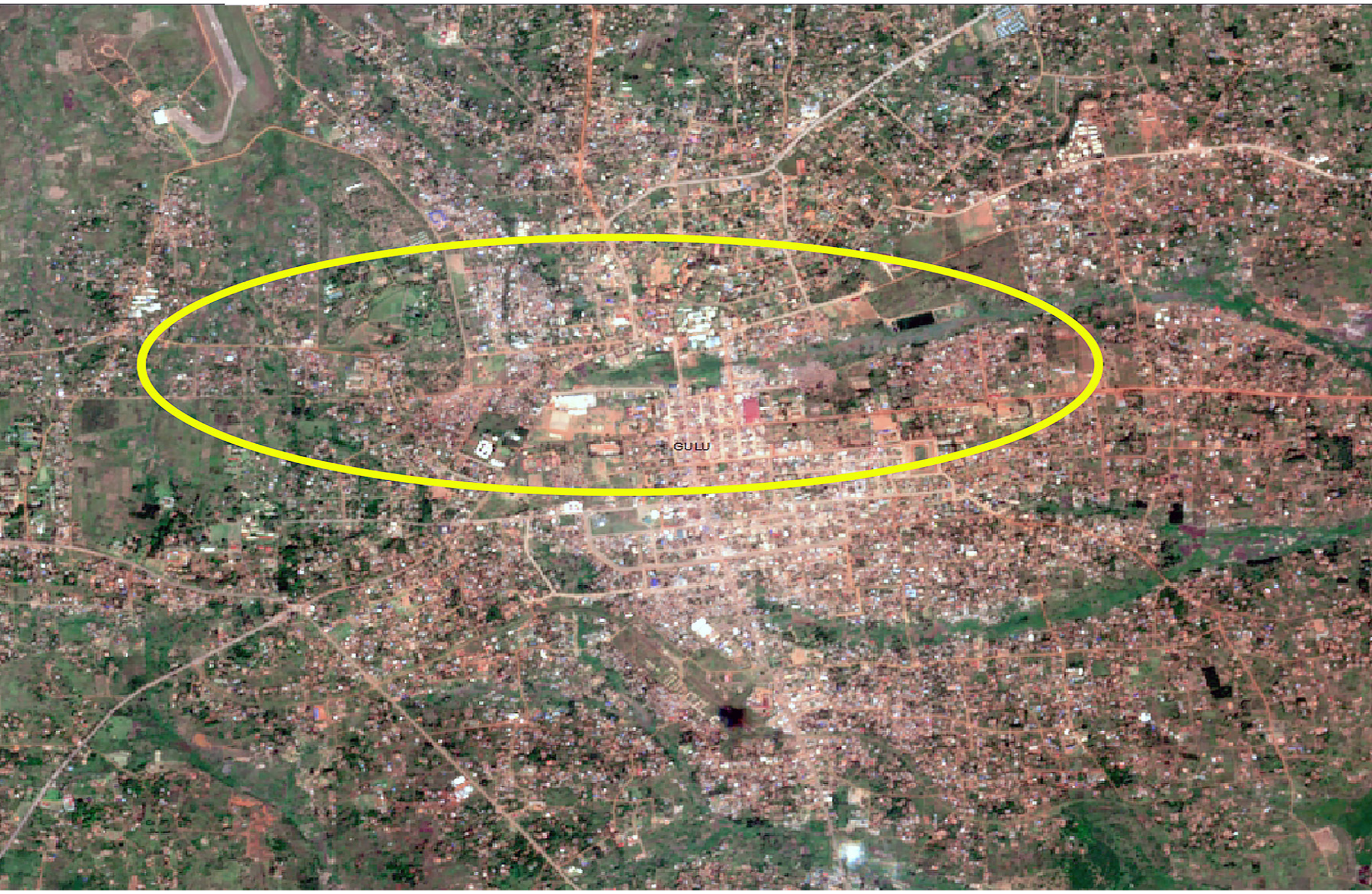
Industrial expansion on Wetland fringes of Lake Victoria in Masese, Jinja2014

Industrial expansion on Wetland fringes of Lake Victoria in Masese, Jinja 2019

Sugarcane expansion in Wetland in Kamuli 2014

Sugarcane expansion in Wetland in Kamuli 2018

Settlement expansion in Pece Wetland in Gulu 2007



Settlement expansion in Pece Wetland in Gulu 2019

In rural areas, wetlands are under pressure mainly from subsistence and commercial agriculture. This is mainly in the prolonged dry season conversion of wetlands into small scale farming is so far the most dominant form of degradation accounting for 95% of the degraded wetland area countrywide. Commercial agriculture and commercial tree planting constituted 0.9% of the degraded wetland area (Table 3.4).

Plate 3.2: (a) shows maize planted on a steep slope along the banks of River Nile (In the background is Namavundu Central Forest Reserve). Plate 2 (b) shows maize planted in within Kalagala Special Conservation Area along the banks of River Nile

Plate 3.3: Comparison of (a) a wetland that has been converted into rice paddies and (b) a natural wetland covered by *Cyperus papyrus within the Kalagala Special Conservation Area.*

Table 3.4: The degradation of wetland by use/activity

Wetland use	Area (Sq.Km)	% of degradation
Commercial farmland	85.6	0.9%
Built up areas	283.7	2.9%
Commercial tree planting	89.2	0.9%
Small scale farmland	9,420.1	95.2%
Bare rocks & soils	6.5	0.1%
Total	**9,885.1**	**100%**

Further analysis shows that Mbale district has the most degraded wetlands with 99% of its wetlands under threat while Ntoroko has the lowest percentage of degraded wetlands (2%). The wetlands in Mbale have been converted into settlements especially in the municipality, for agriculture, and the latest wetland conversion is the establishment of an industrial park at Kamonkoli area that forms part of Namatala riverine wetland. In Ntoroko, most of the wetlands are under protection by UWA in Tooro-Semliki National Park. Although many of the seasonal wetlands in the district are extensively used for livestock grazing in dry season, they are flooded in wet season.

3.3.4 Responses

Restoration of wetlands

Between 2011/12 and 2017/18, 4,487.9 ha of wetland cover across the country were restored, an average restoration rate of 641.13 ha/year (Figure 3.16). Generally, the restoration effort has been declining at a rate of 62 ha/year from the peak annual restoration of over 1,600 hectares in 2012/13 compared to 487 ha restored in 2017/2018 (Figure 3.16). Since the late 2000s, there has been an increase in the number of Government initiatives to cancel and/or reverse perverse subsidies that negatively impact on biodiversity and ecosystems. As a measure to address the problem of wetland degradation, cabinet decided on 16th April 2014 to approve cancellation of land titles in wetlands on public land acquired unlawfully after 1995.

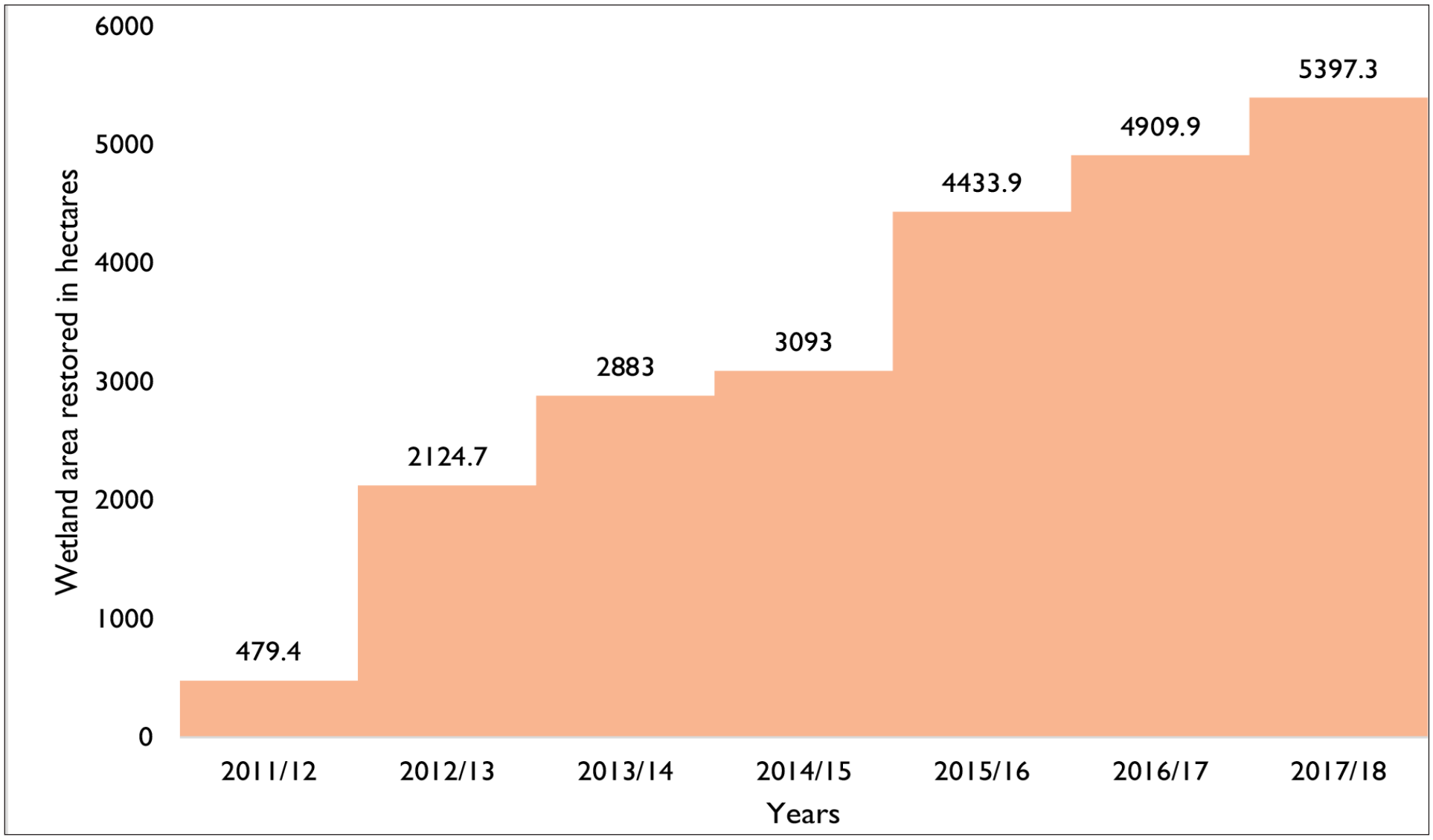


Figure 3.17: Wetland area restored in hectares 2011/12 to 2017/18 Source: MWE SPR (2015, 2016, 2017, 2018)

3.3.5 Recommendations

(a) Minimize further loss of wetlands by restricting the issuance of wetland use permits and certificates;
(b) Strengthen the monitoring and enforcement to ensure compliance
(c) Promote awareness on the values and benefits of wetland conservation;
(d) Demarcate and gazette wetlands
(e) Promoting and supporting eco-tourism and other wetland friendly activities especially community-based wetland eco-tourism
(f) Promoting awareness on the values and benefits of wetland conservation;
(g) Developing and/or implementing community-based wetland management plans
(h) Restoring degraded wetlands

3.4 Wildlife

Wildlife traditionally refers to undomesticated animal species, but has come to include all organisms that grow or live wild in an area without being introduced by humans. The Wildlife is defined by Uganda Wildlife Act of 2019 as any wild plant or animal species or their derivative products that are indigenous, migrated to or introduced in Uganda.

3.4.1 Introduction

Uganda is endowed with a variety of landscapes and geographic features including forests, savannas, dry lands, and wetlands. These coupled with wide climatic variation and different soil types provide an exceptional range of terrestrial and aquatic ecosystems. The varied ecosystems provide a diverse range of habitats upon which a diversity of flora and fauna can thrive.

The uniqueness and diversity of ecosystems and varied climatic conditions have made it possible for Uganda to host 53% of the world's mountain gorillas, 11%of the global recorded species of birds, 7.8 % of global mammalian species, 19% of Africa's amphibians and 14% of African reptilians. (Plumptre et al., 2007, 2019)

In order to promote conservation and management of wildlife, a number of protected area systems have been gazetted and this comprises of ten National Parks with an area of 11,180 sq. km, ten wildlife reserves measuring 8,764 sq. km, seven Wildlife Sanctuaries covering about 850 sq. km and thirteen Community Wildlife Areas of approximately 27,604 sq. km, making up 14% of the total land area of the country (Figure 3.17). The National Forestry and Tree Planting Act (2003) facilitated the creation of 192 Local Forest Reserves (LFRs) approximately 5,000 ha, and 506 Central Forest Reserves (CFRs) totaling about 1.2 million hectares. The gazetted wildlife protected areas and the forest reserves cover about 18.87% of land cover.

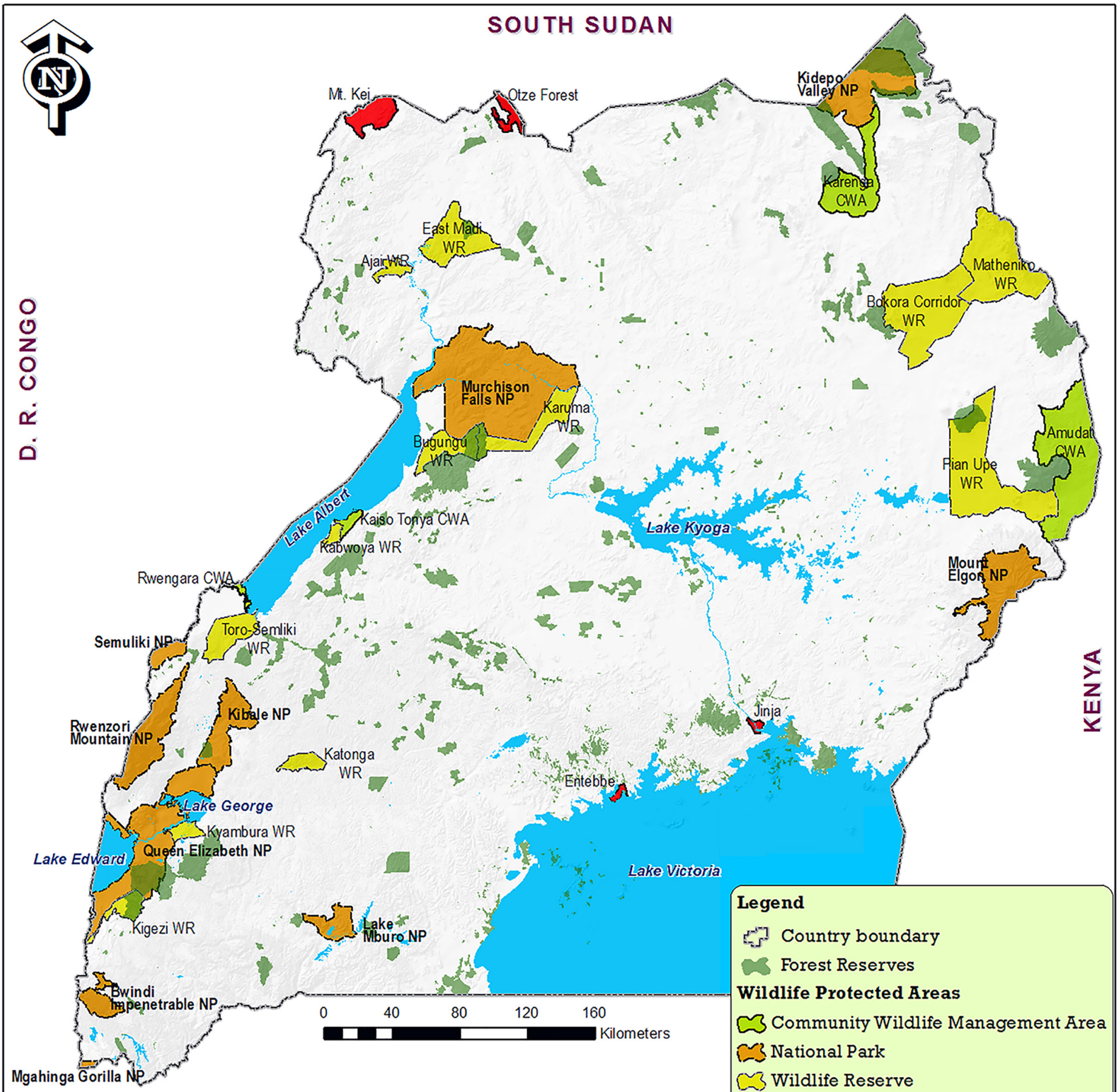


Figure 3.18: Protected Areas in Uganda 2015. Source: MWE 2016

Uganda has 24 (2%) globally threatened bird species and 29 (3%) near-threatened species. The rest of the species are of least concern (Birdlife International, 2014). The globally threatened species include nine endangered species and 15 vulnerable species. The endangered species include three vulture species, White-backed Vulture, Rüppell's Vulture and Hooded Vulture, and the Grey-crowned Crane species.

Plate 3.4: Grey-crowned crane in a maize field adjacent to a wetland in Hoima district

3.4.2 Status and trend

In protected areas, there is increase in wildlife populations. Populations have increased for some species for instance Mountain Gorilla population increased from 292 in 1995 to over 400 in 2017, the Elephant population more than doubled, increasing from about 2000 in 1995/1996 to 5,808 in 2017, Buffaloes increased from about 18,000 in 1995-1996 to 37,054 in 2017, the Giraffe population increased from 250 individuals in 1995 to 880 in 2017 and the Chimpanzee population increased from 3, 300 in 1997 to 4,950 in 2003. Studies to establish current chimpanzee population are ongoing. Results from the Kibale National Park survey conducted in 2019 indicated an increase from 921in 2005 to 1001 in 2019 (Ayebare et al., 2020). Also, the gorilla population census that was conducted in 2018 in the Bwindi-Sarambwe area estimates Gorillas to be 496 (Hickey et al., 2018).

For certain species such as Grant's gazelle, a decline from 100 individuals in 1995 to 57 in 2017 was recorded. The population of Beisa Oryx, Eastern Black rhino, Northern White rhino and the Lord derby's Eland seriously declined to extinction in the wild (Table 3.6). The Black rhinos have, however, significantly increased in captivity from 8 in 2004 to 22 in 2017. The population trends of some of the wildlife species are as shown in Table 3.10 below. Gorilla numbers are records for Bwindi only. However, wildlife outside protected areas are under threat from conversion of existing habitat for cultivation and grazing, illegal hunting as well as illegal wildlife trade.

Human-wildlife conflict (HWC)

Increase in human population has resulted in communities settling close resulting in crop raiding, spread of zoonotic diseases e.g. anthrax in queen Elizabeth Protected Area, loss of property and attacks on humans. The number of reported cases of HWC has increased over the years (Figure 3.18) with Murchison Falls Conservation Area (MFCA) registering the highest number (Table 3.5). The species often associated with these conflicts include elephants, lions, hippopotamus, baboons and monkeys. In retaliation, humans kill the wildlife. These conflicts have cross cutting impacts on human livelihoods, conservation and the economy. The common HWC full incidences relate to crop raiding, human injuries and death.

Table 3.5: Reported Human-Wildlife Conflict incidences across the Wildlife Conservation Areas and UWA Head Office 2009 – 2018 (LMCA = Lake Mburo Conservation Area, BMCA = Bwindi Mgahinga Conservation Area, QECA = Queen Elizabeth Conservation Area, KCA = Katonga Conservation Area. MFCA = Murchison Falls Conservation Area and KVCA = Kidepo Valley Conservation Area)

Year	LMCA	BMCA	QECA	KCA	MFCA	KVCA	UWA hqtrs	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
2017	210	169	302	287	774	208	136	2,086
2018	135	150	590	364	1336	408	133	3,116
TOTAL	**940**	**3,577**	**1,472**	**1,941**	**7,342**	**883**	**1,412**	**17,567**

(Source: UWA, 2019)

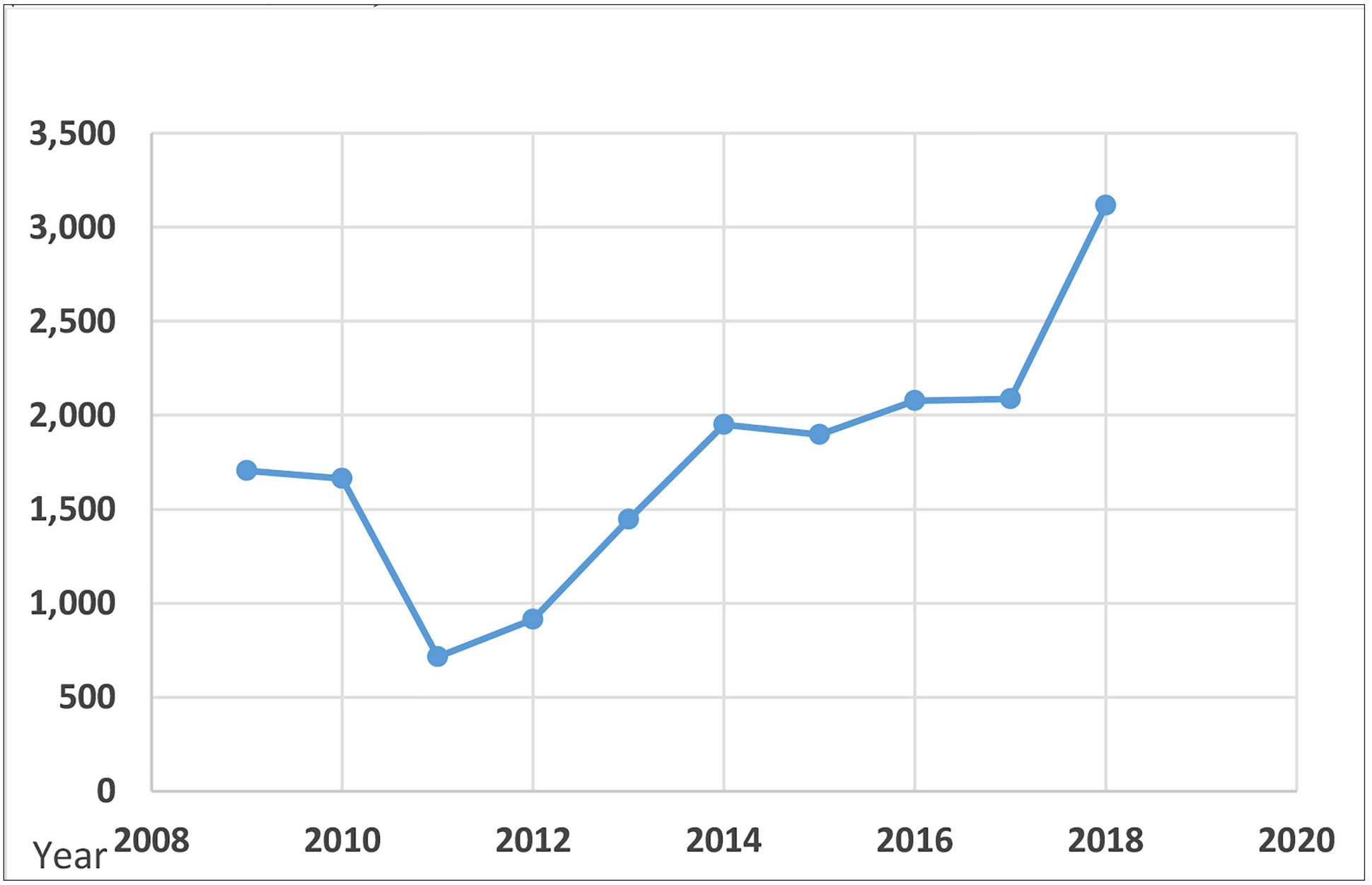


Figure 3.19: Trend in human-wildlife conflict between 2008 and 2018

Table 3.6: Population estimates of selected Medium to large mammals in Uganda

Species	1960s	1982-1983	1995-1996	1999-2003	2004-2006	2007-2010	2011-2014	2015-2017
Buffalo	60,000	25,000	18,000	17,800	30,308	21,565	36,953	**37,054**
Burchell's Zebra	10,000	5,500	3,200	2,800	6,062	11,814	11,888	**11,897**
Elephant	30,000	2,000	1,900	2,400	4,322	4,393	5,739	**5,808**
Rothschild's Giraffe	2500	350	250	240	259	984	880	**880**
Hartebeest	25,000	18,000	2,600	3,400	4,439	4,099	9,667	**9,841**
Hippopotamus	26,000	13,000	4,500	5,300	7,542	6,580	5,838	**5,838**
Impala	12,000	19,000	6,000	3,000	4,705	33,565	33,565	**33,565**
Topi	15,000	6,000	600	450	1,669	845	2,222	**2,222**
Ugandan Kob	70,000	40,000	30,000	44,000	34,461	54,861	77,759	**74,702**
Waterbuck	10,000	8,000	3,500	6,000	6,493	12,925	12,222	**12,809**
Common Eland	4,500	1,500	500	450	309	1,409	1,351	**1,742**
Grant's Gazelle	1,800	1,400	100	50	0	0	57	**57**
Roan Antelope -Sub-species-langheldi	700	300	15	7	0	5	118	**118**
Beisa Oryx	2,000	200	0	0	0	0	0	**0**
Black Rhino	400	150	0	0	0	0	0	**0**
Lord Derby's Eland	300	0	0	0	0	0	0	**0**
Northern White Rhino	300	20	0	0	0	0	0	**0**
Eastern Black Rhino	400	150	0	0	0	0	0	**0**
Southern White Rhino					8	11	17	**22**
Lion						408	493	**493**
Gorilla				320	302		400	**400**
Chimpanzee				4,950				

Source: MTWA 2017 (Note: The Gorilla numbers are records for Bwindi Impenetrable NP only)

3.4.3 Pressures and impacts

The wildlife protected areas nationally are under pressure due to many factors namely; population increase, poaching, wildlife trade, economic developments, and diseases among others. Human population increase and development pressures are driving land use change resulting into many previously undisturbed habitats in Uganda, both protected and on private land, being converted, cleared or otherwise degraded. Hunting of wild animals for meat, over harvesting wild plants especially for commercial purposes are some of the pressures on wildlife outside protected areas. Uganda is also being used as a route by many wildlife traffickers for international illegal wildlife trade.

Invasive species in protected areas reduce foraging area, convert grasslands to woodlands dominated by thickets, cause change in fauna distribution, increase vulnerability of vegetation to fire, and in some cases increase intensity of use of a habitat. This in the long run may result in population decrease affecting tourism.

Table 3.7 shows the invasive species that exist in each of the most affected protected areas and Figure 3.19 shows areas in Semliki National Park where invasive species are being physically removed.

PA	Invasive/Exotic species
Queen Elizabeth National Park	*Dichrostachys cinerea, Lantana camara* *Imperata cylindrica* *Opuntia vulgaris* *Parthenium hystorophorus* *Clomelaena ordorata*
Toro-Semliki Wildlife Reserve	*Dichrostachys cinerea* *Lantana Camara*
Katonga Wildlife Reserve	*Dichrostarchys,* *Lantana Camara*
Lake Mburo National Park	*Acacia hockii* *Cymbopogon nardus*
Semliki National Park	*Terminalia spp* *Cedrella spp*

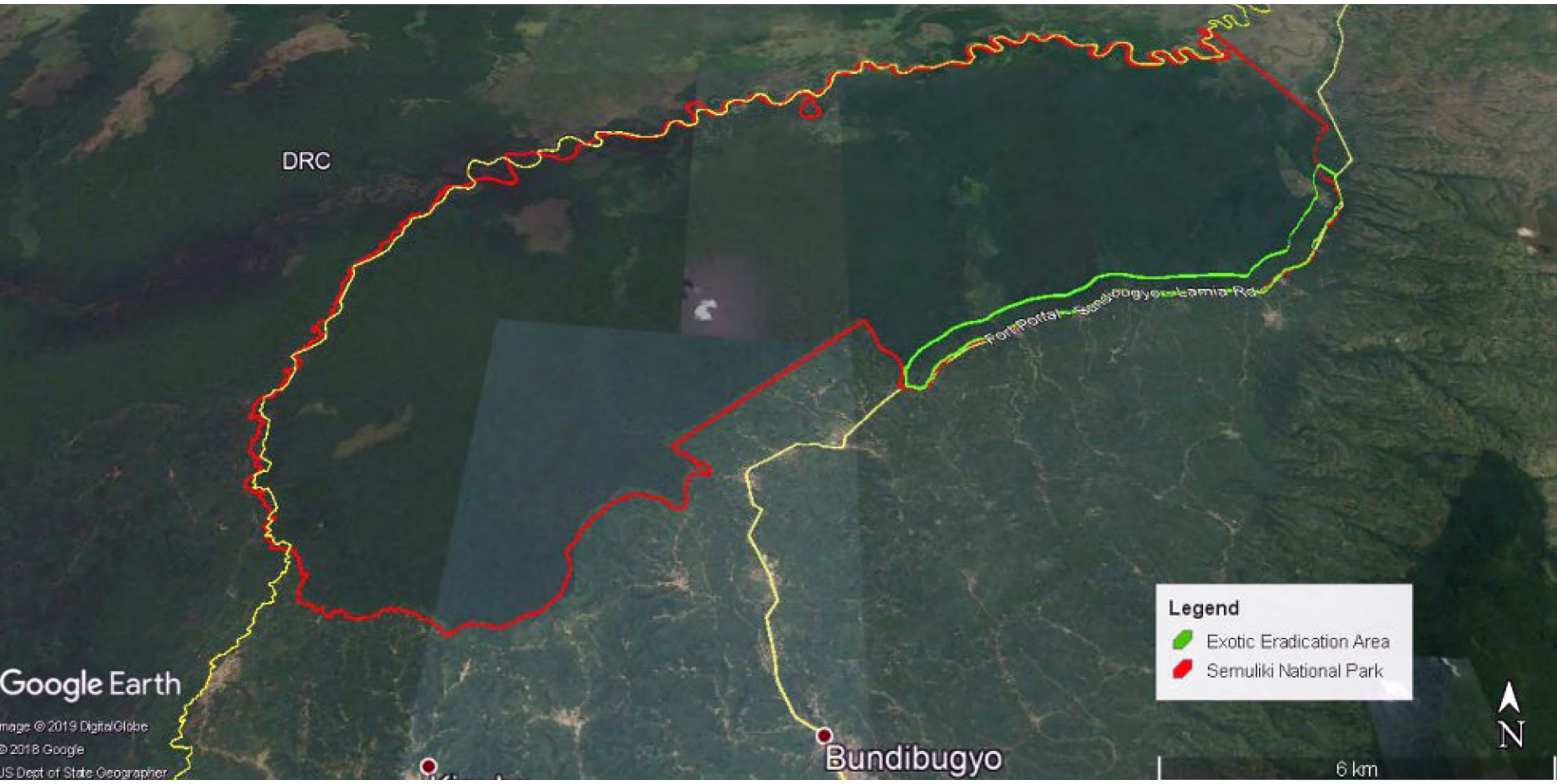


Figure 3.20: Google satellite Map for Semliki National Park showing the proposed eradication area for exotic and invasive species (Green outline on the protected area's edge)

Diseases outbreak

Among the diseases recorded in Uganda's wildlife includes; Anthrax in hippos and buffalos, brucellosis and canine distemper in lions, skin disease in giraffe and scabies in mountain gorillas. According to UWA (2018), "there was an outbreak of anthrax in Omungali sub county Kazo County about 30 km away from the reserve and FMD at Kisagazi within Ruyonza sub county, Kyegegwa district about 10 km from the KAWR". This was contained through quarantine, treatment and vaccination with cooperation from affected districts.

3.4.4 Responses

Development of biodiversity and tourism accounts

NEMA in collaboration with UNEP-WCMC is implementing a project on Natural Capital Accounts which is supported by the Darwin Initiative. One of the accounts that being developed is the tourism and biodiversity accounts. The project supports delivery of the National Development Plan, Green Growth Development Strategy and NBSAP through integration of the value of biodiversity into national reporting, poverty reduction, and planning processes. This will enable decision-makers to implement integrated environmental-economic planning for green growth, poverty alleviation and attaining the Sustainable Development Goals (SDGs) and national biodiversity targets contained in the NBSAP. The capacity of account compilers and users will be developed to institutionalize the accounting approach.

The overall purpose of developing biodiversity and tourism accounts is to support Uganda Bureau of Statistics (UBOS), National Planning Authority, Ministry of Tourism, Wildlife and Antiquities and Ministry of Finance, Planning and Economic Development in integrating natural capital accounts in national accounts and reporting systems. The tourism and biodiversity accounts is finalized and next National State of Environment Report provide more detail information

The Fisheries resources accounts

This account is also being developed by NEMA in UNEP-WCMC and is supported by the Darwin Initiative. The fisheries sub-sector is a very important contributor to economic growth and social transformation in Uganda. The status of the sector is rapidly changing with increasing concerns over depletion of stocks but falling prices. There are concerns over continued use of indiscriminate fishing methods, trade in illegal unregulated and unrecorded (IUU) immature fish and general weaknesses in the governance of the sub-sector.

The overall purpose of developing fisheries resources accounts is to support Uganda Bureau of Statistics (UBOS), National Planning Authority;Ministry of Tourism Wildlife and Antiquities, Ministry of Agriculture, Animal Industry and Fisheries; and Ministry of Finance, Planning and Economic Development in integrating natural capital accounts in national accounts and reporting systems. The fisheries resources accounts is finalized and next National State

of Environment Report provide more detail information.

Review and update of the wildlife legal framework

A new Uganda Wildlife Act 2019 has been put in place by Government. The Act is stronger in penalties the previous Act for example under general offence a person convicted of an offence under this Act for which no penalty is provided is liable-

(a) in the case of a ***first offence,*** to a fine of not exceeding three hundred and fifty currency points or to a term of imprisonment not exceeding ***ten years or both***. In the previous Act the fine was not exceeding three million shillings or imprisonment for a term of not less than three months or to both such fine and imprisonment.

(b) in the case of a ***second or subsequent offence***, to a fine not exceeding five hundred currency points or to a term of imprisonment not exceeding t***wenty years or both.*** In the previous Act the fine was not less three hundred thousand shillings but not exceeding six million shillings or to imprisonment for a term of not less than six months or to both such fine and imprisonment.

Regarding ***offences relating to protected species***, a person who without a permit issued in accordance with the Act -
(a) takes, hunts, molests or reduces into possession protected specimen; or
(b) is found in possession of, sells, buys, transfers or accepts transfer of protected specimen;
commits an offence, and shall on conviction be liable to a fine not exceeding ten thousand currency points or to ***life imprisonment or both.*** In the previous Act it was a fine of not less than one million shillings or to imprisonment for a term of not more than five years or to both; and in any case the fine shall not be less that the value of the specimen involved in the commission of the offence

Review and update of the wildlife legal framework

The revised wildlife law (Wildlife Act 2019) is now in place and more stringent punishment has been placed on wildlife trade offenders through increase of number of years of imprisonment e.g. Section 76. UWA also has in place draft guidelines to enact the different sections of the Act e.g. the biodiversity offset guidelines and the operational guidelines to guide development activities being carried out in protected areas, especially oil and gas related activities.

Fighting Illegal Wildlife trade and poaching

In order to strengthen the fight against illegal wildlife trade and poaching, conservation institutions led by UWA have embarked on developing the National strategy to combat Poaching, Illegal Wildlife Trade and Trafficking of wildlife. This will strengthen the basis for prosecution of offenders.

International trade in wildlife species of fauna and flora is regulated under the Convention on International Trade in Endangered Species of Wild Fauna and Flora(CITES) which Uganda became party to in 1993. Conservation efforts have been greatly undermined by the existing demand and lucrative gains in billions of shillings on Asia markets. These cases have however been curbed by the increased capacity building efforts including but not limited to the Canine unit at the airport. Among the commonly traded wildlife products are pangolin scales, ivory from elephants and African grey parrots. Many efforts including the new Wildlife Act 2019 that puts stringent punishment for offenders have been put in place to curb these vices.

In 2019, a National Wildlife Crime Coordination Taskforce was also constituted by the Minister of Tourism Wildlife and Antiquities. The taskforce is composed of Ministry of Tourism, Wildlife and Antiquities, Uganda Wildlife Authority, Uganda Revenue Authority (Customs Department), Ministry of internal Affairs (Immigration Department), Uganda Peoples Defense Forces, Uganda Police Force, Civil Aviation Authority, National Forestry Authority, Finance Intelligence Authority, Directorate of Public Prosecution, Internal Security Organization and External Security Organization. The task force has been trained in CITES nomination criteria.

Uganda Wildlife Authority with partner organizations has trained judicial officers in wildlife crime. This has greatly enhanced the understanding of the value of wildlife and the need to punish wildlife crime offenders proportionately. The Judiciary in 2017 launched a specialized court (The Utilities, Standards and Wildlife Court) to expeditiously deal with related offenses.

Uganda Wildlife Authority recruited and passed out 480 rangers in 2018 to enhance law enforcement capacity. Joint operations between Uganda Wildlife Authority and Natural Resources Conservation Network, with whom UWA has a Memorandum of Understanding, led to arrests, intelligence gathering and prosecution of offenders.

Human Wildlife Conflict

In order to mitigate conflicts, Uganda Wildlife Authority is piloting electric fencing in Queen Elizabeth National Park (A) and Murchison Falls National Park (B) starting with conflict hot spots. For QENP, construction of a 20 km electric fence along the boundary adjacent to the communities is ongoing (Figure 3.20).

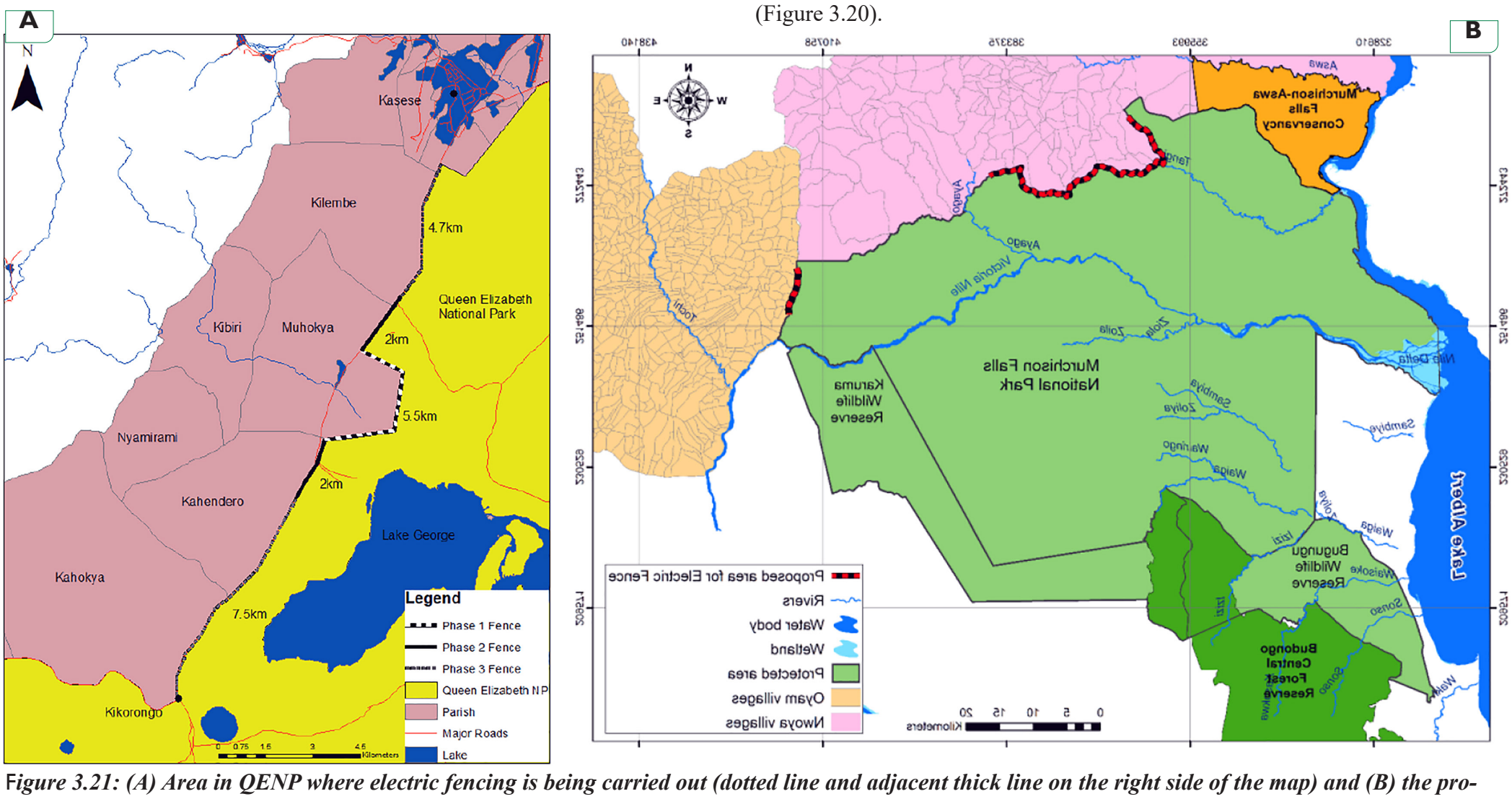


Figure 3.21: (A) Area in QENP where electric fencing is being carried out (dotted line and adjacent thick line on the right side of the map) and (B) the proposed areas for pilot fencing in MFNP (thick red line on the northern part of the park)

Other physical barriers to control Human Wildlife Conflict used include excavation of trenches along park boundaries in several national parks, placing bee hives along trenches to increase the trench effectiveness in controlling crossing of Elephants e.g. in QENP, planting buffer crops such as tea along the boundaries e.g. in Kibale National Park and Bwindi Impenetrable National Park. Where it is not possible to manage the wildlife in some locations, they have been translocated to other parks in areas away from communities.

In addition, the digging and maintaining of trenches has provided employment to a number of communities adjacent to the protected areas diverting their attention from illegal hunting of wildlife e.g. in QENP.

Revenue sharing for Communities

Government shares 20% of gate entry fees with local communities neighboring Protected Areas. The revenue allocated to communities funds projects initiated by the communities. From 2016 to 2018, a total of 12,069,448,833 shillings was shared (Table 3.9). Projects supported vary from infrastructure development to livelihood projects and income generating ventures. Sport hunting has also been undertaken in areas with significant numbers of wildlife, which has enabled local communities to earn revenue from the activity. The activity is regulated by Agreements negotiated and signed among Uganda Wildlife Authority, Local Governments and Associations of Land owners in the area. This has helped to improve attitudes of local people towards wildlife, which is now seen as a resource with economic benefits.

Table 3.8: Revenue sharing for selected PAs

Year	QENP	MFNP	MENP
2015	513,773,705	2,082,700,000	0
2016	907,328,137	2,275,900,000	0
2017	0	0	72,000,701
2018	0	1,877,960,000	0
2019	2,853,351,180	4,189,834,061	105,010,500

Source: UWA records

Uganda Wildlife Authority is piloting a Conservancy concept in areas surrounding Kidepo Valley National Park, Murchison Falls National Park and Lake Mburo National Park in order to increase economic benefits of local communities and land owners from wildlife through well planned and managed ecotourism services.

Developments in protected areas

There are a number of ongoing and proposed developments in the wildlife protected areas e.g. the oil and gas and hydropower developments and roads and electricity transmission lines in Murchison Falls Protected Area. All developments within Protected Areas undergo mandatory Environment and Social Impact assessment. Developers are required to adhere to the mitigation hierarchy (Avoidance, Mitigation, Restoration and Offsetting) and most areas where oil and gas exploration was carried out have been restored to a state close to what existed before the project (Nangendo et al., 2019). A number of tools have been developed to monitor impacts of developments in the protected areas including checklists, sensitivity atlases, and operational guidelines among others. These tools guide on the implementation of the activities in sensitive ecosystems.

Control of disease outbreak

Construction of a Biosafety Level II (BSLII) diagnostic laboratory at Mweya in Queen Elizabeth National Park was commissioned in 2019. The Lab will perform the core functions of disease surveillance and disease outbreak investigations. For zoonotic diseases, a one Health platform has been established to track their occurrence and management through both active and passive surveillance, real time reporting, response and outbreak management.

Investment in biodiversity

In March 2019, Uganda completed the development of its National Biodiversity Finance Plan (NBFP). The vision for Uganda's NBFP is "sustainable and innovative financing for biodiversity conservation and management attained by 2027/28". The mission of the NBFP is "to mobilise adequate additional resources to meet the biodiversity funding gap as well as ensure that funds are used efficiently and effectively to address the biodiversity and ecosystem challenges in biodiversity and ecosystem conservation and management."

The goal of the plan is to achieve "optimal and sustainable financing for biodiversity conservation and management attained by 2027/28." Three objectives complement the goal of the NBFP. The objectives are:
(i) to develop and implement a biodiversity and ecosystem index and payments for ecosystem services; (ii) enhance the use of economic instruments as incentives for biodiversity conservation and management; and (iii) scale up innovative biodiversity management and conservation actions that enhance livelihoods and increase national revenue. The eight finance solutions are:

1. Implementing ecological fiscal transfers: Piloting forest landscape restoration.
2. A national programme on payments for ecosystem services.
3. Scaling up bottom-up enforcement for biodiversity and ecosystem management based on community regulatory systems and incentives model.
4. Develop transport channel for transport and ecotourism for Lubigi wetland system with livelihoods incentives for wetland adjacent communities.
5. Upgrading the value chain for natural ingredient of Shea in Northern Uganda.
6. Rationalise and implement revised charge systems for biodiversity and ecosystem conservation and management.
7. A financing model for biodiversity conservation for central forest reserves.
8. Standardize and regulate implementation of biodiversity offsets.

Aggregate biodiversity expenditure across the four ministries of Energy, Agriculture, Tourism and Wildlife, Water and Environment doubled from UGX 67.3 billion in 2009/10 to UGX 147.8 billion in 2014/15 (Table 3.9 and Figure 3.22). The largest expenditure on biodiversity management was from tourism and wildlife management followed by the Agriculture Ministry. The large rise in biodiversity expenditures can be largely attributed to the inclusion of the Uganda Wildlife Authority's (UWA) locally earned revenues in the budget documents for 2014/2015.

Table 3.9: Aggregate biodiversity management for MEMD, MWE, MAAIF and MTWA

Fiscal Years	Amount (UGX billion)				
	MEMD	MWE	MAAIF	MTWA	Total
2009/10	0.9	12.85	32.68	21	67.43
2010/11	0.72	14.46	33.82	6.63	55.63
2011/12	1.27	22.43	24.26	13.52	61.48
2012/13	2.7	13.46	27.83	14.94	58.93
2013/14	1	19.5	21.95	18.92	61.36
2014/15	3.76	19.97	48.64	75.43	147.8
Average	**1.7**	**17.1**	**31.5**	**15.0**	**75.4**

(Source NEMA, UNDP and Global BIOFIN 2019)

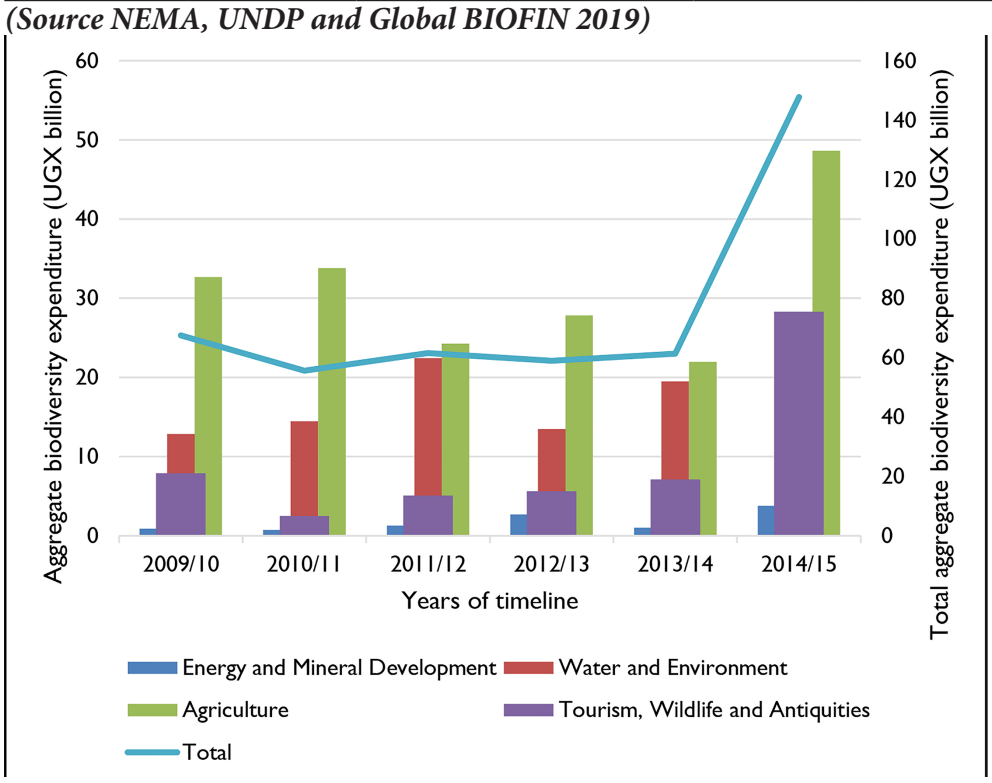


Figure 3.22: Expenditure on biodiversity management by core Government ministries, FY 2005/6 – 2014/15 (Source: NEMA, UNDP and Global BIOFIN 2019)

As part of implementation of NBSAP II, five new funds have emerged. The Uganda Biodiversity Trust Fund (UBTF) an independent conservation fund currently hosted by the Wildlife Conservation Society (WCS). Since its launch in 2016, the trust fund has mobilized $100,000 from the United States Government. The target is to mobilize up to $5 million in the first five years. The first two years were used for establishment of the institutional arrangements, awareness creation and capacity building. Under the National Environment Bill (2018) that was passed by Parliament a new environmental audit charge was proposed, which will raise an expected UGX 6 billion. Additional instruments on payments for ecosystem services and re-enforcement of the Environmental Impact Assessment fees and other instruments in the new legislation have not been assessed.

The Uganda Green Growth Development Strategy (UGGDS) has drawn financing for the five focus areas of agriculture, green cities, sustainable transport, sustainable energy and natural capital management. The European Union office in Uganda has supported the mobilization of at least EUR 207.35 million for implementation of biodiversity conservation and management related activities.

Local Governments received a grant from the MWE as recurrent expenditure for wetland management planning and monitoring. The funds received ranged between UGX 1.0 and 1.29 billion between 2014/15 and 2017/18 (Table 3.10). A larger fund from the ministry is used for water infrastructure development and management activities. However, given that the number of local governments had increased from 136 to 220 by July 2018, the funds are very small and are often used by the Natural Resource Departments to complement environmental planning (MWE SPR 2015, 2016, 2017, 2018).

Table 3.10: Trends of biodiversity related local government grants from MWE

Financial years	Description	Budget (Bn UGX)	Released (Bn UGX)	Spent (Bn UGX)	Released %	% release spent
2014/15	Conditional grants to LG	67.729	67.729	67.729	100.0	100.0
	Vote for wetlands	1.0.	1.0.	1.0.	100.0	100.0
2015/16	Total vote to LGs	68.20	68.20	58.83	100.0	86.3
	Vote for wetlands	1.20	1.20	1.20	100.0	100.0
2016/17	Total vote to LGs	58.73	58.64	51.37	99.8	87.6
	Vote for wetlands	1.29	1.20	1.20	93.0	100.0
2017/18	Total vote to LGs	58.55	58.55	53.89	100.0	92.0
	Vote for wetlands	1.29	1.29	1.29	100.0	100.0

(Source: NEMA, UNDP and Global BIOFIN 2019)

3.4.5 Recommendations

a) Implemented measures for controlling Invasive Alien Species (IAS) within the framework of the National Invasive Species Strategy and Action Plan (NISSAP) including identifying and control pathways of introduction.
b) Study on ecological and socio-economic impacts of IAS to guide decision making including investment on control of IAS
c) Strengthen enforcement to control illegal wildlife trade
d) Implement the financing solutions in the National Biodiversity Finance Plan to mobilize additional financial resources for biodiversity conservation and management
e) Increase investment in restoration and value addition
f) Promote use of natural capital accounting as one of the tools for achieving sustainable development
g) Strengthen protection of biodiversity outside protected areas, including through establishing special conservation areas

3.5 Fisheries

The fisheries subsector in Uganda is a pre-colonial period that was characterized by a few fisherfolk communities living by the lakesides. During the pre-colonial times, generally the fish and fish products were market limited and thus the fisherfolk communities traded their catch through barter. Before 1910, the Ugandan fishery was dominated by the Lake Victoria native tilapiine species including; Oreochromis esculentus and Oreochromis variabilis. However, these vital species are virtually extinct from the Lake Victoria basin as a consequence of many factors including; overfishing, competition from the nonnative species and perhaps hybridization. This sub-chapter highlights on the current trends, pressures and responses on Uganda's capture fisheries and aquaculture resources.

3.5.1 Introduction

Albeit Uganda is landlocked, the country has generally abundant freshwater bodies including, natural lakes, rivers, swamps and artificial/man-made dams, valley tanks and ponds. Overall, these aquatic environments occupy about 42,000 km2 which is approximately 17% of Uganda's total surface area. The fishery in Uganda provides a vital source of livelihoods for many people in the country. Whereas the fisheries sector in Uganda contributes to 12% of the agricultural GDP and supplies 50% of the Animal proteins consumed in the country, a number of constrains including overfishing, water quality deterioration among others, have crippled the industry over the past decades. Additionally, the weak legal and institutional frameworks for the capture fisheries and aquaculture in Uganda remain a hindrance to the sustainable development and exploitation of the sub-sector in the country.

Generally, fish and fish products in Uganda are obtained from capture fisheries and aquaculture. Capture fisheries literally refers to the harvesting of fish or other fish related products from the wild. On the other hand, aquaculture (in this report referred to as fish farming) is the practice of sourcing fish from rearing conditions or captivity, ranging from ponds, cages, or tanks production systems. In this report, we do not detail these production systems, but only generalize aquaculture in Uganda as indicated under the subsection, status and trends.

3.5.2 Status and trends in fisheries

The fisheries subsector in Uganda entirely relied on subsistence capture fisheries since the colonial period in the 1910s and gradually transformed to commercial fisheries following the subsequent introduction of netting materials in 1920s (Graham 1929). Because of the introduction of netting materials and flax, overfishing generally crippled the natural fish stocks and with time this propelled the adoption of aquaculture to contribute to the reduction of fishing pressure on the capture fisheries. In this section, we elaborate on the status and trends of capture fisheries and aquaculture in Uganda.

3.5.2.1 Capture fisheries

Freshwater capture fisheries in Uganda remains the most salient source of fish in the country. The most significant commercial fishery in the country is Lake Victoria. Lake Victoria (the World's largest tropical Lake) is shared by three East African countries; Uganda, Kenya and Tanzania, of which 45% of the water body lies in the former country (Welcomme 1972). The other dominant fish sources in the country include, Lakes Albert, Kyoga, Edward, George, Wamala, as well as R. Nile. However, other fish sources (at subsistence level) include about 160 minor/satellite lakes and wetlands spread throughout the country. The main species of commercial importance under these water bodies are those of the genera *Lates, Oreochromis, Coptodon (Tilapia), Clarias, Proteprus, Alestes, Hydrocynus, Mesobola, Haplochrmis, Synodontis, Bagrus, Barbus, Labeo, Rastrineobola* among others. However, on Lakes Kyoga and Victoria, *Rastrineobola, Lates and Oreochromis dominate while on Lake Albert, Brycinus and Mesobola (Nakiyende 2018).*

Despite the challenges that have ravaged the fisheries subsector in Uganda, fish and fish products have consistently over the past five years (2014-2018) scored second to coffee with respect to Uganda's formal exports by value (Table 3.11). Additionally, in 2018 there was an upsurge in formal exports by value ('000 US$) of fish and fish products from 136,201 (2017) to 169,905 (2018), see Table 3.11. Similarly, in the year 2018/19, the fisheries subsector contributed to the economic development of Uganda by 2.1% compared to 1.6% of 2017/18 (UBOS 2019). Noticeably, the amount of fish exported in 2018 increased by 11% which shows the greatest positive change in exports within the last ten years. This increase might have been attributed to high demand and comparatively good fetch foreign prices than from the local markets. On the other hand, the export of value-added fish products (fillets and maws) generally increased between 2018 and 2019 (Table 3.12). The fish fillets increased noticeably by 6592.1 tonnes from 2018 to 2019 while the maws increased by 208.4 between the years. Although the value (US$ million) fish maws relatively increased over the period, that of the fish fillets was generally insignificant. This was likely a result from the drop in the value of the fillets from the international markets (MAAIF-DFR 2019), see Table 3.12.

Table 3.11. Formal exports by value ('000 US $) of Uganda's top five commodities from 2014-2018

Commodity	2014	2015	2016	2017	2018
Coffee	410,064	402,634	371,674	555,454	436,084
Fish and Fish Products	134,791	117,597	121,467	136,201	169,905
Tea	84,739	70,317	71,488	79,713	88,831
Tobacco	66,018	72,897	64,061	52,762	86,372
Cotton	21,918	20,778	31,571	50,776	44,346

(Sourced and modified from UBOS 2019)

Table 3.12. Weight (tonnes) and value (US$ million) of fish fillets and maws exported to international markets by industrial fish processors

	2018		2019	
FISH PRODUCT	**Weight**	**Value**	**Weight**	**Value**
Fillets	19840.6	100.6	26432.7	101.4
Fish Maws	531.6	52.9	740	76.3
TOTAL	20372.2	153.5	27172.7	177.7

(Source: MAAIF-DFR 2019)

Interestingly, despite the size of L. Victoria, L. Albert over the last two years (2018-2019) has consistently dominated as the biggest contributor of the proportion of freshwater fish production in Uganda accounting for 43% in 2018 (Figure 3.23). The proportion of catch of L. Albert surpassed that of Lake Victoria by a margin of 3.1 % (Figure 3.23). In the same year (2018), these two lakes were followed by L. Kyoga (11.6%), with all the other water bodies generally falling below 3% . These percentage proportions in were congruent with the fish catch per water body in tonnes (Table 3.13). Over the two years (2018-2019, L. Albert indicated the biggest catch in tonnes followed by L. Victoria and then L. Kyoga (Table 3.13). There was a general increase in fish catch per water waterbody in most of the Lakes apart from Kyoga, Albert Nile, and the minor lakes. Similarly, the overall catch by water bodies in 2018 was elevated by 11% in 2019 (MAAIF-DFR 2019). The decline of the fish catch particularly in L. Kyoga might be explained by the influence of anthropogenic activities for instance overfishing with the use of small-sized gill nets (illegal fishing gear) before the law enforcement by UPDF, eutrophication inter alia (Nakiyende et al, 2018). On the other hand, the upsurge in the L. Albert catch may be explained by the abundant small-sized pelagic fish species which is consistent with the observed low fish value between 2018 and 2019.

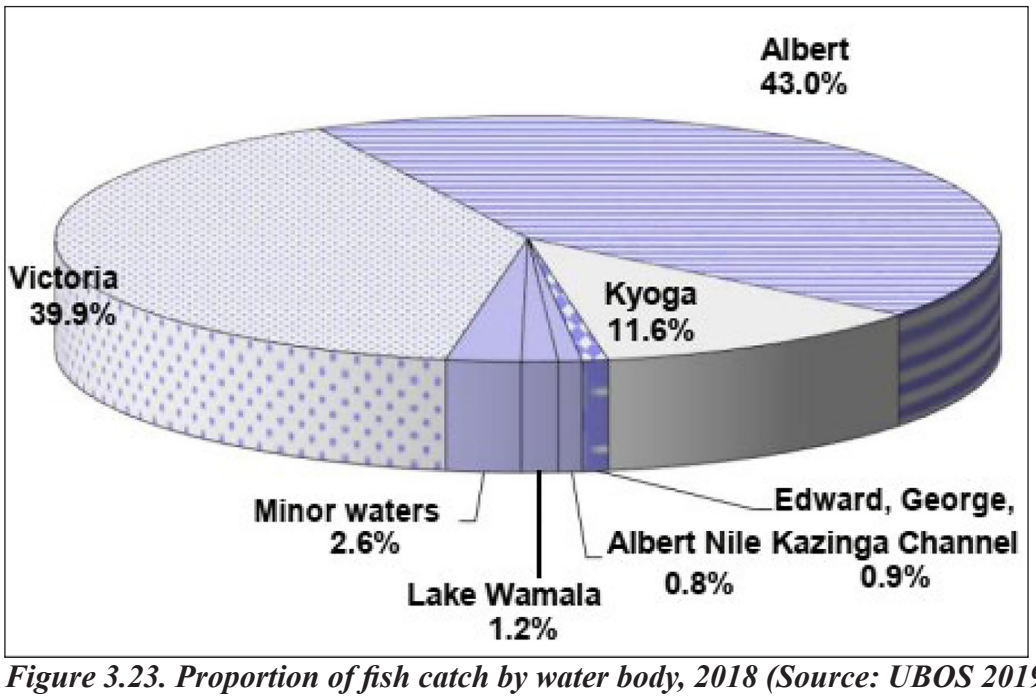


Figure 3.23. Proportion of fish catch by water body, 2018 (Source: UBOS 2019).

Table 3.13. Estimated catch (weight tonnes) and value (UGX Billion)

WATER BODY	2018		2019	
	Weight	Value	Weight	Value
Lake Victoria	165,583.0	990.0	208,861.0	1,033.0
Lake Kyoga	41,585.0	167.8	16,108.0	80.0
Lake Albert	218,420.0	491.9	313,546.6	756.7
Albert Nile	5,062.0	14.3	5,062.1	14.3
Lake Edward	1,772.5	6.6	2,745.6	19.0
Lake George	1,621.0	2.2	3,431.0	29.3
Kazinga Channel	244.0	0.2	461.8	2.9
Minor lakes	13,005.6	41.7	8,830.0	30.6

(Source: MAAIF-DFR 2019)

Expenditure on fish and related imports

Imports of fish and related aquatic products continued increasing. According to data from the Ministry of Trade, Industry and Cooperatives (MTIC), Civil Aviation Authority (CAA), and Uganda Revenue Authority (URA) these products include live ornamental fish, crustaceans, mollusks and filleted fish for consumption. The expenditure on these products has been increasing since 1996 (Figure 3.24). In the 2017/18 financial years, a total of 90.9 million dollars was spent on these imports. The increased importation of fishery products into the country may gain be related to the current high demand attributed to escalated population growth in the country.

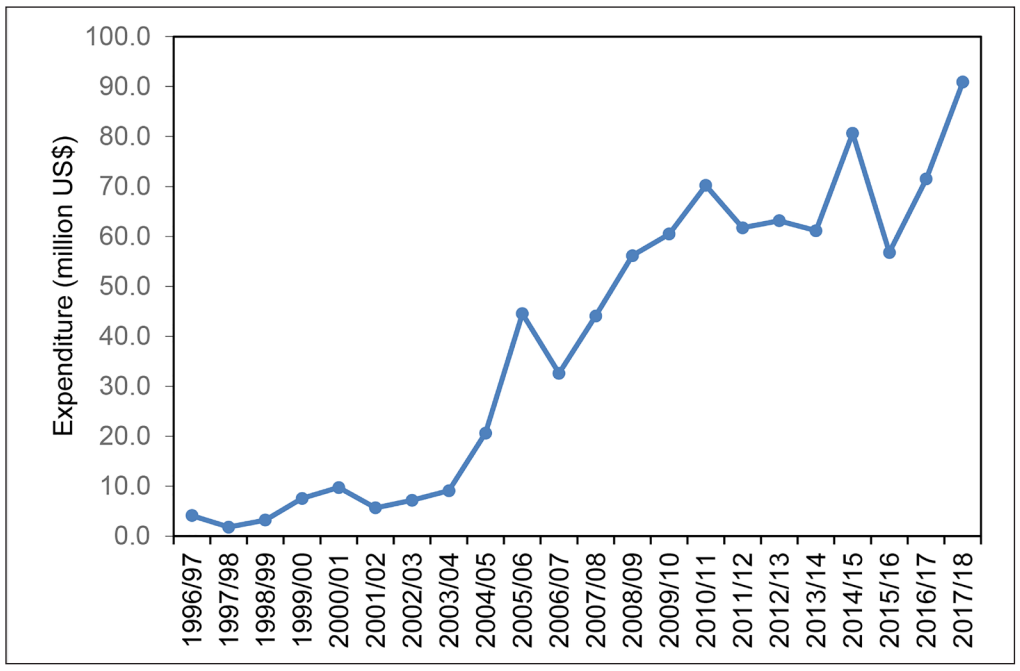


Figure 3.24. Estimated annual expenditure (million US$) on fish and other aquatic products imported into Uganda 1996-2018 (Source: UBOS, URA, CAA)

3.5.2.2 Aquaculture

Despite the economic viability of fish farming, the enterprise is vital for minimizing fishing pressure on the natural ecosystems. Aquaculture in Uganda is reported to have commenced by colonialists in 1941 following the introduction of carp at Kajjansi Fish Experimental Station (FAO 2005-2020). In Uganda, currently there are about 14,000 fish farmers with a total of about 30,000 ponds as well as 2,135 cages in Lake Victoria alone (Sserwambala 2018) while employing about 24,160 people. But generally, in Africa the aquaculture sector employs about 6.2 million people (Adeleke et al 2019). Therefore, aquaculture is potentially a significant anchor of food security, an employment opportunity, for economic development. The major fish species under aquaculture include the African catfish (Clarias gariepinus), Nile tilapia (Oreochromis niloticus) and carp (Cyprinus carpio). However, the latter species is generally cultured at a subsistence scale in the country. The subsector is in general characterized by small-scale farmers, though recently (2018) a very small group of medium-scale farmers have evolved and generate more than 50 tonnes annually (Bas Bolman et al 2018). Although, aquaculture has been on rise in Uganda, the average per capita consumption is currently estimated at 8.3 kg/year compared to 12kg/year in 1991 (Bas Bolman et al 2018). This decline is likely attributed to the decrease in the capture fisheries and high demand as a consequence of human demographic growth in the country.

The distribution of fish farming and species cultured in Uganda are generally influenced by the different agro-ecological (AEZ) environments. For instance, in the eastern dry lands, aquaculture is likely not a priority due to dominance of cattle ranching (Bas Bolman et al 2018), see Table 3.14. On the other hand, because of abundant water resources and perhaps suffice extension services, the Lake Victoria crescent region is dominated by cages (Table 3.14).

Table 3.14. Distribution and characteristics of aquaculture in Uganda's AEZs

#	Agro-Ecological Zone	Aquaculture activities
I	Eastern Dry lands	Very few aquaculture due dominating cattle activities
II	North Eastern Savannah Grasslands	Dominated by Nile tilapia in ponds
III	North Western Savannah Grasslands	Dominated by African catfish in ponds
IV	Para Savannahs	Dominated by African catfish in ponds
V	Kyoga Plains	Dominated by Nile tilapia in ponds
VI	Lake Victoria Crescent	Dominated by Nile tilapia in cages (Lake Victoria)
VII	Western Savannah Grasslands	Nile tilapia in ponds. Nile tilapia in cages (Lake Albert)
VIII	Pastoral Rangelands	African catfish, Nile tilapia in ponds (Lake Edward)
IX	South Western Farmlands	Mirror carp in ponds
X	Highland Ranges	Dominated by Nile tilapia in ponds

(Source: Bas Bolman et al 2018)

Generally, aquaculture in Uganda has experienced an exponential growth over the last 16 years, but with a drop in 2018 (Figure 3.25). Compared to the other countries in the continent, Uganda takes the third position after Egypt and Nigeria in aquaculture production (Table 3.16). However, at Sub-Saharan level, Uganda is considered the largest aquaculture producer after Nigeria (Adeleke et al 2019). Perhaps as a result of boost from the government intervention and overall awareness, aquaculture in Uganda surged from 2360 tonnes in 2001 to 103,737 tonnes in 2018 (see Figure 3.25 and Table 3.15). However, the drop in aquaculture production particularly in the year 2018 might be explained by various constraints including; marketing, limited capital investment, weak institutional frameworks, lack and expensive nature of quality feed and fish seed, diseases, weak and poor extension services, among other (Adeleke et al 2019; Bas Bolman et al 2018). However, several opportunities exist and if exploited could help shift further the aquaculture trend in Uganda. These include; favourable climatic conditions for fish growth, suffice water resources for both tanks, cages and ponds, available fish seed and feeds, high market demand for fish, exisitng of robust institutions and human capacity, supportive government system inter alia.

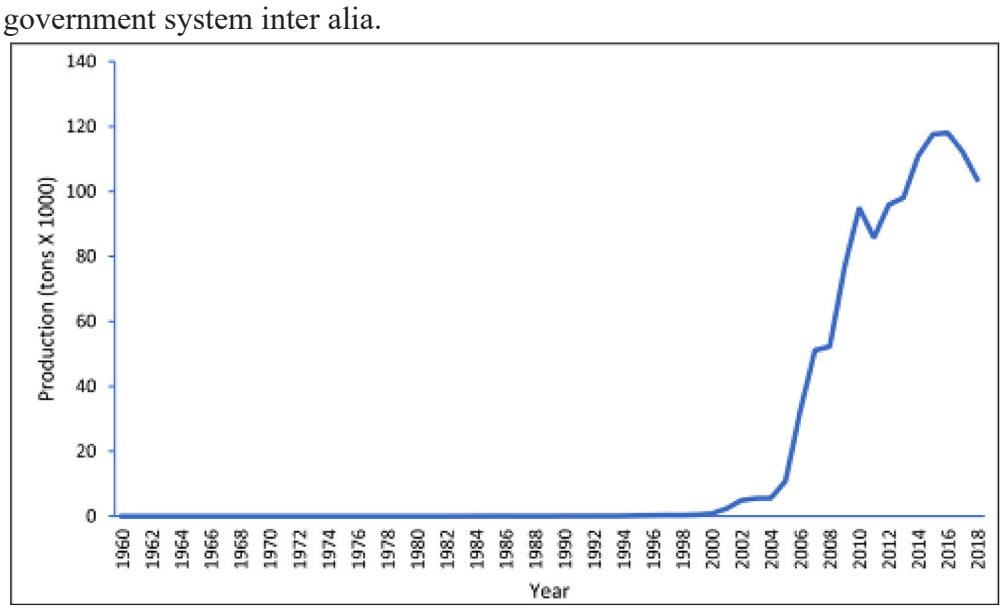


Figure 3.25. Trends of aquaculture production in Uganda from 1960 to 2018. (Source: Adeleke et al 2019)

Table 3.15. The top ten aquaculture producers by Africa countries in 2018

No.	Country	Production(metric tons)	Regional shares (%)	Global Shares (%)
1	Egypt	1,561,457	71.10	1.90
2	Nigeria	291,233	13.26	0.35
3	Uganda	103,737	4.72	0.13
4	Ghana	76,630	3.49	0.09
5	Zambia	24,300	1.11	0.03
6	Tunisia	21,756	0.99	0.03
7	Kenya	15,124	0.69	0.02
8	Malawi	9014	0.41	0.01
9	Madagascar	7421	0.34	0.01
10	South Africa	6181	0.28	0.01

(Extracted from Adeleke et al 2019)

3.5.3 Pressures, impacts and responses

Overexploitation and illegal fishing practices remain a challenge to the fisheries sub-sector in Uganda. Since the 1920s, the fishing effort on water bodies has

been increasing and exacerbated by the increasing population pressure. For instance, on Lake Victoria, the number of boats using outboard engines increased by a factor of approximately 1.7 while the rate of motorization increased from 9.7% to 29% over the last decade (Mkuna and Baiyegunhi 2019). This suggests a general escalated fishing effort which might be detrimental to the fisheries resources overtime.

3.5.3.1 High fishing effort and illegal fishing

The increase in fishing effort was accompanied by illegal fishing practices and gears which for over a long period led to declining fish production levels. This has changed since early 2017 when the Government of Uganda strengthened the enforcement of fishing regulations to curb illegalities in the fishing industry by establishing a Fish Protection Unit. This intervention has tremendously reduced fishing effort on lakes Victoria, Edward, Kyoga and George where the law enforcement was reinforced by the Uganda Peoples Defense Forces (UPDF).
It is worth to note that, since 2016, no frame surveys have been conducted on most water bodies including Lake Victoria and thus the measurable values of fishing effort in these areas have generally not altered. However, a frame survey was conducted on Lake Albert and Albert Nile in 2018.

4,222 new fishers entered the Lake Albert fishery, increasing the total number of fishers by 17.8% since 2016. Over the same period, illegal gillnets increased by 196.3%

Information on Lake Albert and Albert Nile indicates an increase in fishing effort in 2018 compared to 2016 (Table 3.16). More landing sites increased, as well as the number of illegal fishing gear. This implies that the regulation of fishing activities will increasingly become difficult to manage on the water bodies. For instance, after 2016, an increase of 17.8% of fishermen accessed the lake. Moreover, Lake Albert experienced an increase in gillnets with mesh sizes less than 5 inches which are not recommended in Ugandan water bodies. This, alongside the increased number of fishermen is likely to exacerbate overexploitation of the aquatic ecosystems. Despite the presence of Fish Protection Unit in Uganda's water bodies, overfishing is still a major constraint on lakes Albert, Albert Nile, Lake Kyoga, Lake Kwania and other several water bodies within the Lake Kyoga complex. This is potentially related to lack of alternative activities for the fishermen following the quota fishing imposed by the UPDF. Additionally, the increased number of landing sites on Lake Albert and Albert Nile (Table 3.16) might allow many fishermen who may be problematic to manage given the limited number of UPDF officers.

Table 3.16: Levels selected for the indicators of fishing effort obtained from frame surveys conducted on Lake Albert and the Albert Nile (2007, 2012, 2016 and 2018)

Indicator	Lake Albert					Albert Nile			
	2007	2012	2016	2018	% change between. 2016/18	2012	2016	2018	%change between. 2016/18
Number of landing sites	70	78	80	107	33.8	126	122	137	12.3
Number of fishers	15,364	15,424	23,722	27,944	17.8	4,501	7,056	7,086	0.4
Total number of fishing crafts	5,766	6,216	8,672	9,781	12.8	2,681	4,362	3,604	-17.4
Crafts using engines	-	311	1,487	2,734	83.9	3	-	1	
Gillnets by mesh size <5"	82,348	24,041	41,802	123,856	196.3	28,753	39,172	35,326	-9.8
Gillnets by mesh size ≥5"	14,367	18,382	9,411	6,943	-26.2	2,016	6,266	1,639	-73.8
Total gillnets	96,715	126,575	51,213	130,799	155.4	30,769	45,438	36,965	-18.6
Total small seines (Mukene fishing)	1,619	2,297	3,406	3,079	-9.6	13	17	5,039	29541.2
Number of Hooks (Long & hand line hooks)	1,966,322	746,153	1,712,646	1,855,016	8.3	145,613	282,142	163,482	-42.1
Other gears	780	892	8,541	8,900	4.6	1,284	5,351	10,997	105.5

(Source: NaFIRRI, 2018)

3.5.3.2 Invasive aquatic weeds

The Kariba and water hyacinth aquatic weeds remain a burden on many water bodies in Uganda. For instance, the Kariba weed (Salvinia molesta) has continued to expand in the Lake Kyoga complex as well as in many parts of the River Nile and Lake Albert. Albeit, the presence of aquatic weeds in Ugandan water bodies is a consequence of introduction, the weeds have continuously proliferated in the aquatic ecosystems. This is fundamentally attributed to anthropogenic activities particularly regarding poor and unregulated farming activities as well as effluents that influence influx of macro-nutrients like phosphates which favor the flourishment of the aquatic weeds (Andama et al 2017). The cover and spread of Kariba weed has reached optimal and critical levels continuously affecting fish breeding and nursery grounds, water quality and quantity that in turn affect the drinking water supply, hydroelectric power generation, tourism, as well as water transport. Despite the weed initially introduced in the Lake Kyoga complex, the aquatic plant has of recent traversed other virgin places like Lake Victoria basin (Lake Kimira in Bugiri District), some fish ponds, Port Bell in Luzira as well as other sheltered areas (EASE 2019).

A huge expanse of Kariba weed (Salvinia molesta) on one of the Ugandan water bodies (Courtesy of Wanda F.M., July 2015)

3.5.3.2.1 Responses on the invasive aquatic weeds

With respect to the environment, economic and human health impacts, Kariba weed ranks closely second to Water hyacinth on a list of the World's most noxious aquatic weeds (EASE 2019). In this context, Kariba weed has been recently added on the list of the 100 most invasive species in the World (EASE 2019). In response to the eradication of Kariba weed, the Ugandan government through the Ministry of Agriculture Animal Industry and Fisheries (MAAIF), together with other ministries, departments and agencies (MDAs) have endeavored to reduce the weed from the water resources. This has been done through various approaches including manual, mechanical, and biological control. In efforts aimed at boosting the removal of the weed from waters, the Egyptian government committed US$ 230,000 for a one-year pilot phase project to control Kariba weed (EASE 2019). This will enhance and thus contribute to MAAIF's efforts towards the eradication of the weed through procurement of the pertinent equipment.

3.5.3.3 Other emerging pressures: Plastic pollution in Lake Victoria

Plastic contamination of aquatic environment is now a global challenge. Global plastic production increased from 5 million tons per year in 1950s to over 280 million tons in 2016 and may reach exceed one billion tons by 2050 (FAO, 2017; Plastics Europe, 2017). The mass plastic production and consumption have led to the accumulation of plastic debris on land and aquatic environment where they degrade into smaller particles known as microplastics (<5 mm in size). Microplastics present a potential risk for fisheries production (FAO, 2017). Lake Victoria being surrounded by major towns, and with recreational beaches and over 800 fish landing beaches on Ugandan shoreline (FAO 2003), is vulnerable to microplastic pollution. Proper mitigation of microplastic pollution in the lake requires knowledge of the nature of microplastics occurring in the lake, abundance, distribution and sources.

Plate 3.5.Aging plastic bottles at Masese fish landing beach (left) and plastic debris in water at Kasenyi fish landing beach (right).

The National Fisheries Resources Research Institute (NaFIRRI) conducted a study to investigate the occurrence, abundance and distribution of microplastic debris along shoreline and sediment of Lake Victoria. This focused to generate knowledge to guide mitigation of pollution by plastics. The study, using selected four fish landing beaches and two recreation beaches established presence of microplastics in the shoreline and lake sediments.

With a grant from the International Foundation for Science (IFS), scientists at NaFIRRI are studying plastic pollution in Lake Victoria

3.5.3.3.1 Abundance of the microplastics in shoreline and lake sediment

Abundance of microplastics (particles/kg dry) was highest in shoreline sediments, ranging from 0.9-239.8 and lowest in the deeper lake sediment (0-14.5) (Figure 3.26). Areas of fish landing beaches (Masese, Kasenyi, Gaba, Bwondha) had higher microplastic abundance than areas of recreational beaches. At Masese, Gaba, Kasenyi and Lido beach areas, the abundance of microplastics decreased with an increasing distance from the shoreline into water (Figure 3.26).

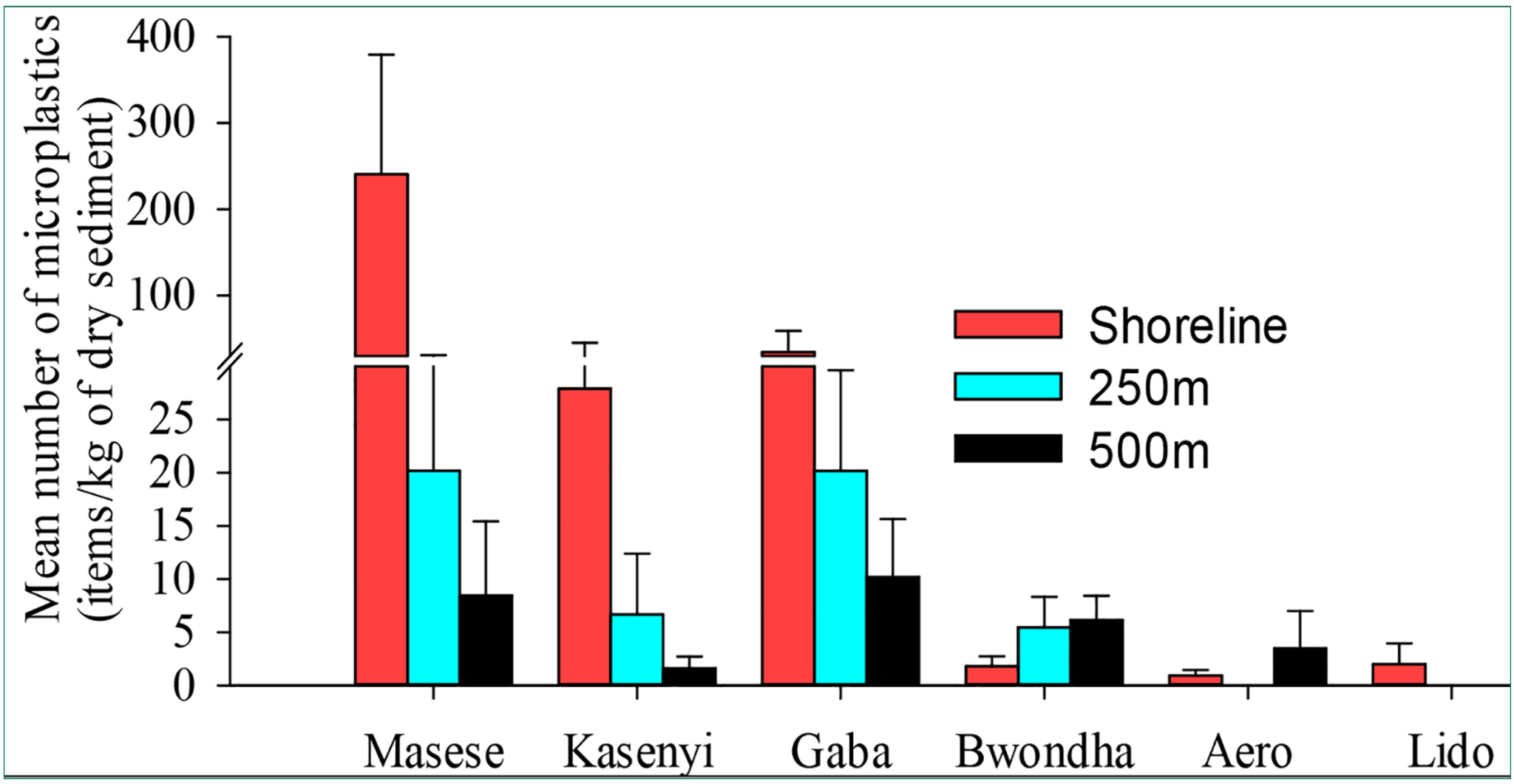


Figure 3.26 Abundance of microplastics in shoreline and lake sediment (250 m and 500 m from the shoreline). Source: NaFIRRI Annual report 2018-2019.

Films are the most abundant form of plastic particles in shoreline sediment while filaments are the most abundant in lake sediment (Figure 3.27). Polyethylene is the most dominant polymer in the plastic materials (Table 3.17). The polymers come from plastic materials used in the community and therefore, the most polluting materials are container caps, water bottle caps, toys, household utensils, consumer bags, fishing nets and lines.

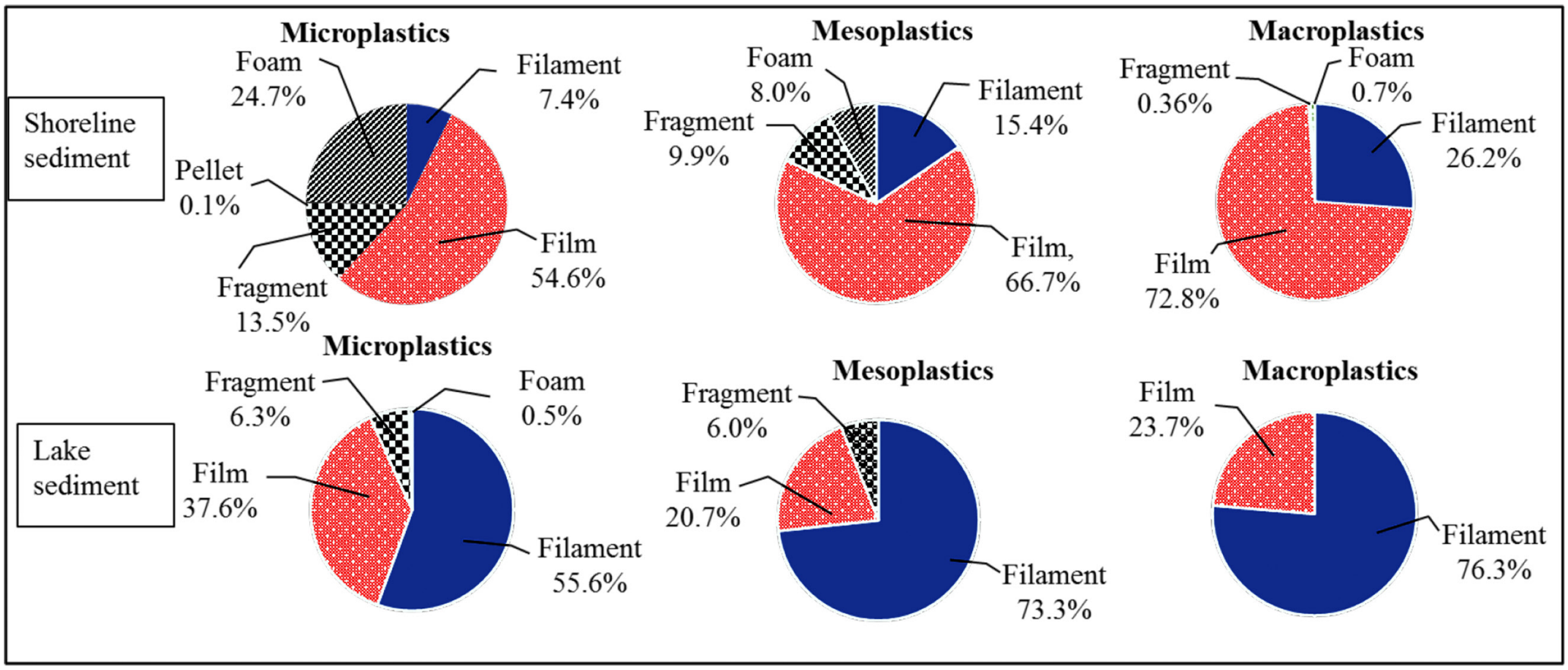


Figure 3.27 Percentage composition of each type of plastic debris per size category (micro-, meso-and macro-plastic) in shoreline and lake sediments (Source: NaFIRRI annual report 2018-2019)

Table 3.17: Major polymers in the plastic particles identified in samples from Lake Victoria and some of their likely sources.

Major polymers in samples	% in sample	Typical sources
Polyethylene (PE)	54.2	Container caps, water bottle caps, toys, household utensils, consumer bags, fishing nets and lines.
Polypropylene (PP)	23.3	Floor coverings, carpets, rugs, pipes, sportswear, fishing nets, and milk containers.
Polyvinyl chloride (PVC)	11.7	Packaging containers, pipes, electric cable insulators and clothing fabric.
Polyethylene Terephthalate (PET)	4.2	Drinking water and soda bottles, fruit containers
Polyamide (PA)	2.5	Clothing, thermoplastics, luggage, parachutes, backpacks.

(Source: NaFIRRI annual report 2018-2019).

Microplastics widely occur on beach shores and sediment of Lake Victoria and were breakdown products of large plastic materials generated from nearby shore and fishing activities on water. Interventions aimed at banning or minimizing the use and spread of plastics will sustain the health of aquatic environments. Proper management of plastic wastes is required to limit pollution sources.

3.5.3.4 Catchment degradation on water bodies: Lessons from Lake Wamala

The expansion of farmlands with conversion of forests and wetlands is one of the greatest challenges affecting aquatic ecosystems through enhancing loading of sediment, pollutants, and nutrients. Farmlands are also associated with constraints such as the use of agro-chemicals and pesticides and diversion of river courses. In Uganda, excessive nutrient loads are responsible for eutrophication in aquatic ecosystems which can be detrimental to fish growth and health. Croplands are expected to expand and if not properly planned could damage the aquatic resources. In this context, the Lake Wamala ecosystem is a paradigm of an aquatic system undergoing anthropogenic threats in Uganda.

Responses

Following various threats in Ugandan water bodies and particularly the fisheries subsector, there have been numerous outcries from all the stakeholders regarding the future uncertainty of the aquatic ecosystems in Uganda. As a result of many stressors to the fisheries, many species have declined with some virtually extinct e.g. Oreochromis esculentus, Oreochromis variabilis inter alia. Albeit some natural environmental turbulences (climate change) might play some roles, the anthropogenic activities are pivotal drivers of the constraints to the Ugandan freshwater fisheries. Some of the responses to the fisheries subsector are outlined here

3.5.3.4.1 Establishment of the fish protection unit to strengthen the enforcement of fishing regulations

In February 2017, the government of Uganda established a Fish Protection Unit (FPU) to enforce fishing regulations and end illegal fishing. The FPU started its work on Lake Victoria on 25th March 2017. Since then, the operations have been active on Lake Victoria, Lake Edward, Lake George and Kazinga channel as well as Kyoga.

Despite the presence of FPU, no systematic research studies have been conducted on Lake Victoria since 2017 to assess the impact of the FPU on state of fisheries. However, a frame survey conducted by the NaFIRRI in 2018 on lakes Edward, George and Kazinga channel revealed that illegal fishing gears and boats were completely absent on these water bodies. This is attributed to the efficiency of the FPU operations. In the long term (3-5 years), these efforts are expected to increase fish production and catches.

No illegal fishing gears or crafts were recorded on lakes Edward, George and Kazinga Channel where the Fish Protection Unit is present, a rare achievement in a long time (NaFIRRI, 2018).

3.5.3.4.2 Appropriate number of boats on Lake Victoria

On Lake Victoria, NaFIRRI has provided the number of boats for sustainable harvesting of the fish species (Table 3.19). Only 10,884 boats are recommended for Nile perch, 6,206 for Nile tilapia and 6,004 for Mukene in the lake. Additionally, the boats are supposed to be licensed to serve as a measure of reducing pressure and minimize open access so as to contribute to the sustainability of the fisheries.

Table 3.18. The recommended number of boats for licensing on Lake Victoria, allocated to each of the riparian districts. Estimates are for the three major commercial fish species

Districts	Nile perch	Districts	Nile tilapia	Districts	Mukene
Kalungu	25	Rakai	58	Kalungu	0
Jinja	39	Kalungu	59	Kampala	0
Kampala	40	Busia	65	Busia	1
Busia	50	Kampala	66	Jinja	12
Bugiri	87	Bugiri	88	Rakai	57
Mpigi	147	Jinja	167	Bugiri	66
Rakai	297	Masaka	188	Masaka	141
Masaka	318	Mpigi	324	Mpigi	311
Buikwe	381	Kalangala	387	Wakiso	398
Wakiso	714	Buikwe	428	Namayingo	659
Mayuge	1,100	Namayingo	711	Buikwe	724
Namayingo	1,217	Buvuma	744	Mayuge	758
Mukono	1,541	Wakiso	847	Mukono	773
Kalangala	1,637	Mukono	1,029	Kalangala	946
Buvuma	3,291	Mayuge	1,045	Buvuma	1,158
Total	**10,882**	**Total**	**6,204**	**Total**	**6004**

3.5.3.4.3 The promotion of aquaculture

Cage aquaculture has been growing on the Uganda water bodies since 2005. The sector is being promoted to increase fish production and reduce pressure on the capture fisheries. In Uganda, cage aquaculture is now practiced on several lakes and rivers including lakes Victoria, Albert, George, and other small lakes such as Kawi, and Mugogo (Table 3.19). Lake Victoria hosts most of the cage fish farms, mostly in Buikwe, Jinja and Mukono districts. Several cages of varying sizes are expected to be on these water bodies.

Plate 3.6.A cage aquaculture farm on Lake Victoria, Buikwe district (Source: NaFIRRI)

3.5.3.4.3.1 Practices for cage aquaculture

Development of cage aquaculture without proper guidance can degrade the environment and cause conflicts with other water users. Cages are usually installed in sites where they have minimum interference with other lake uses, have suitable conditions for fish growth and allow replenishment of wastes. For cage installation, recommended minimum distances or buffers from other lake uses are observed e.g. 100m from navigation routes, 500m from recreational facilities, 200m from landing sites, 200m from fish breeding and nursery areas and 500 m from water extraction points and effluent discharge or waste disposal points as well as ensuring no fish escapes.

Best Management Practices (BMPs) are required for developing socially, economically and environmentally sustainable cage fish farming enterprises. This is necessary because cage aquaculture on our water bodies is expanding. NaFIRRI has led efforts to develop BMPs that detail practices that should be adhered to for cage establishment and other operations. The best practices among other things inform conducting suitability and capability assessments and Environmental and Social Impact Assessment (ESIA).

3.5.3.4.3.2 Establishment of zones (aqua parks)

Cage installations should be established only in aqua parks to avoid detrimental impacts on the environment and conflicts with other uses. Zoning will allow the exclusion of areas that overlap with other uses features such as fish breeding and nursery areas, and exclude shallow and small lakes where impacts of cage fish farming can be pronounced. Zoning could also consider prohibiting cage aquaculture near the shoreline and encourage establishment of cages away from the shoreline. However, the hindrance to restricting cage aquaculture offshore is that growing fish offshore increases operational costs but could help farmers avoid near shore waters that have excessive nutrients.

Table 3.19 Cage fish farms and estimated number of cages on selected water bodies in Uganda. The estimates are based on research from the National Fisheries Resources Research Institute

Water body	Number of cage aquaculture farms	Estimated total number of cages
Lake Victoria	29	1473
River Nile	8	135
Lake Albert	2	-
Lake Kyoga	2	102
Kazinga Channel	1	10
Lake George	1	10
Lake Kawi	1	3
Lake Mugogo	1	-
Lake Pallisa	1	4
Reservoir	1	10

(Source: Musinguzi et al. 2019)

3.6 Protection of threatened plant species outside protected areas

A threatened species is a plant or animal species generally perceived as likely, in the near future, to become endangered within all or much of its range.

3.6.1 Introduction

The wildlife protected areas and forest reserves altogether constituted 18.8% of the total land area of Uganda. This therefore means much of the biodiversity is outside protected areas, either on communal land or private lands. Whereas Uganda Wildlife Authority (UWA) is responsible for management of wildlife in the country, and whereas National Forestry Authority (NFA) is mandated to manage central forest reserves and the plant biodiversity therein, management of biodiversity outside protected areas (especially plants) is not clear and hence harvesting of plant species, mainly those targeted for commercial purposes is unsustainable. This section will focus on the intervention by NEMA on the protection of shea butter tree and Afzelia africana.

3.6.2 Status and trends

The shea butter trees

Shea butter trees are found in unbroken belt approximately 6,000 km long by 500 km wide from Senegal to Uganda and Ethiopia. The species is of African origin. Shea tree occurs in 19 countries across the African continent namely: Benin, Ghana, Chad, Burkina Faso, Cameroon, Central African Republic, Democratic Republic of Congo, Ethiopia, Guinea Bissau, Guinea, Cote D'Ivoire, Mali, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Togo and Uganda (Fig 1). In Uganda the trees are found in a belt covering the following districts: Lira, Otuke, Alebtong, Pader, Agago, Dokolo, Soroti, Serere, Amuria, Katakwi, Abim, Moyo, Arua, Kitgum, Nebbi and Nakasongola.

The shea butter trees are very important biodiversity resource for the local communities in north and north-eastern, the people of Uganda in general and the global community. The most important product of Vitellaria paradoxa is shea butter. Shea butter is a butter obtained from the nuts of Shea buttertrees. Traditionally most of the shea nuts collected are processed into shea butter for home consumption and to meet local market demand. The fruits from shea trees are important source of food for local communities. The fruits of the shea trees ripen just before the harvest of crops and therefore greatly supplement the diet of the local communities.

Today, shea nuts are important internationally and are sold to European and Japanese food industries. The refined fat is sold as baking fat and margarine. Shea-butter, or shea-oil, is used in modern factories to produce baking fat, margarine, cocoa butter substitutes and various moisturizing beauty and pharmaceutical products. Dermatologists are starting to recommend it to their patients for treatment of eczema, rashes, burns and severely dry skin. Shea butter is rapidly becoming one of the top moisturizing agents in use today. Shea butter soap is manufactured in Togo and other West African countries.

Shea butter is used as a base for many commercial preparations. Increasingly, cosmetics, especially those that prevent skin drying and good-quality lipsticks, use shea butter. Shea butter is naturally rich in Vitamins A and E as well as a number of other vitamins and minerals. Vitamins A and E help to soothe hydrate and balance the skin. Shea butter has a fatty composition similar to that of cocoa butter, so is often used as a substitute for cocoa, and in pastry because it makes highly pliable dough. The shea fruit has enormous nutritional benefits that are also important for health purpose.

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A recent study of the general population of the shea trees in Abim, Agago, Kitgum and Otuke districts indicated that there were more shea trees (76trees/ha) in the forest reserve and 67trees/ha in grazing land compared to short fallows (51trees/ha), gardens (24trees/ha) and homesteads (14trees/ha) respectively (Figure 3.28).

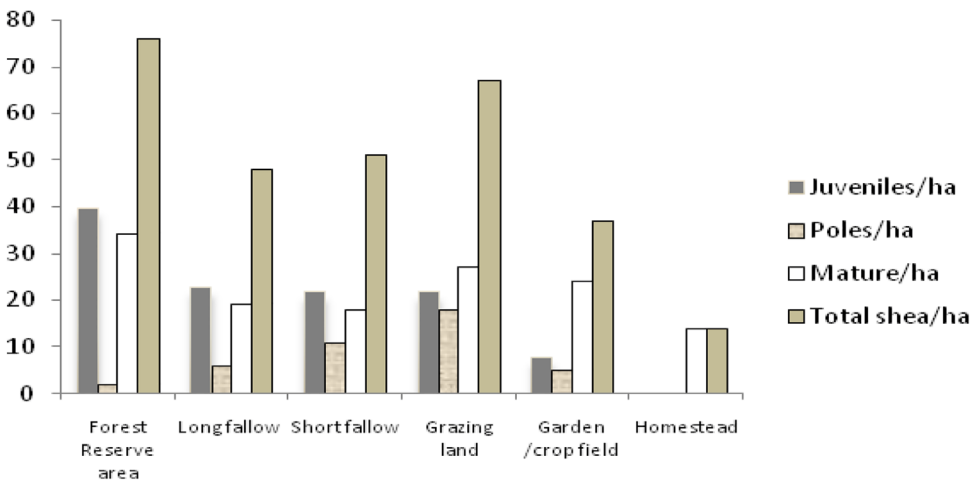


Figure 3.28: Average number of shea plants per ha in different land use types from 126 plots in Otuke, Kitgum, Abim, Agago, Kitgum and Kitgum Districts

The results also showed that economic activity and land use types also had influence on the distribution of shea trees under different land uses. While more shea mature trees (10 to 14/ha) were encountered on lands under long fallows in Kitgum and Agago districts, more saplings (34 shea trees/ha) were encountered in Otuke compared to other districts in this study.

The computation from all the inventories carried out in Abim, Agago, Kitgum and Otuke districts indicated that there were more mature shea trees followed by shea juveniles and lastly the saplings/poles in all the four districts.

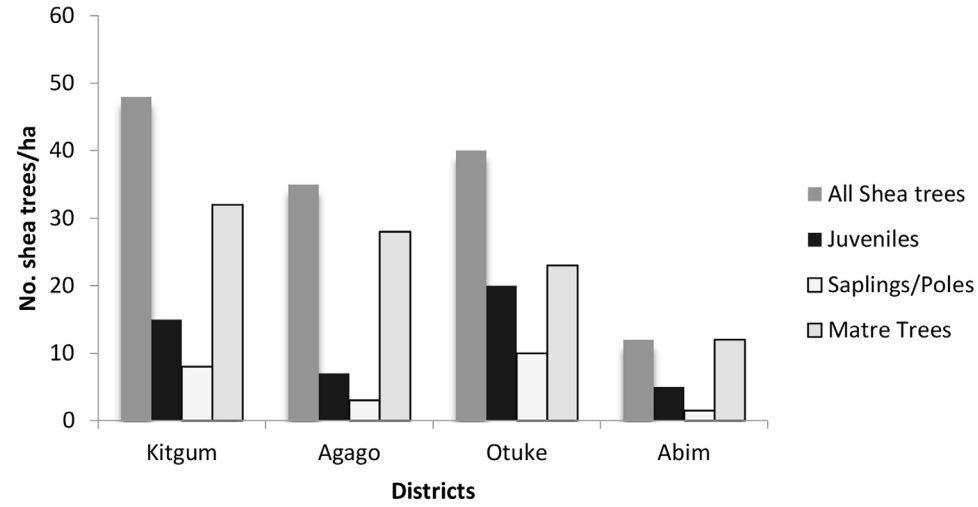


Figure 3.29 Density of all categories of shea trees in Abim, Agago, Kitgum and Otuke Districts

In particular, more shea trees were encountered in Kitgum district followed by Agago, Otuke, and Abim districts respectively. There were more juvenile shea trees in Otuke followed by Kitgum, Agago and Abim districts. Otuke district had more saplings/poles compared to Kitgum, Agago and Abim districts (Figure 3.29).

The computation of the shea tree population density per respective districts in this are presented in the Figure 3.29. In all sites inventoried seedling density was high in sites that had been under fallow compared to those sites which had been under crop cultivation respectively. Generally, Shea tree sapling density was very low in all the four project districts suggesting that the Shea tree population risks degradation (Figure 3.30)

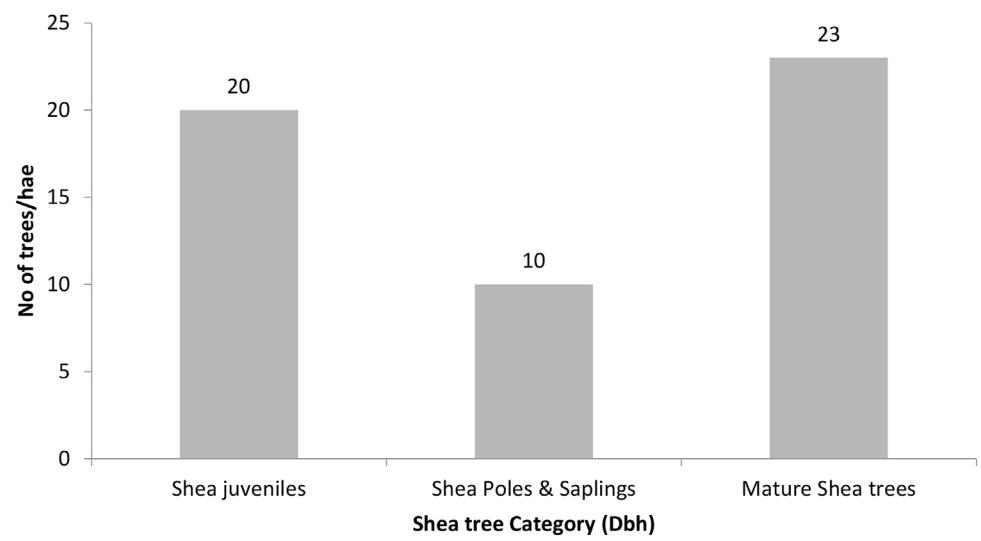


Figure 3.30: Population status of inventoried shea trees in Otuke District

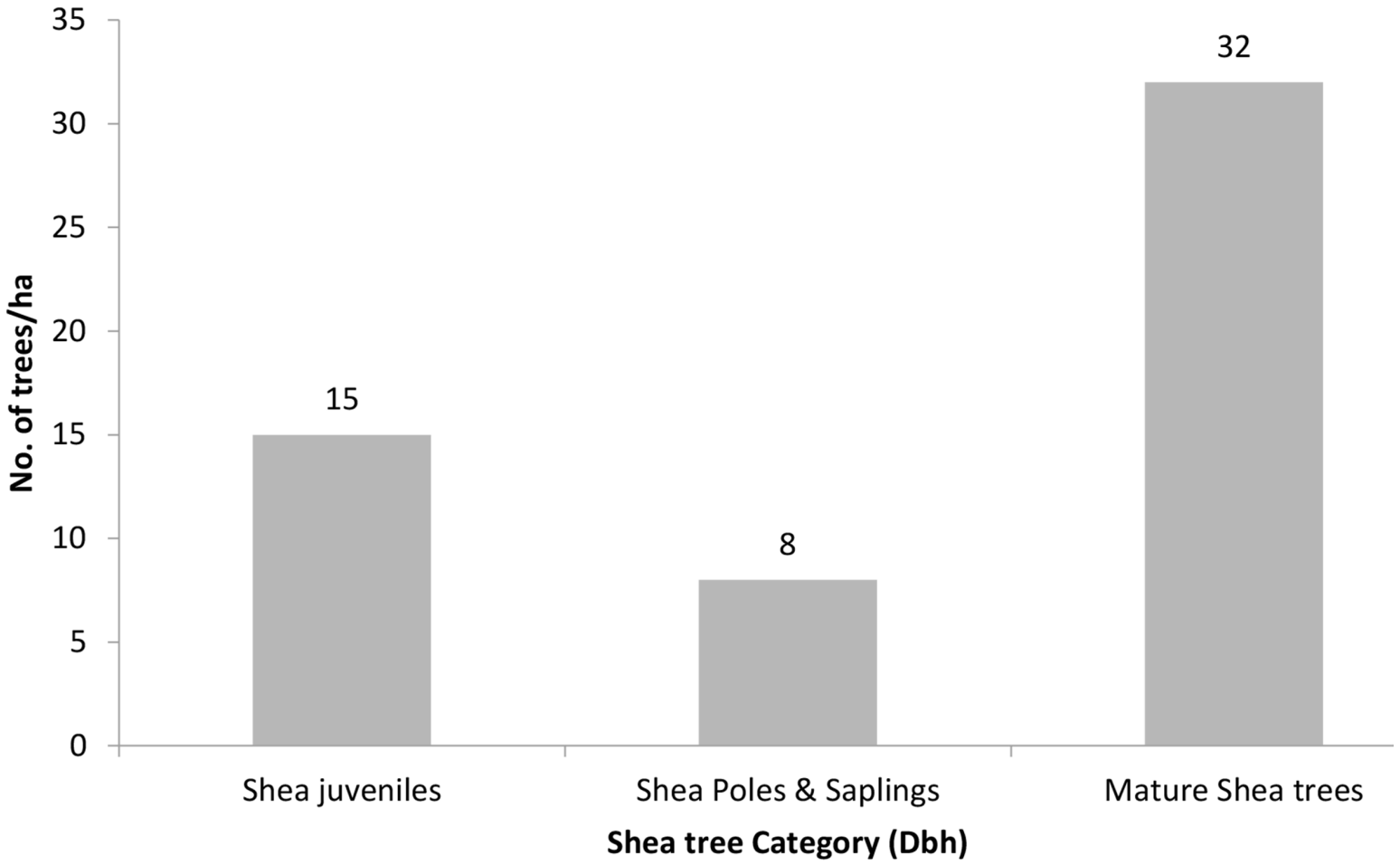


Figure 3.31: Population status of inventoried shea trees in Kitgum District

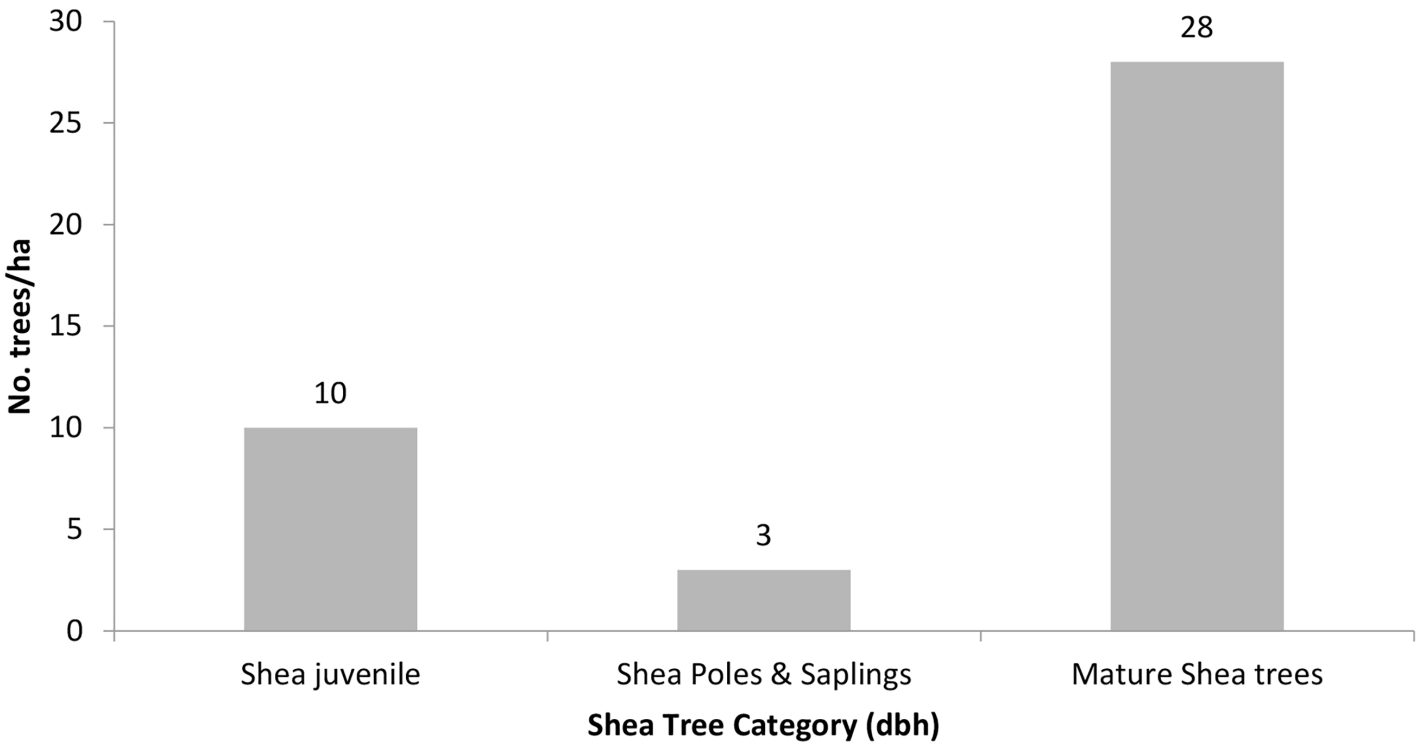


Figure 3.32: Population status of inventoried shea trees in Agago District

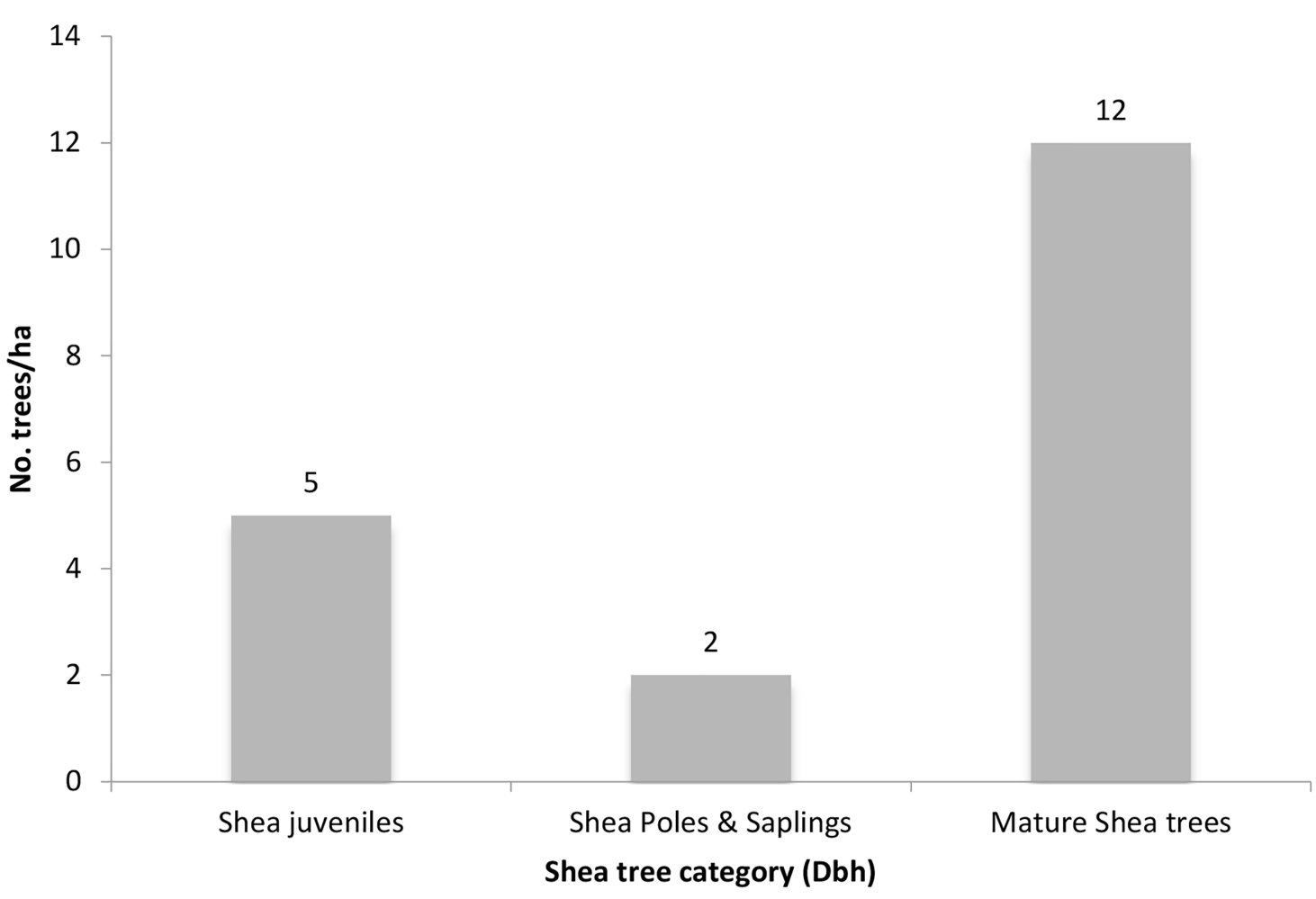


Figure 3.33: Population status of inventoried shea trees in Abim District

Afzelia africana

Afzelia africana is a tree species in the Fabaceae family. It occurs in Benin; Burkina Faso; Cameroon; Central African Republic; Chad; Congo; Congo, The Democratic Republic Congo; Côte d'Ivoire; Ghana; Guinea; Guinea-Bissau; Mali; Niger; Nigeria; Senegal; Sierra Leone; South Sudan; Sudan; Togo; Uganda. In West Nile *Afzelia africana* is found in Arua and Yumbe districts. Mature trees grow between 10 and 20 meters in height.

Afzelia africana are prized for their quality wood, their bark which has many medicinal uses, and their nitrogen-rich leaves which enrich the soil. The wood from *Afzelia africana* is hard, heavy, durable, termite-proof, light brown to red-brown in colour, excellent timber, difficult to work, though. Used in carpentry, canoe and house building, furniture making.

Products from *Afzelia africana* have numerous uses for human medicine including febrifugal, analgaesic, anti-hemorrhageic, laxative, emetic, emmenagogic and aphrodisiac, the foliage is good cattle forage, particularly before the re-growth of grass in the early rainy season. Wild animals browse the arils, and antelopes eat the young shoots. Pods are rich in ashes used for making soap.

3.6.3 Pressures and Impacts

The major reported threats to regeneration and management of young shea trees were continued fire outbreaks, cutting down of mature trees (no fruits to regenerate the shea parkland).

Fire outbreak especially in the dry seasons is still rampant. Fires are set up by hunters especially young people to trace the wild animals during hunting process, while some fires are accidental from farmlands. Bush burning still common in the area whereby cattle grazers burn to get fresh grass for livestock.

Charcoal burning is still one of the threats to the conservation and management of shea in the areas like Abim Sub County. Sometimes charcoal burners cut the whole stump thus affecting the coppicing of shea trees.

Grazing animals are also a danger to juvenile shea trees through trampling while some browsers like goats also eat juvenile shea trees.

Plate 3.8. Destruction of the tree for charcoal production in Agago District

In Yumbe and Arua there is massive illegal cutting of Afzelia africana which is being smuggled out of the country to Asia and other parts of the world. Just like the shea butter tree, Afzelia africana is under threat of extinction

3.6.4 Responses

Protection shea trees and value addition

Some of the most outstanding partnerships established were for the Shea tree and Shea butter processing field. Shea butter products are a part of a rapidly increasing market. Shea has become a popular input into chocolate, cosmetics, and natural products. While historically about 90 percent of shea butter was used in chocolates, cosmetics represent a rapidly growing market segment. Uganda exports Shea products to Germany, Japan, Kenya, India, Canada, Middle East, Rwanda, France and Kenya (Business Week 2019). Less than 20% of the shea producers sell their nuts to organizations such as: The Northern Uganda shea Processors' Association – (NUSPA) in Lira, Guru Nanak Oil Mills in Lira and CREAM in West Nile (Okullo et al., 2017). Uganda Export Promotions Board (UEPB) has set a target of supporting and enabling shea product producers to have at least 200,000 to 500,000 tonnes of shea nut produced by 2022. UEPB stated the trade targets will be achieved by conserving and stopping the depletion of the shea butter trees, which are largely cut down for charcoal burning (Business Week, 2019).

NEMA developed the "National strategy for the conservation and sustainable use of the threatened Shea butter trees in Uganda". Training Manual on Post-Harvest Handling, Standardization and Diversifcation of Shea Butter Tree Products, National Export Strategy for Shea Butter Products (in collaboration with Uganda ExPort Promotion Board. Furthermore, shea market information centres have been set in Otuke and Agago district under the Kidepo Critcial Landscape project supported by the GEF through the United Nations Development Programme (UNDP)

Implementation of the strategy is estimated at a total cost of US$ 21.65 million over the 10-year period. Implementation of the first five years is estimated at a cost of US$ 12.65 million which is US$ 2.53 million per annum while the last five years (second phase) is estimated to cost US$ 9.0 million which is US$ 1.8 million per annum. Government of Uganda (GoU) and local governments are expected to provide the funds for implementation of the project.

Enrichment planting

NEMA is carrying out enrichment planting in Oliduru Central Forest Reserve in collaboration with National Forestry Authority (NFA) to restore shea trees that were cut down in the forest reserve. So far 42 ha have been restored out of the 222 ha of the forest.

Enforcement

NEMA has an on-going programme on protection of shea butter trees and *Afzelia africana*. This is being carried out in collaboration with district local governments in the shea belt districts as well as districts in West Nile in the case *Afzelia africana*. The enforcement is contributing to protection of the shea butter tree. Study in 2019 shows overall, 75% of the respondents reported remarkable changes in the number of shea trees as a result of the shea tree conservation implementation of the laws.

Table 3.20: Reported changes in the number of shea trees as result of enforcement

Categories of Shea Trees	%Respondents Reporting on each Change status of shea trees		
	Increasing	Decreasing	No Change
Juveniles	64	19	17
Saplings/Poles	55	13	32
Mature	62	11	27

(Source: NEMA, 2019)

Overall Strategies to improve the state of Uganda's biodiversity

The legal framework to guide biodiversity conservation has been put in place. This includes the National Environment Act No.5 (2019), the Wildlife Act (2019), the National Biodiversity Strategy and Action Plan (NBSAP) 2015-2025 (NEMA, 2016) and the national biodiversity and offset strategy (MWE, 2019).
In March 2019, Uganda completed the development of its National Biodiversity Finance Plan (NBFP). The goal of the plan is to achieve "optimal and sustainable financing for biodiversity conservation and management attained by 2027/28." Three objectives complement the goal of the NBFP. The objectives are: (i) develop and implement a biodiversity and ecosystem index and payments for ecosystem services; (ii) enhance the use of economic instruments as incentives for biodiversity conservation and management; and (iii) scale up innovative biodiversity management and conservation actions that enhance livelihoods and increase national revenue. The eight finance solutions are:

1. Implementing ecological fiscal transfers: Piloting forest landscape restoration.
2. A national programme on payments for ecosystem services.
3. Scaling up bottom-up enforcement for biodiversity and ecosystem management based on community regulatory systems and incentives model.
4. Develop transport channel for transport and ecotourism for Lubigi wetland system with livelihoods incentives for wetland adjacent communities.
5. Upgrading the value chain for natural ingredient of Shea in Northern Uganda.
6. Rationalise and implement revised charge systems for biodiversity and ecosystem conservation and management.
7. A financing model for biodiversity conservation for central forest reserves.
8. Standardize and regulate implementation of biodiversity offsets.

As part of implementation of NBSAP II, five new funds have emerged. One of these is the Uganda Biodiversity Trust Fund (UBTF) an independent conservation fund. Under the National Environment Act No.5 (2019), a new environmental audit charge was proposed, which will raise an expected UGX 6 billion. Additional instruments on payments for ecosystem services and re-enforcement of the Environmental Impact Assessment fees and other instruments in the new legislation have not been assessed.
The UGGDS has drawn financing for the five focus areas of agriculture, green cities, sustainable transport, sustainable energy and natural capital management. The European Union office in Uganda has supported the mobilization of at least EUR 207.35 million for implementation of biodiversity conservation and management related activities.

Bibliography

EASE 2019. East African Suswatch E-bulletin. A monthly from the East African Sustainability Watch Network founded by Uganda Coalition for Sustainable Development (UCSD), Tanzania Coalition for Sustainable Development (TCSD) and SusWatch Kenya

Andama M, Ongom R, Lukubye B (2017) Proliferation of Salvinia molesta at Lake Kyoga Landing Sites as a Result of Anthropogenic Influences. Journal of Geoscience and Environment Protection 5 (11):160-173. doi:https://doi.org/10.4236/gep.2017.511012

Adeleke B, Robertson-Andersson D, Moodley G, Taylor S (2019) Aquaculture in Africa: A Comparative Review of Egypt, Nigeria, and Uganda Vis-À-Vis South Africa. Reviews in Fisheries Science & Aquaculture:1-31

Bas Bolman, Arie Pieter van Duijn, Justus Rutaisire, 2018. Review and analysis of small-scale aquaculture production in East Africa; Part 4. UGANDA. Wageningen Centre for DevelopmentInnovation, Wageningen University & Research. Report WCDI-18-021. Wageningen

FAO 2005-2020. National Aquaculture Sector Overview. Uganda. National Aquaculture Sector Overview Fact Sheets. Text by Mwanja, W.W. In: FAO Fisheries Division

Graham, M 1929. The Victoria Nyanza and its Fisheries: A Report on the Fishing Survey of Lake Victoria, 1927-1928, and Appendices. Crown agents for the Colonies

UBOS, 2019. Uganda Bureau of Statistics, statistical abstract

Welcomme, R.L., 1972. The inland waters of Africa. Les eaux interieures d'Afrique. CIFA Tech.Pap./Doc.Tech.CPCA, (1): 117p.

Nakiyende, H., Taabu-Munyaho, A., Nasereko, F., Mbabazi, D., 2018. Socio-economic and sustainability consequences of the decline of large fish species in the Ugandan large lakes

Mkuna E, Baiyegunhi LJ (2019) Determinants of Nile perch (Lates niloticus) overfishing and its intensity in Lake Victoria, Tanzania: a double-hurdle model approach. Hydrobiologia 835 (1):101-115. doi: https://doi.org/10.1007/s10750-019-3932-9

MAAIF-DFR 2019. Ministry of Agriculture Animal Industry and fisheries-Directorate of Fisheries resources Entebbe-Uganda.

Sserwambala, S. 2018. Viability of aquaculture in Uganda. United Nations University Fisheries Training Programme, Iceland. Final project. http://www.unuftp.is/static/fellows/document/Simon17prf.pdf

Ministry Agriculture Animal Industry & Fisheries (MAAIF), Entebbe.

Andama, M., Ongom, R. &Lukubye, B. (2017). Proliferation of Salvinia molesta at Lake Kyoga Landing Sites as a Result of Anthropogenic Influences. Journal of Geoscience and Environment Protection, 2017, 5, 160-173

DFR (2014). Department of Fisheries Resources 2014/15 Annual report. Ministry of Agriculture, Animal Industry and Fisheries, Department of Fisheries Resources (DFR), Entebbe,

DiFR (2016). Uganda National Draft Frame Survey Report, 2016

FAO (2004). Fishery country profile: The Republic of Uganda. Food and Agriculture Organisation of the United Nations (FAO), Rome.

FAO (2003). Information on fisheries management in the republic of Uganda:

FAO (2017). Microplastics in fisheries and aquaculture: Status of knowledge on their occurrence and implications for aquatic organisms and food safety. Rome. Pp 1-126

FAO (2016). The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome. 200 pp.

Kifuko Richard (2015). The State of Cage Fish Farming in Uganda: Actors, Enabling environment, Challenges and Way forward. Intl. J. of Education and Research.Vol. 3 No. 3 March 2015.

Lukwago, N. (2018). A report on the Kalangala town hall. Accessed 2020-01-09.

A debate on fishing rights and the UPDF influence

MAAIF (2011). Department of Fisheries Resources Annual report 2010/2011. Ministry of

MAAIF (2015). Agricultural Sector Strategic Plans, 2015/16 to 2019/20; Ministry of Agriculture, Animal Industry and

MAAIF (2016). Joint Agriculture Sector Annual Review Report, 2017

Manson, J.G. & Manson, B.E. (1958). Water hyacinth reproduces by seed in New Zealand. New Zealand Jour. Agric. 96: 191,

Matthews, L.J., Manson, B.E. & Coffey, B.T. (1977). Longevity of water hyacinth (Eichhorniacrassipes (Mart.) Solms) seed in New Zealand. Proc. 6th Asian-Pacific Weed Sci. Soc. Conf. 1968, Vol. 1: 263-267.

Musinguzi et al. (2019). The extent of cage aquaculture, adherence to best practices and reflections for sustainable aquaculture on African inland waters. Journal of Great Lakes Research, https://doi.org/10.1016/j.jglr.2019.09.011

NaFIRRI (2016). Control of Kariba weed (Salvinia molesta) on Uganda's water systems

NaFIRRI (2016). Guidelines for Cage fish farming in Uganda.

NEMA (2016). State of the Environment Report for Uganda 2014. National Environment Management Authority (NEMA), Kampala.

NOAA (2015). Laboratory Methods for the Analysis of Microplastics in the Marine Environment: Recommendations for quantifying synthetic particles in waters and sediments.

Plastics Europe (2017). Plastics-the Facts. An analysis of European plastics production, demand and waste data. Brussels, p. 44.

Hickey, J.R., Uzabaho, E., Akantorana, M., Arinaitwe, J., Bakebwa, I., Bitariho, R.,Eckardt, W., Gilardi, K.V., Katutu, J., Kayijamahe, C., Kierepka, E.M., Mugabukomeye, B., Musema, A., Mutabaazi, H., Robbins, M.M., Sacks, B.N., and Zikusoka, G.K. 2019. Bwindi-Sarambwe 2018

NEMA (2016): National Biodiversity Strategy and Action Plan II (2015-2025)

NEMA, UNDP and Global BIOFIN (2019): National Biodiversity Finance Plan, National Environment Management Authority, Kampala

Surveys: monitoring mountain gorillas, other select mammals, and human activities. GVTC, IGCP & partners, Kampala, Uganda, 40p. Hughes.D.F, Greenbaum.E, Lukwago.W, and Behangana.M,, 2016. Conservation status of Amphibians and Reptiles in Uganda

Uganda Wildlife Act 2019

Uganda Wildlife Act Cap 200

Ayebare S., Mulondo P., Mugabe H., Mutungwire N., Gonya M., Masereka A.K., Karebi O., Kitimbo H., Nangendo G., & Nampindo S. (2020). Chimpanzee Census in Kibale National Park. Unpublished report

Hickey, J.R., Uzabaho, E., Akantorana, M., Arinaitwe, J., Bakebwa, I., Bitariho, R., Eckardt, W., Gilardi, K.V., Katutu, J., Kayijamahe, C., Kierepka, E.M., Mugabukomeye, B., Musema, A., Hughes.D.F, Greenbaum.E, Lukwago.W, and Behangana.M. (2016). Conservation status of Amphibians and Reptiles in Uganda

Hughes.D.F, Greenbaum.E, Lukwago.W, and Behangana. M. (2016). Conservation status of ` Amphibians and Reptiles in Uganda

Mutabaazi, H., Robbins, M.M., Sacks, B.N., and Zikusoka, G.K. (2019). Bwindi-Sarambwe 2018 Surveys: monitoring mountain gorillas, other select mammals, and human activities. GVTC, IGCP & partners, Kampala, Uganda, 40p.

MTWA (2017)

Nangendo G. Kirunda B., Bisimbeko N. P., Dhabasadha D., Ayebare S., Kyasiimire B. and Nampindo N. (2019). Building national capacity to mitigate industry impacts in MFNP. Unpublished report. CEPF-103663

NEMA (2019). The National Environment Act No. 5, 2019

NEMA (2019: Inventory and Mapping of Shea Butter Trees in Abim, Otuke, Agago and Kitgum Districts

NEMA (2016): Population Structure and Conservation Status of the Shea Butter Trees in Abim, Agago, Kitgum and Otuke Districts

Plumptre, A.J., Ayebare, S., Pomeroy, D., Tushabe, H., Nangendo, G., Mugabe, H., Kirunda, B., & Nampindo, S. (2017). Conserving Uganda's Biodiversity: Identifying critical sites for threatened species and habitats. Unpublished report to USAID and Ministry of Tourism, Wildlife and Antiquities.

Republic of Uganda (2019). The Uganda Wildlife Act, 2019

Ayebare S., Plumptre J.A., Kujirakwinja D., Segan D. (2018). Conservation of the endemic species of the Albertine Rift under future climate change. Biological Conservation 220: 67-

Hickey, J.R., Uzabaho, E., Akantorana, M., Arinaitwe, J., Bakebwa, I., Bitariho, R., Eckardt, W., Gilardi, K.V., Katutu, J., Kayijamahe, C., Kierepka, E.M., Mugabukomeye, B., Musema, A., Mutabaazi, H., Robbins, M.M., Sacks, B.N., and Zikusoka, G.K. (2019). Bwindi-Sarambwe 2018 Surveys: monitoring mountain gorillas, other select mammals, and human activities. GVTC, IGCP & partners, Kampala, Uganda, 40p

https://reliefweb.int/report/uganda/unhcr-uganda-resettlement-factsheet-2019-28-february

Jayachandran S., de Laat J., Lambin F. E., Stanton Y C., Audy R., Thomas E. N. (2019). Cash for carbon: A randomized trial of payments for ecosystem services to reduce deforestation. http://science.sciencemag.org

National Planning Authority (NPA). (2015). Second National Development Plan (NDP II) 2015/16 - 2019/20

National Planning Authority (NPA). (2013). Uganda Vision 2040

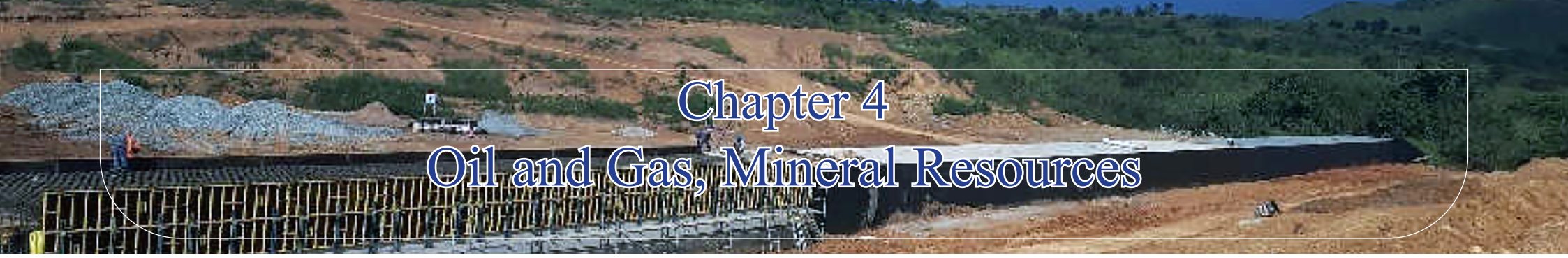
NEMA. (2016). National Biodiversity Strategy and Action Plan II (2015-2025), https://nema.go.ug/sites/all/themes/nema/docs/NBSAP%20Uganda%20 2015%20-%20Re-designed.pdf

Plumptre, A.J., Ayebare, S., Pomeroy, D., Tushabe, H., Nangendo, G., Mugabe, H., Kirunda, B., & Nampindo, S. (2017). Conserving Uganda's Biodiversity: Identifying critical sites for threatened species and habitats. Unpublished report to USAID and Ministry of Tourism, Wildlife and Antiquities.

Plumptre, A. J., Davenport, T. R. B., Behangana, M., Kityo, R., Eilu, G., Ssegawa, P., … Moyer, D. (2007). The biodiversity of the Albertine Rift. Biological Conservation, 134, 178–194

Republic of Uganda (2019). The Uganda Wildlife Act, 2019 Väänänen, E., Runsten, L., Blyth, S., Mugumya, X., Mwebesa, M. and Mant, R. (2014). Supporting planning for multiple benefits from REDD+ Uganda:Exploring synergies in with the Aichi Biodiversity Targets. UNEP-WCMC, Cambridge, UK

WCS. (2016). Nationally threatened species for Uganda: National Red List for Uganda for the following taxa: mammals, birds, reptiles, amphibians, butterflies, dragonflies and vascular plants. Uganda: Report for Ministry of Environment and National Environment Management Authority



Chapter 4
Oil and Gas, Mineral Resources

4.1 Introduction

Mineral exploitation is critical for the industrialization process, yet owing to their intrinsic value as part of a manufactured product, minerals also have a significant general value to an economy from both a financial and an employment standpoint. The country's mineral sector is unfortunately dominated (about 80%) by small scale/artisanal miners, using rudimentary mining methods due to lack of capital to invest in the requisite technology to carryout mining activities in an environmentally sound manner.

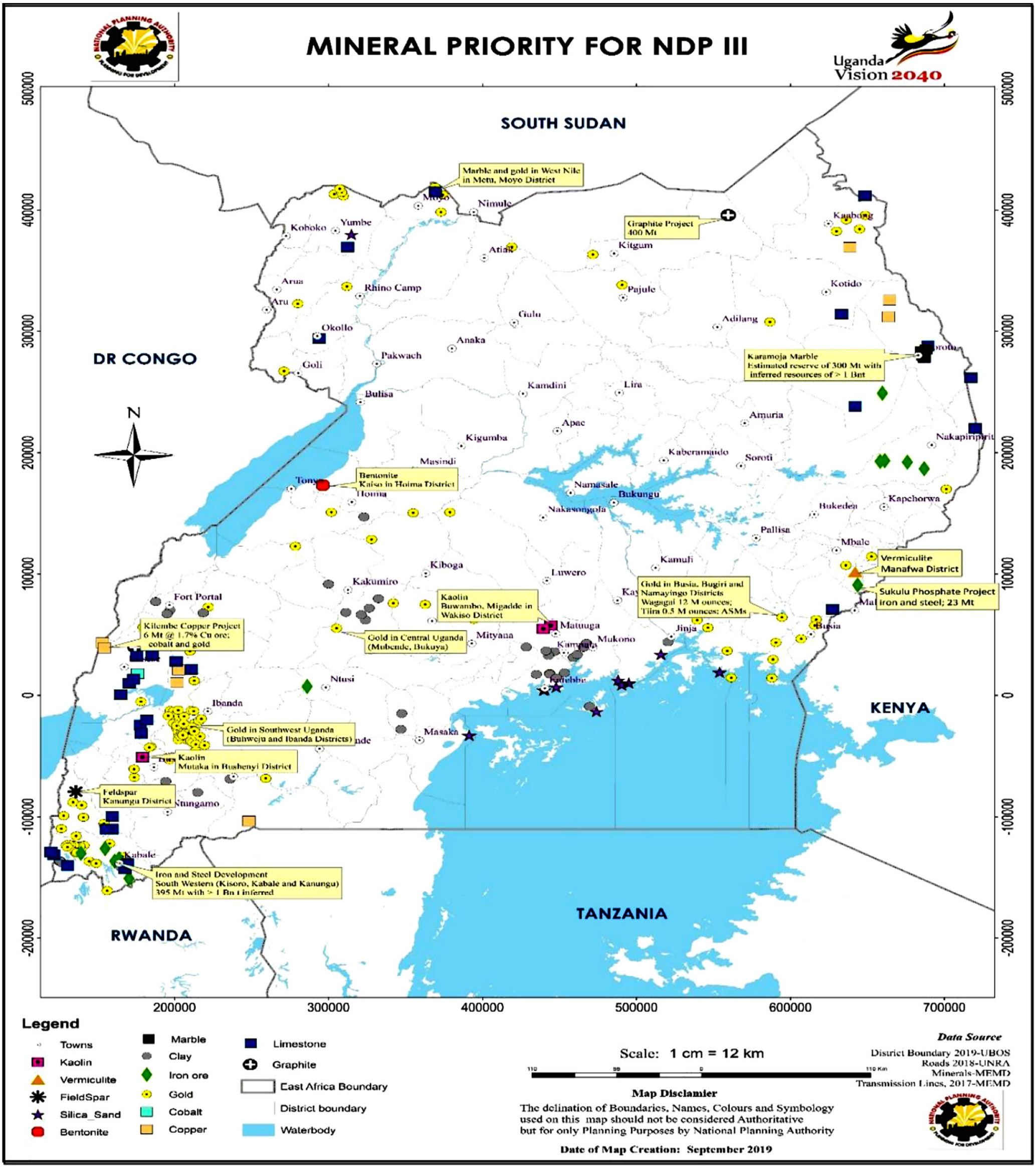


Figure 4.1. Mineral Priority Areas

Uganda is currently described by the World Bank as the hottest inland exploration frontier in the world and the country to watch in the oil and gas space, due to the commercial discovery of an estimated 6.5 billion barrels of oil, 1.4 billion of which are recoverable. One of the Objectives of the National Oil and Gas Policy (2008) is to "ensure that oil and gas activities are undertaken in a manner that conserves the environment and biodiversity".

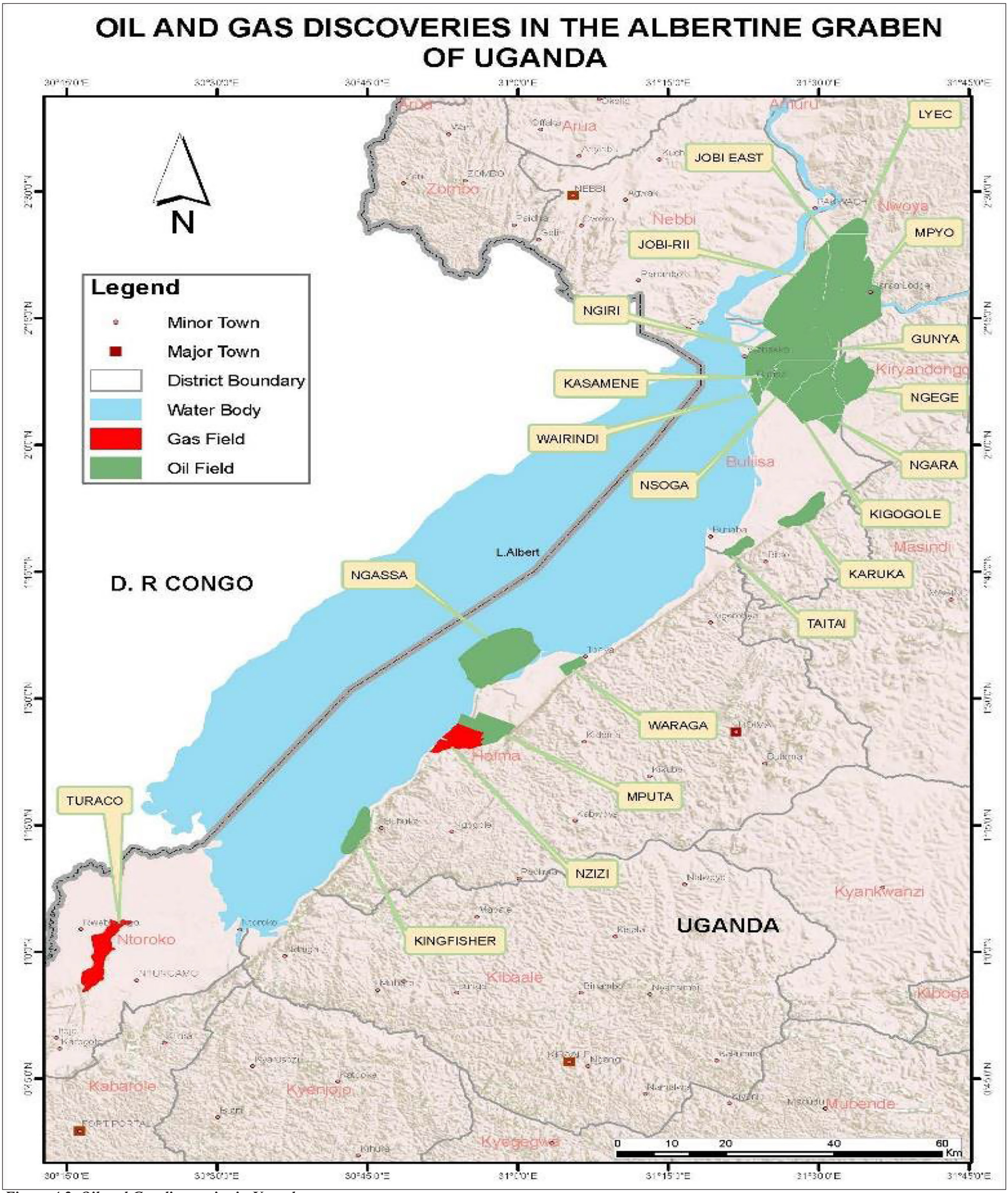


Figure 4.2. Oil and Gas discoveries in Uganda

The need for environmental protection is thus strongly underscored within the framework for harnessing the country's mineral resources.

4.2 Petroleum resources

Oil and Gas developments have potential for environmental degradation if care is not taken during various phases of the petroleum value chain. Environmental degradation can be occasioned by land-use changes, vegetation clearance, occurrences of oil spills, gas flaring and other emissions, waste management practices including the disposal of produced water, as well as the displacement of indigenous persons.

The country is known to have six (06) sedimentary basins namely the Albertine Graben, the Hoima basin, the Lake Kyoga basin, the Lake Wamala basin, the Kadam-Moroto basin, and the Lake Victoria basin. The Albertine Graben has been proven to have viable oil and gas resources while the potential for the other basins is subject for further investigations.

The Albertine Graben is coincidentally the region of the country with the most biodiversity and one of the most naturally rich regions on the African continent, and subsequently on planet earth. The region also has 10 of Uganda's 22 national parks and wildlife reserves, several of the largest forest reserves including Budongo and Bugoma forests, 60% of Uganda's water bodies, and numerous archaeological sites. It is protected areas, such as Queen Elizabeth and Murchison Falls National Parks that establish the Albertine region as Uganda's largest pull for tourism, one of the country's primary economic activities (International Alert, 2013).

4.2.1 Status and trends of petroleum resources

For the discoveries so far made, the sector is in transition from Exploration to Development. The development of some fields has been initiated with Environmental and Social Impact Assessments done for:

The Tilenga Project.

This will mainly cover Buliisa and Nwoya Districts (Murchison Falls National Park) with the neighboring districts similarly experiencing some of the project-induced impacts. The project shall involve:

i) Development of a Central Processing Facility (CPF) with capacity to process 190,000 barrels of oil and 700,000 barrels of total liquid per day.
ii) Drilling of over 426 wells (200 water injector wells, 196 oil producer wells, 2 polymer pilot wells and 28 reference wells) which are planned to be drilled on 31 well-pads.
iii) Over 160 kilometres of flow-lines which will transport crude oil and water from the wells to the CPF.
iv) 95 km 24 inch feeder pipeline which will transport the processed crude oil from the CPF in Buliisa to the export hub and Refinery in Kabaale in Hoima District.
v) Other supporting infrastructure include; Victoria Nile Crossing, Temporary and Permanent Operation Support Base camps and a Lake Water Abstraction Station.

The Kingfisher Development Project

The Kingfisher Development Area (KFDA) is located along the shores of Lake Albert, initially covering the Kingfisher field located in Kikuube District with plans for future tie-in of Mputa-Nzizi-Waraga fields in Kaiso-Tonya, Hoima District. The project shall involve:

i) Development of a Central Processing Facility (CPF) with a capacity of 40,000 barrels of oil per day.
ii) Thirty one (31) wells (11 injectors and 20 producers) to be drilled on four (4) well pads.
iii) Nineteen (19) kilometres of flow-lines to connect the fields to the CPF.
iv) A forty-six (46) kilometer 12 inch feeder pipeline from the CPF in Buhuka to the export hub and Refinery in Kabaale, Hoima District.
v) A Lake Water Abstraction station.
vi) Supporting infrastructure such as temporary and permanent camps, a materials yard, a jetty and several access roads, among others.

The East African Crude Oil Pipeline.

In line with the Government's strategy for commercialisation of the discovered petroleum resources in Uganda, feasibility studies on the development of a Crude Oil Export Pipeline from the Albertine Graben in Uganda to the East African Coast, were undertaken. The Hoima (Uganda) – Tanga (Tanzania) route was selected. A 1445km long, 24-inch diameter, buried and heated East African Crude Oil Pipeline (EACOP) from Kabaale, Hoima in Uganda to Chongoleani in Tanga, Tanzania, is to be established to transport crude oil from Uganda to Tanga port in Tanzania.

In Uganda, the EACOP shall traverse 25 sub-counties in 10 districts (Hoima, Kikuube, Kakumiro, Kyankwanzi, Mubende, Gomba, Ssembabule, Lwengo, Rakai, and Kyotera). The project shall comprise of:

i) a 296-kilometre-long, 24-inch-diameter buried pipeline from the Kabaale Industrial Park, in Hoima District, to Mutukula near the border with Tanzania.
ii) Aboveground installations (AGIs) which consist of:
   a. two stations with pumps (pumping stations) to keep the oil moving through the pipeline from north to south
   b. 19 valves at key locations where the oil flow can be reduced or stopped for maintenance and in case of emergencies
   c. 4 electrical substations, collocated with valves, to power the electrically heated cable
iii) Access roads to the key facilities
iv) 4 main camps and pipe yards where pipe and equipment will be stored and construction workers housed.

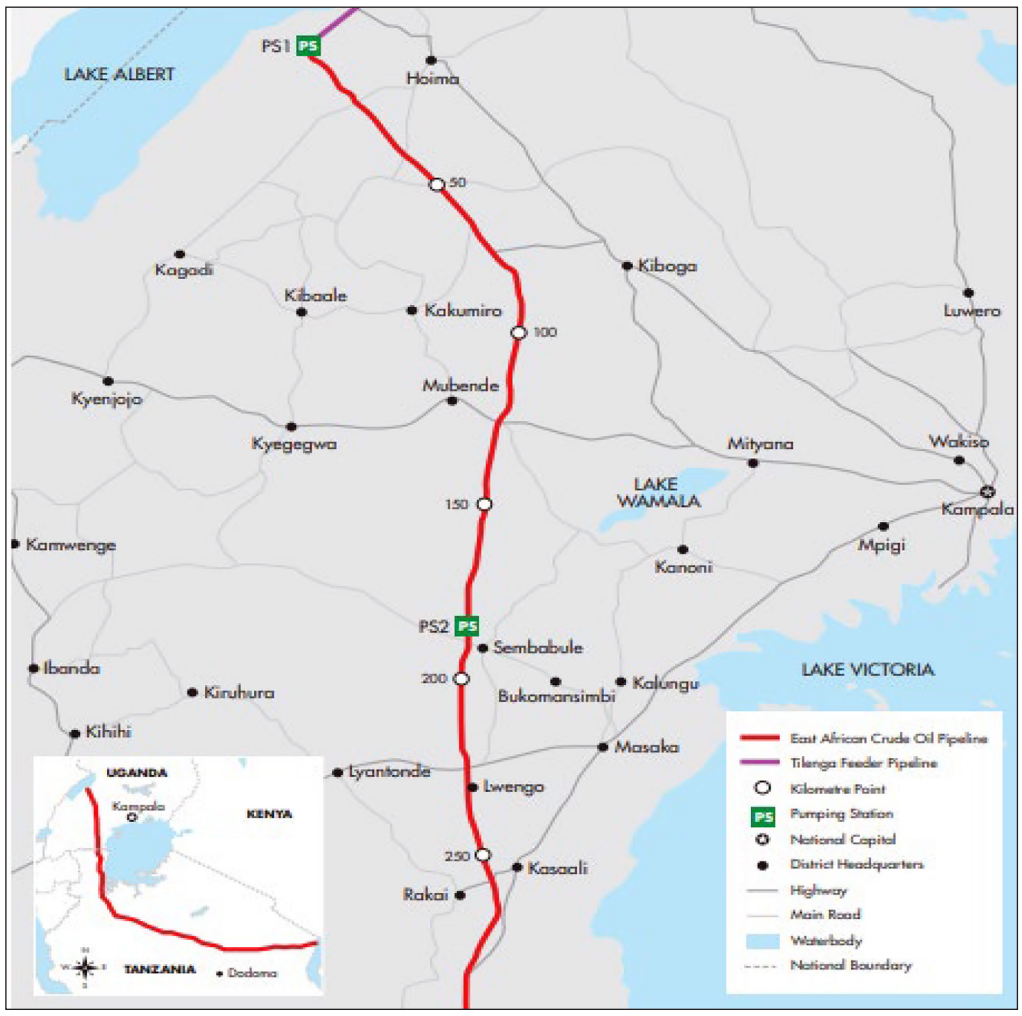


Figure 4.3: East Africa Crude Oil Pipeline (Source: The ESIA for the EACOP project)

Kabaale Industrial Park

In 2012, the Government of Uganda, through the Ministry of Energy and Mineral Development acquired 29.57 km² (2957 hectares) of land near the oil fields of the Albertine Graben Region for the development of a petro-based industrial park. The Park, commonly referred to as Kabaale Industrial Park (KIP), is located in Kabaale Parish, Buseruka Sub-County, Hoima District.

A Master Plan for the development of the park has been prepared, in consultation with Government Ministries, Departments and Agencies, and has been approved by Uganda's National Physical Planning Board. The KIP will accommodate, in a phased manner:

i. Uganda's 2nd International Airport
ii. Crude Oil Export Pipeline Hub
iii. Uganda Refinery
iv. Polymer and Fertilizer Industries
v. Mixed (Light / Medium) Industries
vi. Warehousing & Logistics
vii. Agro-Processors
viii. Common facilities and services including worker housing, expatriate accomodation, schools, recreation areas, medical facilities, among others.

The construction of the Airport (Kabaale) commenced in 2018. Importantly, the construction has generated employment opportunities, skills and upsurge in income and business openings in this area. The influx of people during construction has, however, impacted on the host population through increased insecurity, social conflicts, and pressure on existing resources and infrastructure/ social services. Additionally, the noise and vibrations resulting from airport construction activities, landscape alteration including clearance of vegetation are impacts that have to be managed during this development.

Plate 4.2: Site works at Kabaale International airport

Licensing for Exploration

Three (3) exploration licenses were issued in 2018 and these include Kanywataba area to Armour Energy Ltd, Ngassa deep and shallow play to Oranto Petroleum Ltd. These companies have planned work programmes for four (4) years and these will include reprocessing the existing seismic data; acquiring new seismic data; geological and geophysical studies; and drilling of at least two exploration wells.

4.2.2 Pressures and impacts

The oil and gas industry holds major potential for degradation of the environment as activities within the sector can easily lead to pollution of air, water and land. Pollution is associated with virtually all activities throughout all stages of oil and gas value chain – including the ancillary developments such as waste management facilities, social amenities (roads, housing, etc.), and the KIP among others.

Environmental Assessments and regulatory oversight in the oil and gas sector has revealed the major impacts that Uganda has to deal with, as being:

i. Land disturbance as a result of vegetation Clearance, land-use changes and Soil erosion
ii. Ecosystem disruptions that impacts on wildlife through affecting their breeding/mating grounds,ranging/watering areas,habituation of wildlife (& increased vulnerability/poaching)
iii. Pollution of air, water, Land through emissions and discharges,waste management (including produced water)
iv. Aquatic Impacts
    - ❍ Water quality & quantity
    - ❍ Aquatic life (fish, crocodiles, hippopotamuses, Water-based flora, etc)
v. Impacts on tourism
    - ❍ Unsightly development
    - ❍ Increased traffic
iv. Human and Socio-economic impacts

The areas impacted upon by the Oil and Gas activities are predominantly rural with subsistence economic activities (fishing and livestock raring, low standards of living). These communities have however been opened up by the sector as it has caused an influx of developments & people in largely unplanned areas; which has consequently led to:

- ❍ Change in land-use patterns
- ❍ Impacts on economic activities
- ❍ Planning challenges / Development of unplanned settlements
- ❍ Stress on available resources
- ❍ Socio-cultural disruptions
- ❍ Localized Inflation – increase in value of goods

Notwithstanding these impacts, and whereas permanent changes are taking place in the affected districts, environmental restoration/rehabilitation has been undertaken in the protected areas. This initiative coupled with the resilience of the affected environments has led to minimal net negative impact by Oil and Gas developments on the natural environment

4.3 Minerals and Extractives

There is an abundance of minerals in Uganda, though not all are being exploited (Fig.4.4). Currently, the minerals being commercially mined include gold, iron ore, limestone, vermiculite, wolfram and kaolin. Other resources such as sand, clay and rock mining have also become significant in the face of economic growth.

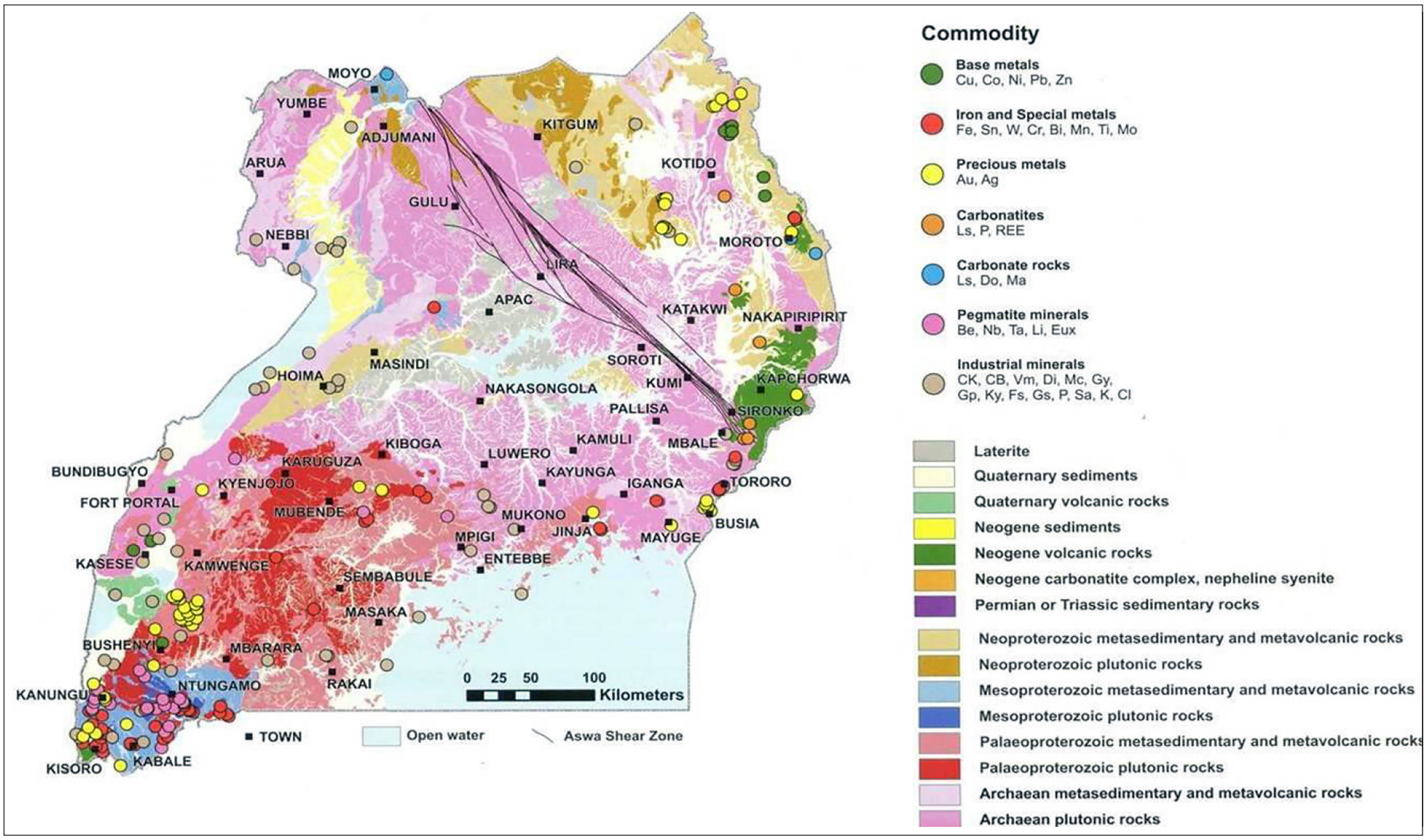


Figure 4.4: The geology and mineral potential of Uganda.

4.3.1 Status and trend

The most highly extracted mineral is limestone which is used in the production of cement followed by Pozollana. Gold, although currently dominated by Artisanal and Small-Scale Miners (ASM), has for a long time contributed to the national GDP. For example, a joint study sanctioned by Ministry of Energy and Mineral Development MEMD and ACP-EU/UNDP Development Minerals in 2017 revealed that the ASM sector contributed about 3.5% to GDP and estimated unregulated illegal ASM miners to be over 200,000 across the country.

4.3.2 Pressures and Impacts

Demand for mineral and mineral products

There is increasing demand for both export and domestic use of cement, iron and steel, sand dimension stones and limestone. This has been especially true over the last five years as there have been some major projects including power dams, roads, residential and non-residential buildings. The high demand has increased mining activities for the raw materials used in the manufacturing plants. However, the mining activities have impacted negatively on the environment in some cases.

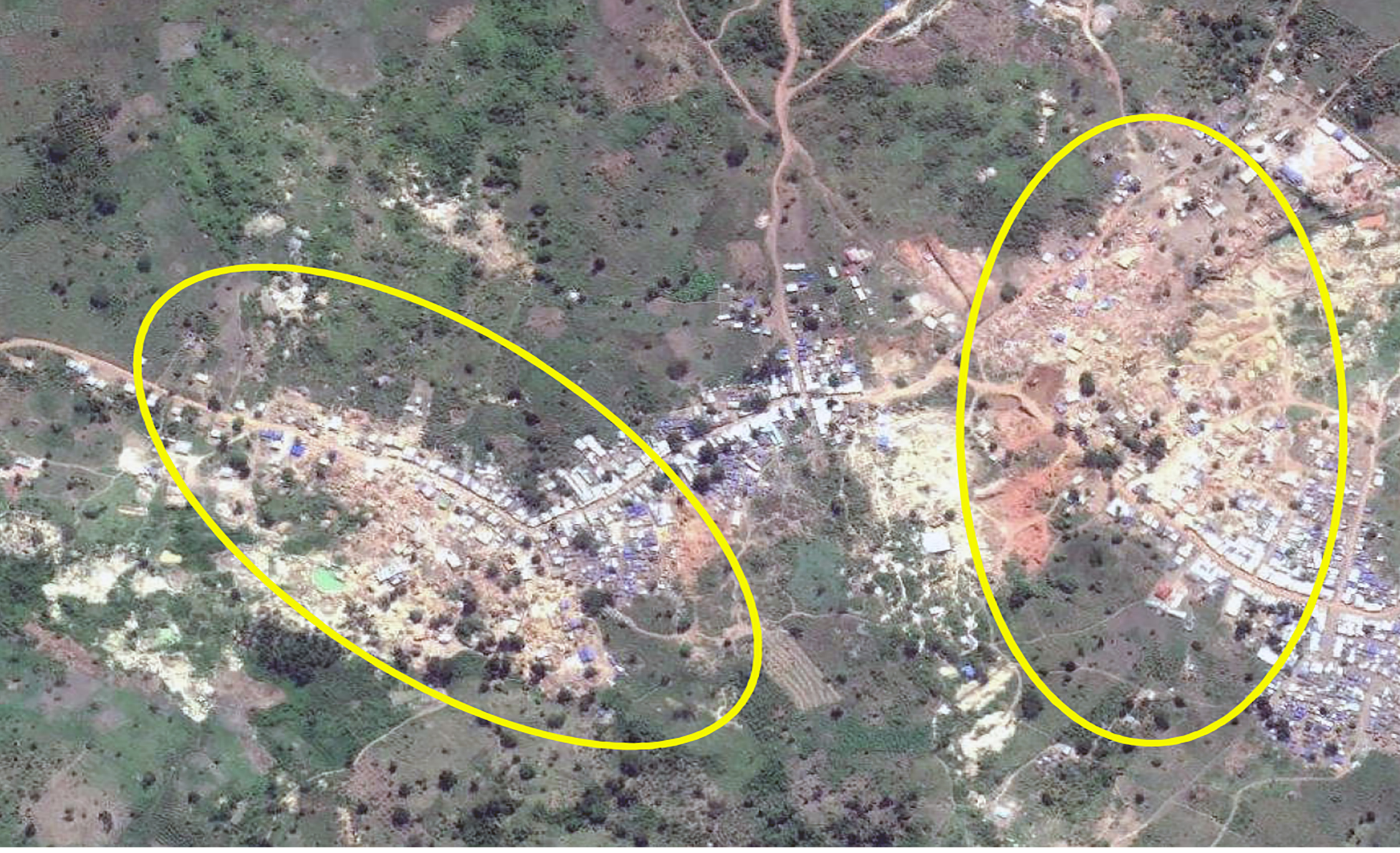
Gold Mining and use of Mercury

The Minamata Initial Assessments (MIA) (NEMA, 2018) revealed that the annual total mercury releases from different sources to be 31,038 kg/y. Mercury released into the air, water and land was found to be 19,926 kg/yr; 3,719 kg/y, 4,770 kg/y respectively. Out of the total mercury released, ASGM was found to be responsible for 18,495 kg/y.

The National Overview of the Artisanal and Small-scale Gold Mining (AGSM) Sector, Including, Baseline Estimates of Mercury Use and Practices (NEMA, 2018-2019) revealed that mercury use estimates per region was over 15,000 kg per year. The Central region uses the highest amount of all mercury in gold production with over 7,800 kg Hg/y (51%); followed by the Eastern region with over 5,000 kg Hg/y (33%), Karamoja region uses over 1,200 kg Hg/y (8%). According to (NEMA, 2018-2019) mercury hot spot districts include Busia, Namayingo, Bugiri, Buhweju, Mubende, Kassanda, Moroto, Amudat and Nakapiripirit Districts.

Plate 4.13: Open pits and undulated landscape are common consequences of gold mining in Kasanda.

Gold Mining in Kasanda in 2013



The extent and effect of Gold Mining in Kasanda in 2017

4.4 Policy & Action Responses:

1. Careful planning and implementation of ALL projects linked to the oil and gas industry which provides a great opportunity to make significant contribution across all SDGs - either by enhancing the positive contributions or by avoiding or mitigating negative impacts to ensure that "no one is left behind".

2. A concerted effort towards institutional capacity (especially at Local Government) and multi-sectoral planning for oil-sector to ensure that there is a right balance between utilization of the extractives resources, social wellbeing, and the protection / conservation of the natural environment;

3. The Legal and regulatory framework for the mineral sector needs to be revised to bring the ASM actors under regulation to foster effective application of the necessary environmental safeguards

Bibliography

PAU (2019). The Kingfisher Development Project

PAU (2019). The Tilenga Project

PAU (2019). Petroleum Exploration in Uganda

The East African Law Society (2018), Situation Analysis – The State of Oil and Gas in Uganda

The National Development Plan III, 2020-2025

CNOOC, Total E&P, Tullow Uganda, 2018. Tilenga Project, Environmental and social Impact Assessment. Volume 1

MEMD (2019). Ministerial Policy statement, MEMD, March 2019.

MEMD (2014). Ministry of Energy and Mineral Development Annual Report 2014

Levin Sources. Market Study and Value Chain Analysis of selected Development Minerals in Uganda, 2017

Hinton et. al. (2011). Hand book of Artisanal And Small Scale Miners

NEMA (2019). The National Environment Act No.5, 2019

NEMA (2018). National Minamata Initial Assessment Report

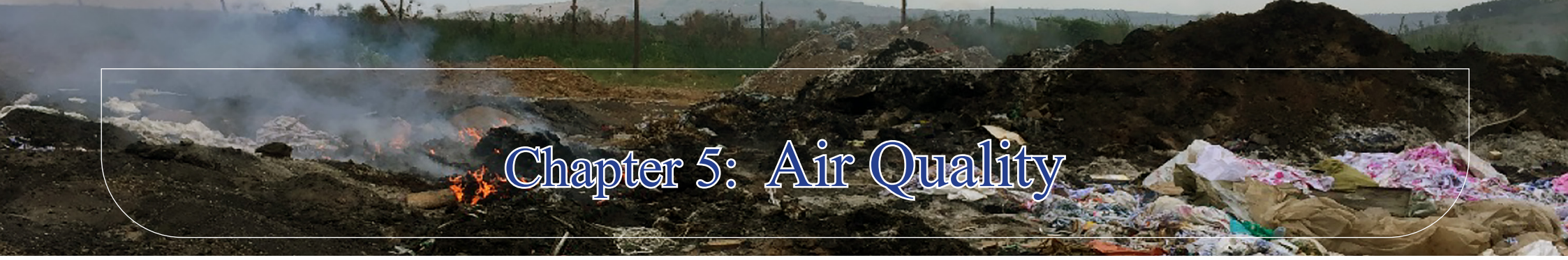
COWI, 2016, Mercury Trade and Use for Artisanal and Small-scale Gold Mining in Sub-Saharan Africa

NEMA (2018-2019). The National Overview of the Artisanal and Small-scale Gold Mining (AGSM) Sector, Including, Baseline Estimates of Mercury Use and Practices

Minamata Convention on Mercury (2013)

http://www.oecd.org/fr/daf/inv/mne/mining.htm;

http://www.oecd.org/daf/inv/mne/GuidanceEdition2.pdf



Chapter 5: Air Quality

5.1 Introduction

Clean air is essential for sustainability of all forms of life on earth. Emissions from human activity are a key contributor to changes in air composition, with consequences on both human health and the environment. Initiatives to study air quality, particularly in urban areas in Uganda, indicate that particulate matter and nitrogen dioxide are above the WHO recommended levels. Particulate matter ($PM_{2.5}$) in the central business district of Kampala Capital City ranges from 36µgm^{-3} to above 80 µgm-3 (24-hour mean) which is above the WHO recommended 25 µgm^{-3}.

Air pollution is one of the most important environmental contributors to the global disease burden, leading to an estimated 6 to 7 million premature deaths annually (UNEP 2019). It affects the respiratory and circulatory system, damaging the lungs, heart and brain and is a global challenge which has caused various health problems that have become an economic burden across the world. Some of the factors contributing to air pollution in Uganda include; motor vehicle emissions (more than 80% of the vehicles are reconditioned), open burning of municipal waste (45% of total waste generated in Kampala City is collected), unpaved roads, poor land use practices and combustion of biomass (as a main source of energy in institutions, industry and for cooking and lighting in households).

Whereas various mechanisms are in place to reduce air pollution in the developed countries, it is still a challenge in most developing economies including Uganda, where limited capacity to monitor emissions and air quality, limited availability of adequate data and the absence of air quality standards are major challenges. The WHO Air Quality Guidelines and the East African Standard - Air Quality Specification (EAS 75:2010) have provided key reference points for the interventions undertaken by the government of Uganda, academia, private sector and other entities. This chapter presents the current state of air quality in the country based on available data, the potential causes and impacts, responses and recommended actions.

5.2 State of Air Quality

Comprehensive information on air quality in the country is limited as Uganda lacks air quality monitoring networks to provide spatially representative information on air quality in the country. However, recent studies carried out within selected urban centers indicate gradual deterioration in the quality of air.
Monitoring ambient air quality has been mainly centered within the greater Kampala Metropolitan Area (GKMA) and selected districts, through installation of one real time monitoring station at the National Environment Management Authority headquarters in Kampala to monitor particulate matter, Nitrogen dioxide and ozone, and air quality monitoring units installed by Makerere University College of Computer Sciences in various locations across the country to monitor $PM_{2.5}$, as well as one $PM_{2.5}$ monitoring station at the US Embassy in Kampala. Current monitoring data available is limited to Particulate matter (PM2.5 and PM_{10}) and Nitrogen dioxide (NO_2).

5.2.1 Critical pollutants

(i) Particulate Matter

Particulate matter is often used as a proxy indicator of air quality and reported as annual or 24-hour average concentrations of particles per cubic meter of air volume (m3). Results from monitoring of particulate matter in selected locations within the greater Kampala metropolitan area (GKMA) and selected districts by NEMA, KCCA and Makerere University, indicate that the levels of PM2.5 exceeded the WHO recommended annual limit values of 10µgm-3. Analysis of available datasets from 2019 reflect seasonal variations with higher pollutant levels recorded during the months of June, July, August, September, and lower pollutant levels during the wet season months of March, April and May, while October reflected the lowest pollution levels, possibly as a result of precipitation and particulate suppression (Figure 5.1).

Figure 5.1: Levels of PM2.5 in different parts of Uganda in 2019 (Source: (AirQo)

The diurnal observations reflect that higher pollution levels occur in the early mornings (from 05:00 to 09:00) and late evenings (from 17:30 to 00:30) and much lower levels after morning hours (09:30 to 17:00) as if to replicate a sinusoidal curve. This pattern is largely consistent for all locations monitored. Whilst site-specific contexts are important for understanding the variations, the resulting diurnal patterns are not unique to the different monitoring scenarios and locations observed elsewhere. The characteristic diurnal profiles can be partly traced to the atmospheric conditions that influence pollution decay or dispersion towards background levels. For instance, daytime conditions being characterized by turbulent conditions that lead to higher pollution dispersion rates, whereas nighttime conditions largely hinder pollution dispersion. The actual pollution levels can be attributed to the nature of activities within the areas monitored, such as traffic volumes and outdoor cooking in the evenings, among others. Nonetheless, the average diurnal concentrations for most of the locations monitored were above the 24-hour WHO recommended level of 25 μgm^{-3} and East African Air Quality Standards of 75μgm^{-3}.

(ii) Nitrogen Dioxide (NO2)

Nitrogen dioxide (NO2) arises as a result of combustion particularly of fuels, and in the presence of sunlight and other pollutants contributes to formation of ground level ozone. Scanty monitoring data is available on NO2 in the country, however, a study undertaken in 2014 within the GKMA indicated that levels of NO2 were generally below the WHO recommended limit of 40µg/m3 (annual), except for two locations within commercial areas in the central business district and one location along Jinja Road, which is a main transport corridor into the City (Figure 5.2.) (Kirenga et al., 2015). A subsequent study undertaken during the period December 2018 to May 2019, also indicated that the NO2 concentrations in commercial areas and along major roads were higher than the WHO recommend levels of 40µg/m3 (Mapping for Change - UK). The results reflected that NO2 concentration in 2018/2019 was above the levels observed in similar areas by Kirenga in 2014 (Figure 5.2).

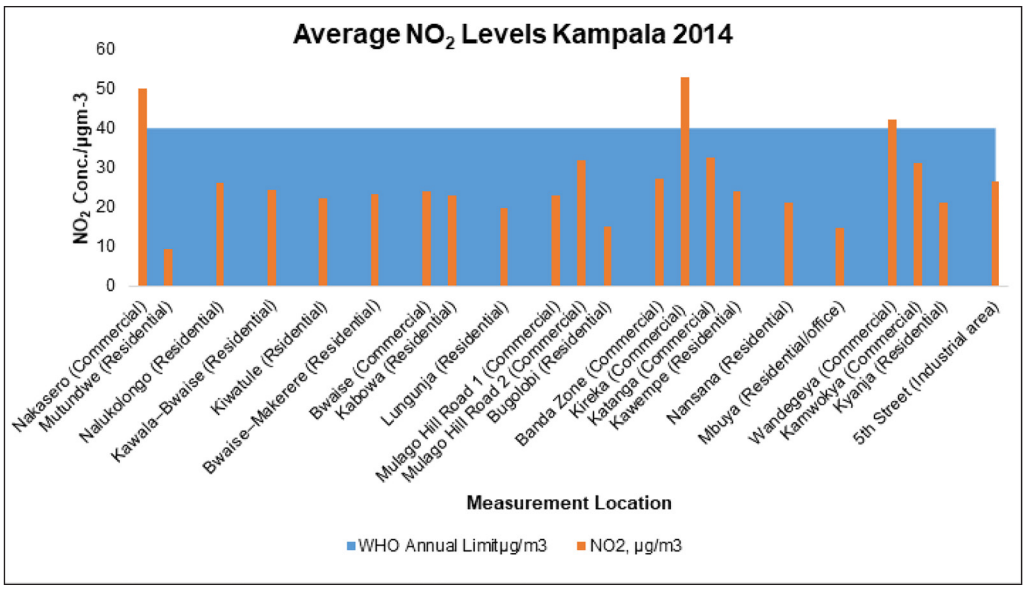


Figure 5.2: Average NO2 levels in GKMA in 2014 (Kirenga et al., 2015)

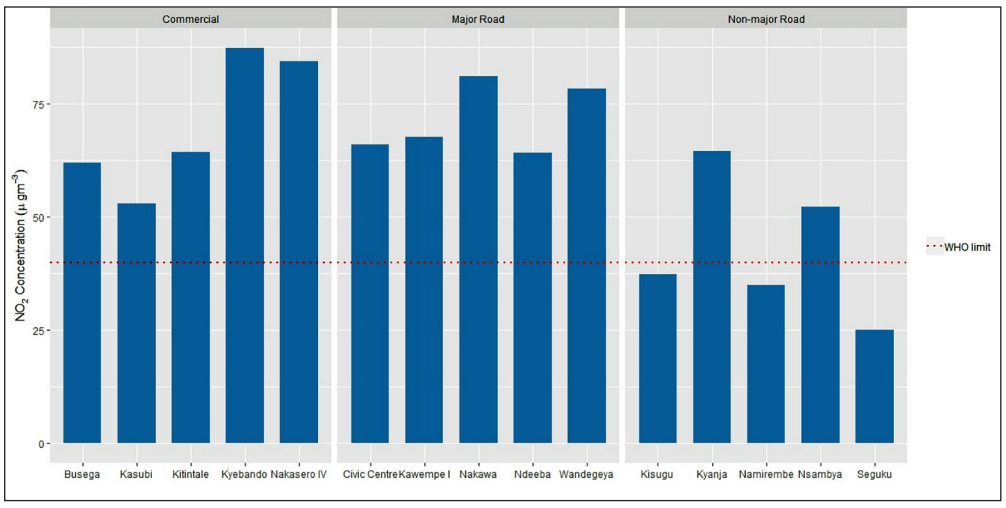


Figure 5.3: NO2 concentration in selected locations in GKMA, 2018/2019 (Mapping for Change -UK)

5.3. Air pollution pressures and impacts

There is very limited quantitative data on source emissions to inform sector-based pollution attribution. The available information from the data so far collected indicates that domestic energy use, the transportation sector, and increased urbanization are the likely air pollution drivers and pressures.

Transportation

The transportation sector plays a key role in socio-economic development by ensuring the mobility of the public, goods and services from one point to another, but transport-related air pollution is increasingly becoming a major concern globally due to the significant contributions to ambient pollution and Greenhouse Gas (GHGs) emissions. Transport-related air pollution in Uganda is a function of the vehicle fleet age (from a life-cycle assessment perspective), quality of vehicle maintenance, traffic management and the share between the use of public transport and private cars influenced by the status of public transport system.

Uganda imports large numbers of pre-owned vehicles and official records show vehicle population has been steadily increasing in the last 6 years (figure 5.4). Increased vehicle population contributes to sustained deterioration of air quality particularly where combustion efficiency and quality of fuel is low.

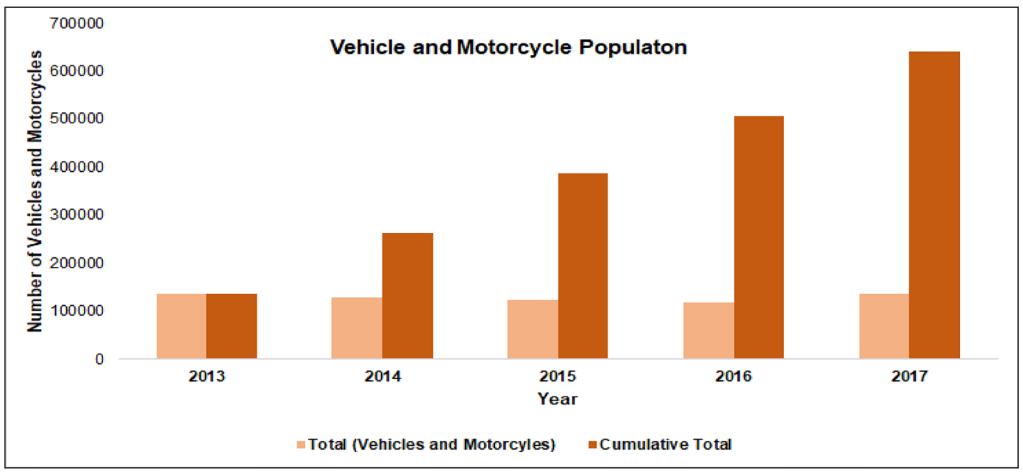


Figure 5.4: Automobile populations 2013 – 2017 (Source: UBOS, 2018)

Similarly, the status of national roads has affected the levels of surface road generated particulate, and this has been exacerbated by the share proportion of unpaved roads which stands at more than 70% of the national road network (Figure 5.5).

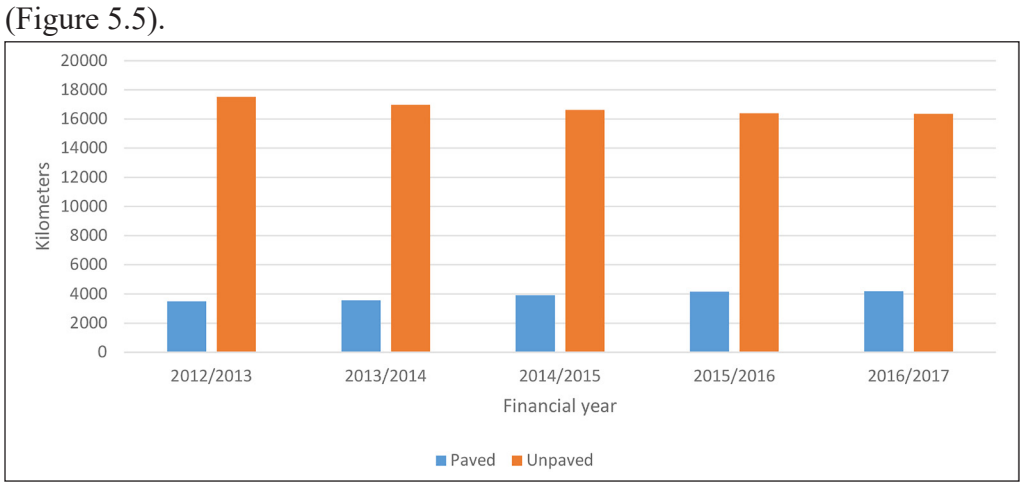


Figure 5.5: Proportion of paved and unpaved national roads (Source: UBOS, 2018)

Combustion Fuel

(a) Petroleum

Total imports of petroleum fuels have been gradually increasing reaching over 45% increase between 2013 and 2017 (Figure 5.6). At present, Uganda imports all petroleum fuels including Petrol (PMS), diesel (AGO). While import quantities of petroleum products is expected to reduce with the emergence of the upstream and midstream oil and gas sector, the activities of the sector could have significant implications on air quality both for public health and the sites of ecological importance within the Albertine Graben.

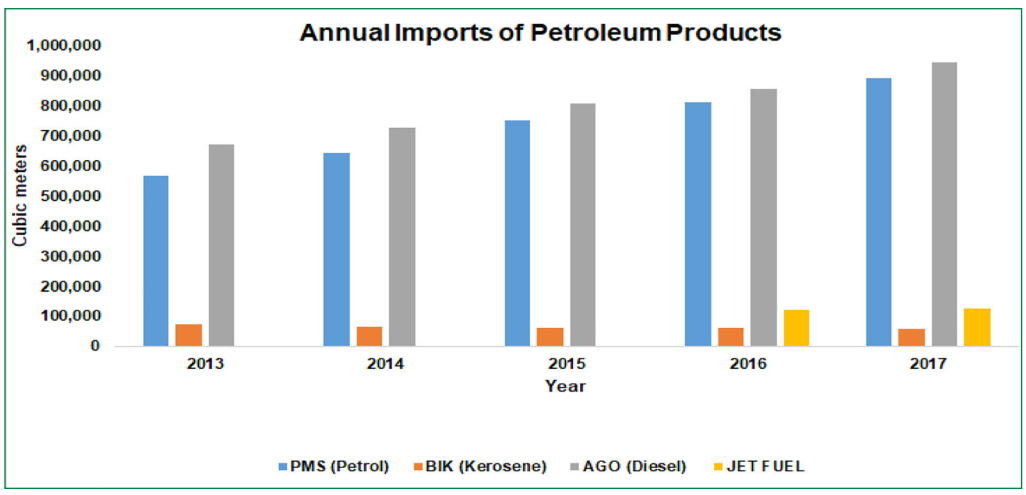


Figure 5.6: Annual imports of petroleum products (Source: UBOS, 2018)

Domestic energy

The domestic energy profile in Uganda comprises biomass, electricity, paraffin, and gas for cooking, lighting and thermal comfort. More than 95% of households in Uganda use biomass for cooking, combusted through open fires, traditional stoves, and charcoal stoves (Table 5.1). Combustive nature of domestic energy profile coupled with the housing situation can have a strong effect on the deterioration of both indoor and outdoor air quality. Depending on fuel composition, emissions could be a mixture of particulates and gases including CO, VOCs, PAHs and NOx.

Table 5.1: Domestic energy use by fuel type

Fuel type	Electricity	Gas	Parafin	Firewood & Charcoal	Total
Number of Households	152406	62446	81147	6947073	**7243072**
Percentage (%)	2.104162	0.86215	1.12034	95.91335	**100**

Source: (UBOS, 2015)

Industrialization

The industrial sector contributes about 21% of the country's GDP, with most industries hosted in urban areas and air quality deterioration in major towns has been partly a result of clustering and saturation of firms within urban centres which host more than 70% of Uganda's manufacturing sector (Lall et al., 2014; World Bank, 2016). Whilst there is no comprehensive data on pollution source apportionment at a national level, air pollution concerns have often been associated with metal manufacturing and processing industry, textiles and plastics manufacturing, agro-processing facilities, and construction activities.

Waste Management

Population growth is a key driver to waste generation in the country, and while municipal and city authorities are mandated to manage municipal waste, they are challenged with inadequate capacity to collect and appropriately dispose of all the wastes generated and limited waste management infrastructure in most parts of the country, subsequently, much of the waste generated remains un-collected. For instance, in Kampala Capital City, it is estimated that between 2011 and 2017, the annual waste volumes generated increased by 48% from (227,916 to 481,081 tons) corresponding to a 54% increase in population, and although waste collection efficiency increased from 30% in 2010 to 64% in 2017, only 45% of total waste generated in the City is collected by waste collection companies and KCCA (Aryampa, 2019, GGGI 2018). Significant quantities of uncollected waste is disposed of by indiscriminate dumping and open burning contributing to release of pollutants.

Waste management in industrial facilities is similarly a challenge, with most waste treatment and disposal infrastructure inefficient or lacking maintenance. Many industrial and health care waste incinerators are not designed to effectively handle the type of waste and ensure efficiency in burning, and lack proper emission control equipment. Sometimes, waste is disposed of by open burning (Plate 5.1).

Plate 5.1: Open burning of waste at an industrial facility

5.3.1 Air Quality and Health

Air pollution (ambient and indoor) exposure is ranked among the 24 leading risk factors for global mortality accounting for more than 7 million deaths annually (WHO, 2018; 2019). These mortality cases are more pronounced in low and middle-income countries. Previous studies have shown that there are more air pollution-related premature deaths in Africa than malnutrition or unsafe water with over 700,000 deaths compared to 275,000 and 542,000 from malnutrition and unsafe water, respectively (Roy, 2016).

In Uganda, although there is limited empirical evidence to link exposure to specific pollutants to pollution-related morbidity and mortality, air pollution was ranked as the fourth (4th) risk factor leading to death and disability in the country in 2017 (IHME). A study undertaken in Kampala and Nakaseke districts to assess the prevalence and risk factors for chronic respiratory diseases in urban and rural Uganda, concluded that although Chronic Obstructive Pulmonary Disease (COPD) was prevalent in both rural than urban areas in Uganda, it was significantly higher in rural than urban areas, while asthma was more prevalent in the urban area (Siddharthan, 2019). Living in a rural residence was identified as the most important risk factor for CODP which is probably associated with the nature of fuel used in the rural areas (fuel wood), while the urban environment was the most important risk factor for asthma.

In 2017/2018 no pneumonia (cough and cold) came second to malaria at 26.9% of all Out-Patient department attendances in the country, while pneumonia came 8th at 2.6% (MoH, 2018). The national records of reported air pollution-related illnesses reflect that no pneumonia (cough and cold) remains the most prevalent among such illness and could be indicative of the prevailing associated health burdens of deteriorating air quality (Figure 5.7).

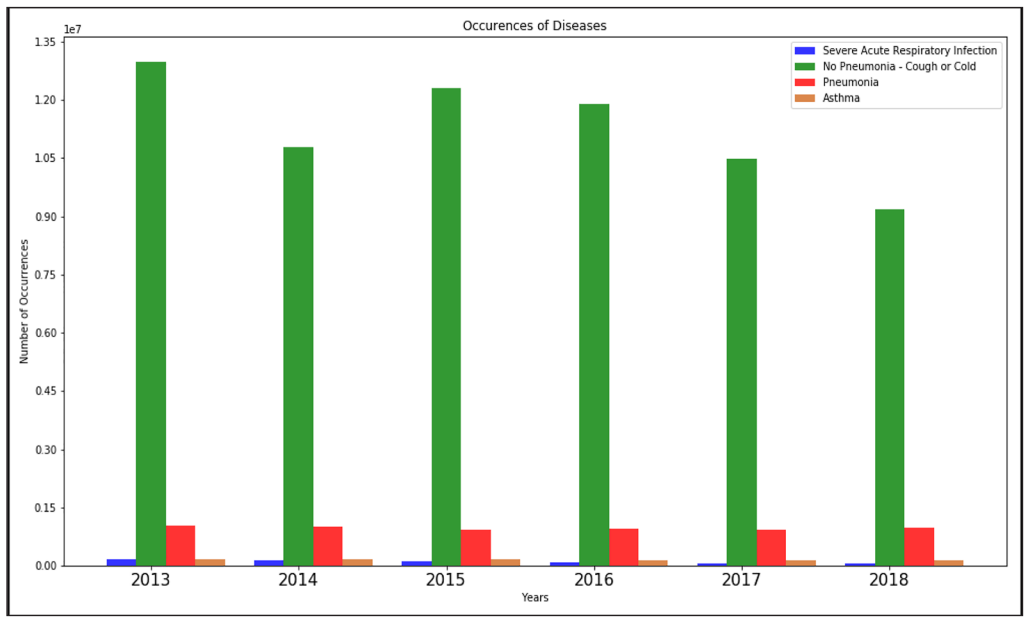


Figure 5.7: Reported cases of air pollution-related illnesses in Uganda 2013-2018 (Source: MoH database)

5.3.2 Air Quality and the Environment

Poor air quality has deleterious effects on living organisms and ecosystems, material property and can impair or interfere with amenities and other legitimate uses of the environment. Emissions can lead to acid precipitation that affects biodiversity, land resources and property. There is limited information available on the effects of poor air quality on the environment in the country, however, communities located near facilities such as cement manufacturing plants have often raised concerns about poor air quality. Similarly, areas within the neighbourhood of some industrial facilities have reported impacts on shelters such as rusting of iron sheets potentially arising from emissions from industrial facilities. Such cases need to be investigated comprehensively.

5.4 Policy and Action Response

Air quality monitoring

The country lacks comprehensive air quality monitoring networks to provide spatially representative information on air quality in the country. However, a preliminary air quality survey was conducted by the National Environment Management Authority in liaison with Kampala Capital City Authority and Mapping for Change, a research body in the United Kingdom. The survey involved deployment of passive samplers (diffusion tubes), and collation of secondary data from the various monitoring initiatives for indicative characterization of air pollution in the Greater Kampala Metropolitan Area. The results from the survey have been used to inform further initiatives to regulate emissions, monitor air quality in the country and set targets for improvement.

The National Environment Management Authority has procured both stationary and portable air quality monitoring equipment, to facilitate monitoring of critical air pollutants including, particulate matter, nitrogen dioxide, ozone and Volatile Organic Pollutants. Kampala Capital City Authority is in the process of operationalizing the Kampala Air Quality programme under the climate change strategy project. Subsequently, potential monitoring sites have been identified and 25 air quality monitors have been installed to measure PM2.5 and PM10 and NO2.

Targets to improve air quality in the country have been set in the National Development Plan III (NDP III) 2020-2025, particularly for urban ambient air quality. The indicators are as provided in Table 5.2.

Table 5.2: Air quality Targets 2020-2025

	Parameter	Current position	Air quality target 2025
Air pollution index Kampala (ambient air)	PM2.5	65µg/m³- hourly mean	40 µg/m³ hourly mean
	PM10	80µg/m³ hourly mean	50 µg/m³ hourly mean
	NO2	75µg/m³ hourly mean	40 µg/m³ annual mean
	SO2	(no previous data)	20 µg/m³ hourly mean
	O3	(no previous data)	12.5 µg/m³ hourly mean

Development of standards and regulations

The government of Uganda acknowledges the need to develop air quality regulations. Currently, reference is made to the World Health Organization Air Quality Guidelines and the East African Standard - Air Quality Specification (EAS 75:2010) to regulate air emissions and monitor ambient air quality. However, while these standards provide guidance for critical air pollutants, they may not comprehensively address all relevant pollutants and reflect the situation in the country. Other regulatory frameworks include, the Traffic and road Safety Act that provides for the control of emissions from motor vehicles and the government also introduced an age limit of not more than 15 years from the date of manufacture for reconditioned vehicles imported into the country. It should be noted however, that taxes on older vehicles still remain higher, which is a deterrent factor to the purchase of more efficient vehicles. The national air quality regulations and standards are under development and NEMA has assisted some municipalities to develop ordinances and bylaws that can encourage reduction of emissions for instance, by ensuring proper waste management practices as opposed to waste burning.

Reducing potential sources of emissions from transportation

Urban and Municipal councils are implementing actions to improve the coverage of tarmacked road networks within the urban councils to reduce on particulate matter emissions. This is partly with support from the World Bank through the Uganda Support to Municipal Infrastructure Development Program (USMID). Kampala Capital City Authority has planned strategic interventions to re-design the transportation systems within the City, including construction of non-motorized streets and pedestrian walkways within the city center to reduce traffic congestion and encouraging mass transport, among others. The primary objective of the redesign of Namirembe Road and Luwum Street in the City centre to create a 1.95km Non-Motorised Transport Corridor (NMT) is to improve safety of road users but will also contribute to decongesting these parts of the City from vehicular traffic.

Reducing potential sources of emissions from transportation

The Authority and other regulatory bodies working with the Uganda Cleaner Production Center, have provided compliance assistance to the regulated community to address air emissions. Cement factories in particular have been able to implement cleaner production practices, recovering up to 80-90% of material that was originally lost through emissions to air. Similarly, industry is required to install air emission control equipment and to regularly monitor emissions against the East African Air Quality Standards.

Research and Innovation

Makerere University is undertaking research on air quality tackling both air quality monitoring and its impacts on health. Specifically, the Lung Institute is undertaking research on the effect of air pollution on health, whereas AirQo research initiative under the Makerere University College of Computing and Information Science is developing and deploying low-cost air quality monitors installed in different urban areas in Uganda to collect real-time data on air quality. Highlights of each of the research initiatives are presented. The East African GeoHealth Hub, a Research and Capacity building program under the School of Public Health, focuses on air pollution, and child health, occupational health and climate change and has been implemented since 2017.

Air quality awareness

Air quality awareness initiatives have been undertaken by the National Environment Management Authority, Makerere University School of Public Health and the College of Computer Sciences, among others to raise awareness of the public about the status of air quality within the country using available data and associated impacts.

5.5 Recommendations

There are limited networks in place to facilitate air quality monitoring in the country. However, the few studies undertaken reflect an increase in potential sources of pollution, decline in air pollution over time, and notable occurrences of the disease burden arising from air-pollution related illness. Key interventions should include both short- and long-term interventions including:

Short term:

- ❍ The on-going work to develop air quality regulations should be expedited. The national air quality regulations need to be enacted and operationalized as they will provide standards that align to the needs of the country.
- ❍ Develop a comprehensive air quality monitoring network to inform policy and other interventions to address air quality and monitor progress. This should include, equipment and strengthening institutional capacity for air quality monitoring through the provision of financial resources and capacity building of technical staff to conduct monitoring and analysis of air quality data. There is need for robust air quality monitoring within key hotspots such as the urban centres, major transport corridors and the Albertine Graben were key petroleum developments will take place.

Mid- and longterm interventions:

- ❍ Development of a national air quality management plan and strategy to provide a clear framework to support the implementation of air quality regulations and raise awareness of the key country targets to improve air quality. The strategy will set national air quality objectives, targets and financial requirements to achieve set objectives, provide a cost-benefit analysis of the best interventions, identify monitoring and research needed to further understand sources of air pollution, and public awareness mechanisms and information to enable public participation.

Sectoral interventions:

Improving air quality in the country will require multi-pronged approach as there are several contributing factors. Sector-specific actions that need to be undertaken to complement and operationalize policy and regulatory frameworks in place include:

Transport

- ❍ Increase percentage coverage of paved roads to reduce particulate matter pollution from suspended loose particles.
- ❍ Improve traffic management systems to reduce congestion by utilizing traffic lights, to reduce air pollution as a result of congestion.
- ❍ Enact and enforce comprehensive regulations on vehicle emissions standards.
- ❍ Develop and implement incentives to promote use of more efficient vehicles and improve engine efficiency.
- ❍ Increase the share of low carbon efficient transport like bus rapid transit systems, passenger train transport.
- ❍ Increase share of non-motorized transport to promote walking and cycling in urban centres and cities.

Urbanization

- ❍ Development of integrated national and local development plans that take into account the inter-relation among industrial, commercial and residential land use, to minimize pollution concentrations and exposure of the populace; improved public transport; open and green spaces; incorporating services in communities to reduce movement, among others.
- ❍ Regulating land use activities that can be accepted in different areas taking into account the national air quality regulation and strategy. This can be achieved through zoning to designate acceptable land uses like commercial, residential, industrial, transport and transportation/utility routes. Bring services closer to people to reduce movements.
- ❍ Promote the 3Rs (Reduce, Reuse and Recycle) for waste management by providing incentives and implementing the legal frameworks available, increase waste collection efforts particularly in urban areas and cities to reduce waste burning.

Energy

- ❍ Promoting the use of improved cookstoves to reduce the use of biomass energy and open stone fire cooking. Improve access to electricity, liquefied pressured gas through reducing costs to improve affordability.
- ❍ Promote and increase access to clean energy to reduce reliance on 'dirty fuels' e.g. biomass and kerosene.

Industry

- ❍ Provide an enabling environment and enforce legal requirements for air pollution control within industrial facilities.
- ❍ Promote and provide an enabling environment for self-regulation and reporting. For instance, (Pollutant Release and Transfer Register – PRTR) for on-line reporting on emissions, compliance monitoring, feedback and public accountability.

Research and Development

- ❍ Promote linkages between industry, academia, regulatory agencies and policy makers to inform policy and innovation in air pollution control and air quality monitoring.
- ❍ Increase resource allocation towards research on air quality in Uganda focusing on monitoring, and health impacts to inform action planning.

Bibliography

CCD, Ministry of Water & Environment, Objective and Functions (2019). Available from: http://ccd.go.ug/about-us/

Institute of Health Metrics website, accessed http://www.healthdata.org/uganda on 21st August 2020

KCCA (2019). Development of the Kampala ambient air quality monitoring system: Preliminary air quality baseline.

Kirenga, B.J., Meng, Q., Van Gemert, F., Aanyu-Tukamuhebwa, H., Chavannes, N., Katamba, A., Obai, G., Molen, T.V.D., Schwander, S. and Mohsenin, V. (2015). The state of ambient air quality in two Ugandan cities: a pilot cross-sectional spatial assessment. International journal of environmental research and public health, 12(7), pp.8075-8091.

Lall, Somik V., Schroeder E., Schmidt E. (2014). "Identifying spatial efficiency– equity trade-offs in territorial development policies: Evidence from Uganda." The Journal of Development Studies 50.12 (2014): 1717-1733.

Larsson, M.L. (2009). Legal definitions of the environment and of environmental damage. Available at: http://www.scandinavianlaw.se/pdf/38-7.pdf

Mage, D., Ozolins, G., Peterson, P., Webster, A., Orthofer, R., Vandeweerd, V. and Gwynne, M. (1996). Urban air pollution in megacities of the world. Atmospheric Environment, 30(5), pp.681-686.

MGLSD, Directorate of Labour, Employment, Occupational Safety and Health (2019b). Available from. http://www.mglsd.go.ug/directorates/directorate-of-labour-employment-occupational-safety-and-health.html

Ministry of Finance, Planning and Economic Development (2019). Retrieved from: https://www.finance.go.ug/mofped/our-mandate

Ministry of Health, 2018 Annual Health Sector Performance Report Financial Year 2017/2018

Ministry of Health Uganda (2019). Retrieved from: http://health.go.ug/about-us/ about-ministry-health

Ministry of Lands, Housing and Urban Development (2019). [Online]. Available at. https://mlhud.go.ug/about-us/ (Accessed 10 June 2019)

MTIC, Mandate. Available from: http://www.mtic.go.ug/index.php?option=com_ content&view=article&id=13&Itemid=126

MWE, About the Ministry (2019). Available from: https://www.mwe.go.ug/mwe/ about-ministry

NEMA, NEMA Uganda Objectives, Available from: https://www.nema.go.ug/aboutus/nema-uganda

Mapping for Change – UK, NEMA, KCCA, Monitoring Nitrogen Dioxide in the Greater Kampala Metropolitan Area. unpublished

Penner, J.E., Chuang, C.C. and Grant, K. (1998). Climate forcing by carbonaceous and sulfate aerosols. Climate Dynamics, 14(12), pp.839-851.

Ramanathan, V. and Feng, Y. (2009). Air pollution, greenhouse gases and climate change: Global and regional perspectives. Atmospheric Environment, 43(1), pp.37-50.

Review Report on Uganda's Readiness for the Implementation of Agenda 2030, United Nations Voluntary National Review 2016, retrieved on 27/1/2019, Available from https://sustainabledevelopment.un.org/memberstates/uganda

Rotstayn, L.D. and Lohmann, U. (2002). Tropical rainfall trends and the indirect aerosol effect. Journal of Climate, 15(15), pp.2103-2116.

Roy, R. (2016). The cost of air pollution in Africa. [Online]. Available at: https://www.oecd-ilibrary.org/content/paper/5jlqzq77x6f8-en (accessed 20 Sept. 2019)

Shamim Aryampa, Basant Maheshwari, Elly Sabiiti, Najib L Bateganya, and Brian Bukenya, 2019. Status of Waste Management in the East African Cities: Understanding the Drivers of Waste Generation, Collection and Disposal and Their Impacts on Kampala City's Sustainability. Published in Sustainability Journal, 6 October 2019.

Tilenga Project Environmental and Social Impact Assessment (ESIA). [Online]. Available at: https://www.nema.go.ug/media/esia-report-tilenga-project- available-public-review-and-comments (Accessed 20 April 2019)

Trishul Siddharthan, Brooks Morgan, Matthew R Grigsby, Robert Kalyesubula, 2019. Prevalence of chromic respiratory disease in urban and rural Uganda. Article in the Bulletin of the World Health Organization – May 2019. Accessed on 24th August 2020.

UBOS Act of 1998. Available from: https://www.ubos.org/about-us/vision-and-mission/

UBOS, Census of Business Establishment (COBE) 2010/2011, 2011. Available from: https://www.ubos.org/publications/statistical/20/

Uganda Bureau of Statistics (UBOS), Statistical Abstract (2018). Available at:https://www.ubos.org/wp-content/uploads/publications/05_2019STATISTICAL_ABSTRACT_2018.pdf

Uganda Bureau of Statistics, 2018. 2018 Statistical Abstract

UNBS, Background. Available from: https://www.unbs.go.ug/content.php?src=background&pg=content

US EPA, 'Criteria Air Pollutants | US EPA' (US EPA, 2018). Accessed from: https://www.epa.gov/criteria-air-pollutants

US EPA (2014). Air Quality Index-A Guide to Air Quality and Your Health. Available from: https://www.airnow.gov/index.cfm?action=aqibasics.aqi

Watson, J.G. and Chow, J.C. (2002). A wintertime PM2.5 episode at the Fresno, CA, supersite. Atmospheric Environment, 36(3), pp.465-475.

WHO, Ambient Air Pollution: Health Impacts (2019). Available from: https://www.who.int/airpollution/ambient/health-impacts/en/

WHO (2005). Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. [Online]. Available at https://www.who.int/ health-topics/air-pollution (Accessed 13 Oct 2018)

WHO, 'Global Health Observatory (GHO) data: Ambient air pollution' (2018). [online]. Available at: http://www.who.int/gho/phe/outdoor_air_pollution/en/ Accessed 18 Sept. 2018

WHO, 'Global Urban Ambient Air Pollution Database (Update 2016)', (World Health Organization, 2018) Available at http://www.who.int/phe/ health_topics/outdoorair/databases/cities/en/ Accessed 10 September 2018.

WHO, 'Urbanization and health' (2018). [online] Available at: http://www.who.int/bulletin/volumes/88/4/10-010410/en/ [Accessed 10 Sept. 2018].

World Bank, Access to Electricity (% of Population), 2019. Available from: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS

World Bank, Uganda Economic Update. 'From Smart Budgets to Smart Returns: Unleashing the Power of Public Investment Management'. 2016

Zhao, X., Zhang, X., Xu, X., Xu, J., Meng, W. and Pu, W. (2009). Seasonal and diurnal variations of ambient PM2. 5 concentration in urban and rural environments in Beijing. Atmospheric Environment, 43(18), pp.2893-2900.

Zhu, Y., Kuhn, T., Mayo, P. and Hinds, W.C. (2006). Comparison of daytime and nighttime concentration profiles and size distributions of ultrafine particles near a major highway. Environmental science & technology, 40(8), pp.2531-2536.

Chapter 6: Water quality

6.1. Introduction

Uganda has approximately 18 percent of its land surface covered by water, which includes lakes, rivers and the rest are wetland resources which are threatened as a result of various human activities and interference. These threats include; wetland encroachment, pollution from point and non-point sources which have an eventual impact on the quality of water in an area. Water quality is an important part of environment which affects not only the aquatic life but also the surrounding ecosystem. The quality of water therefore directly affects the health of the people, animals and plants that drink or otherwise utilize the water. When water quality is compromised, its usage puts users at risk of developing health complications. The environment also suffers when the quality of water is low. There are different uses of water which include domestic use, irrigation, industrial use, and ecosystem sustenance that demand specific water quality characteristics. Thus, adequate water resources management is key for improved quality and quantity.

In assessing the state of environment and water quality in Uganda it is important to consider the status/trends of water quality across the water bodies and the existing pressure and environmental impacts. Furthermore there is need to establish policy responses to address the environmental impacts that are caused by abuse of water quality especially through human activities.

This chapter hence focuses on water quality of selected water resources pointing out the current status and trends, pressures and impacts, responses and singling out case studies on water pollution as a threat in selected regions of the country. The chapter also highlights some key concerns of water demand with bias on emerging issues of the currently developing oil and gas sector and the threatened Rwizi catchment.

6.2. Water quality Status and trends

6.2.1. Lakes

Monitoring of water resources is conducted to determine the changes in the water quality of the various water sources over a given period of time. Observing the changes in the quality of a water body is very important since it provides information where there are major changes in the quality of a water body for appropriate actions to be taken. The status of the water quality of a given water body is assessed using a number of parameters which include chemical, biological, physical-chemical and radiological. The MWE as a lead Agency responsible for monitoring the quality of water resources across the country has a number of water quality monitoring stations situated in various places around the country which include surface water, effluent, ground and operational water. The information which is generated from the various monitoring exercises is used by the relevant institutions to address the variations from the norm. Figure 6.1 hence reflects the water quality monitoring networks across Uganda and the sections below present some of the results from water quality monitoring.

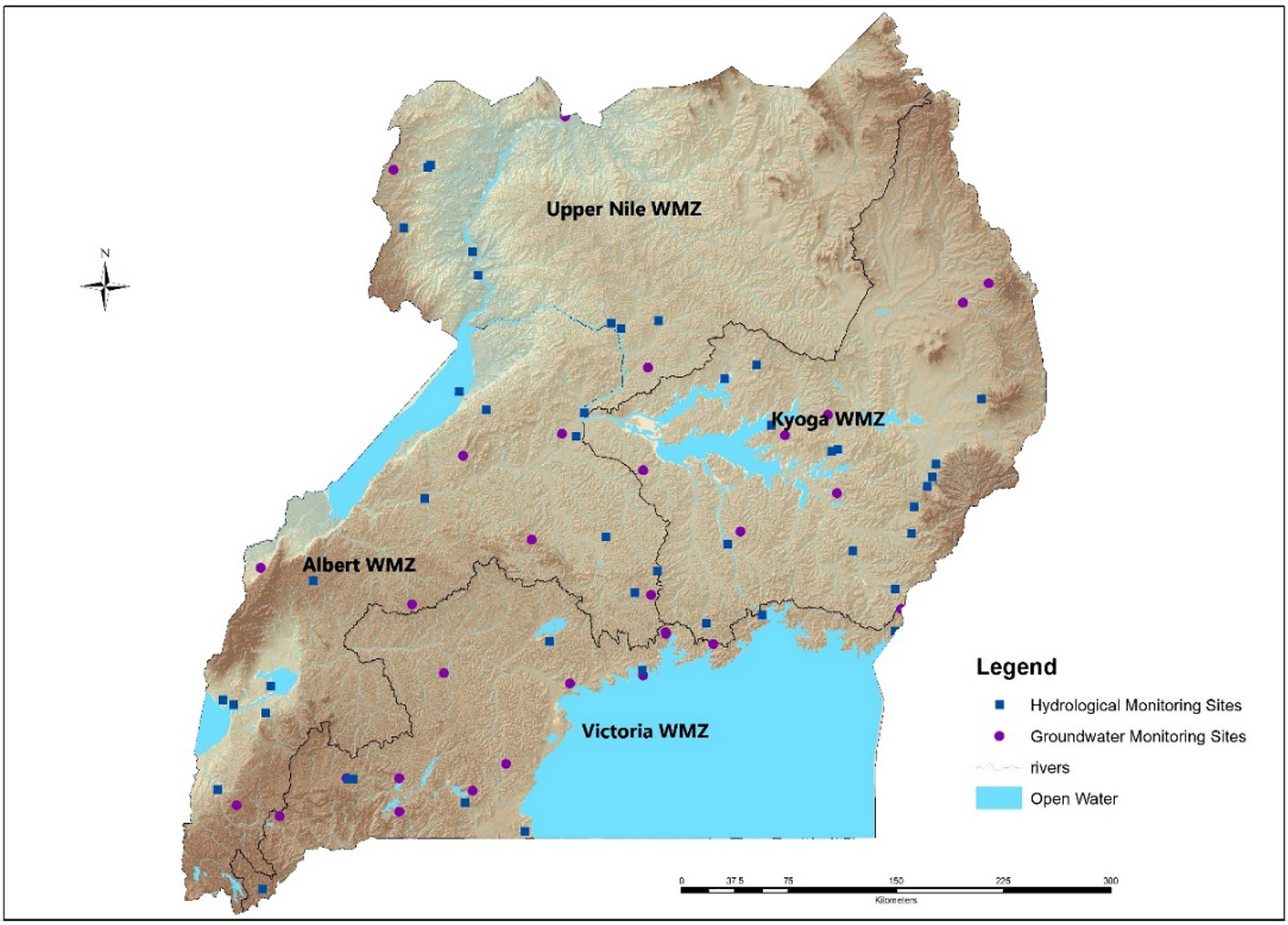


Figure 6.1: Active water monitoring stations for 2017 and 2018. Source: (MWE, 2017)

(i) pH and Electrical conductivity

Generally, the data collected from routine monitoring of the major lakes in 2018 indicated that the water bodies have different water quality characteristics in terms of the electrical conductivity of the water and pH (Graphs in Figure 6.2 and 6.3) indicate results from water quality monitoring of selected lakes and rivers.

(ii) Electrical conductivity

Lake Victoria had the lowest conductivity while Lake Albert had the highest. Conductivity is a measure of water's capability to pass electrical flow. This ability is directly related to the concentration of ions in the water which are mainly salts and other electrolytes.

Lake George had a pH below 6 which was the lowest while Lake Albert had the highest pH. pH is the measure of acidity or alkalinity of water, thus water with low pH may be corrosive and unfit for human consumption.

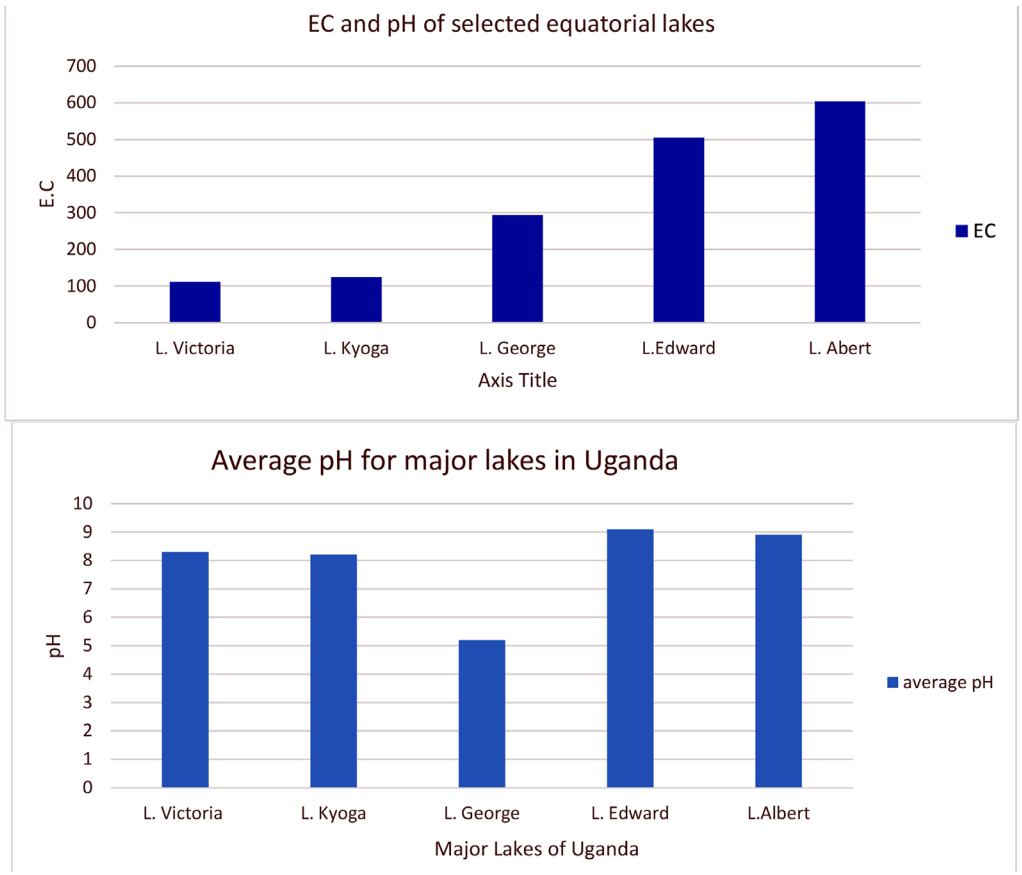


Figure 6.2: Averaged EC and pH Values from quarterly monitoring of the year 2018 for selected lakes. Source: DWRM, 2018

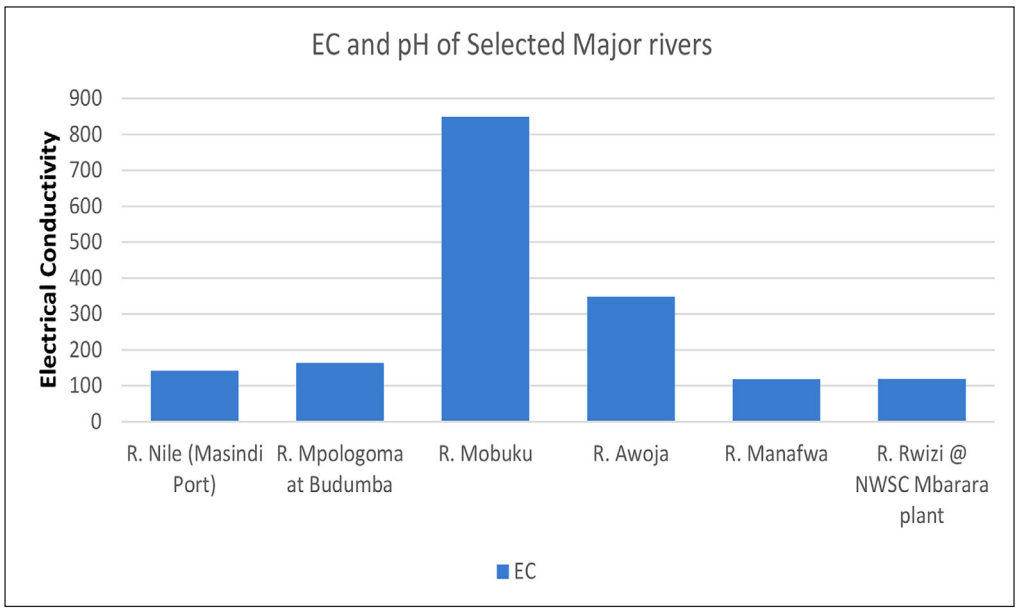
6.2.2. Water quality of the major Rivers of Uganda

pH

Figure 6.3 below demonstrates the concentration of conductivity and pH in selected major rivers. The data obtained during the quarterly monitoring of the water quality for the various major rivers indicated that River Mobuku had the highest pH while River Rwizi had the lowest. The high pH levels recorded by river Mobuku could be attributed to the geological chemical formation of the area (Mwesigye et al., 2016.

Electrical Conductivity (EC)

Quarterly monitoring data for the various major rivers in Uganda showed high EC for River Mubuku while River Manafwa recorded the lowest. The geological formation of the area could be responsible for the high ion concentration in the water while the vegetation and decomposing organic matter (peat) could be responsible for the low pH in River Manafwa.



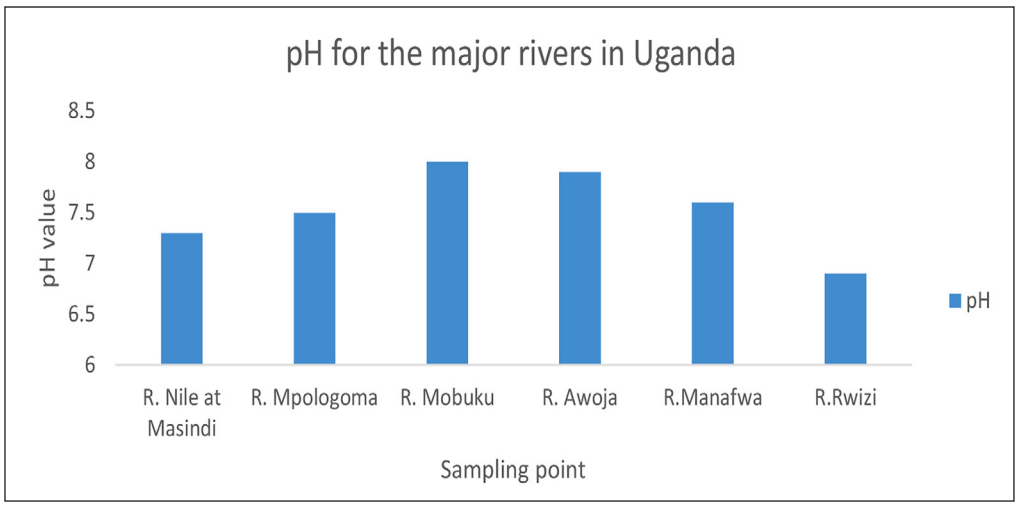


Figure 6.3: Averaged EC and pH Values from quarterly monitoring of the year 2018 for selected major rivers. Source: DWRM, 2018

Water quality of Lake Victoria

The charts below summarizes the water quality trends for selected points in Lake Victoria for the period between November 2016 and December 2018. pH, Conductivity and Dissolved oxygen (DO) were analyzed for the two seasons as mentioned above. As a general observation from the data collected and presented in the charts below, it was noted that pH and electrical conductivity for the year 2016 were higher than that of 2018. However, for dissolved oxygen, concentrations in the various points of the lake showed high dissolved oxygen levels of DO in 2016 than there was in 2018. Dissolved oxygen is necessary to many forms of life including fish, invertebrates, bacteria and plants. These organisms use oxygen in respiration, similar to organisms on land. Fish and crustaceans obtain oxygen for respiration through their gills, while plant life and phytoplankton require dissolved oxygen for respiration when there is no light for photosynthesis. The amount of dissolved oxygen needed varies from creature to creature. Bottom feeders such as crabs, and worms need minimal amounts of oxygen (1-6 milligrams per Litre of water or 1-6 mg/L), while shallow water fish need higher levels (4-15 mg/L).

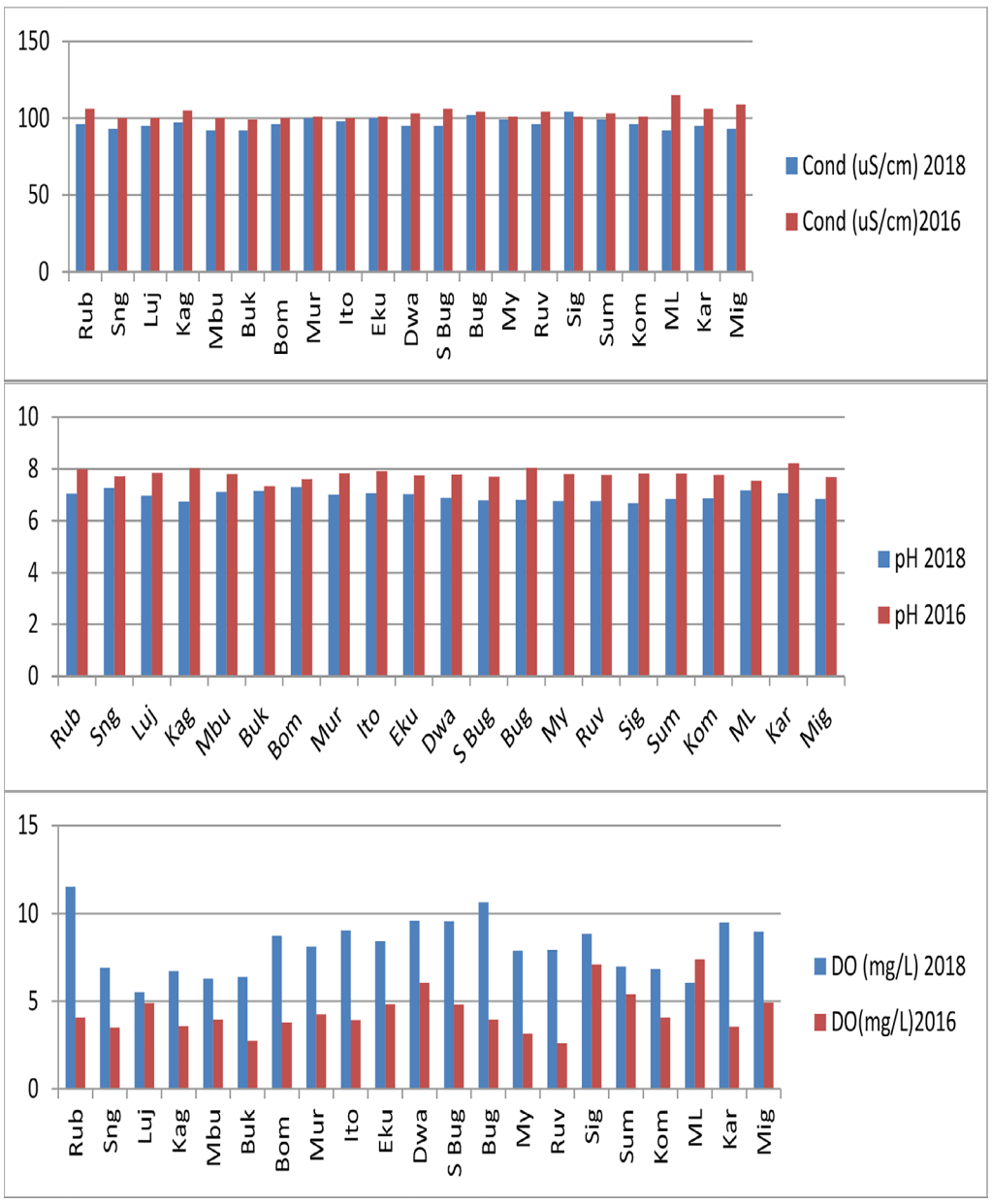


Figure 6.4: Averaged EC, pH and DO for selected point on L-Victoria for year 2016 and 2018. Source: NaFIRRI, 2018

Key											
Station name	Rubafu Bay	Sango Bay	Lujabwa	Kagegi Gulf	Mbugwe Island	Mid Lake/ SW Bukasa	Bomangi Bay	Murchison Bay	Itome Bay	Ekunu Bay	West Dwaji
Name ID	Rub	Sng	Luj	Kag	Mbu	Buk	Bom	Mur	Ito	Eku	Dwa
Station name	South Bugayi	Bugaiya	Off Mayu	Ruvia Island	Off Sigulu	Off Sumba Island	Off Komogwe	Mid Lake 2	Off Karung	Off Migingo	
Name ID	S Bug	Bug	My	Ruv	Sig	Sum	Kom	ML	Kar	Mig	

6.3. Pressures and impacts

6.3.1. Pollution threat on River Rwizi Catchment

River Rwizi catchment currently covers an estimated area of 8200km2 spanning over twelve districts namely; Buhweju, Bushenyi, Sheema, Ntungamo, Mbarara, Isingiro, Kiruhura, Lyantonde, Lwengo, Rakai,Kyotera and Rwampara.

The abuse of the river has been widely manifested in middle catchment especially in Mbarara municipality. This is attributed to the population pressure, urbanisation, and industrialisation among others. The growth in population has led to the increased demand for agricultural land and infrastructure development, and this has impacted on the river through reclamation of the river riparian wetlands for subsistence agriculture. Destroying wetlands undermines their role of water filtration and storage among others, other sources of pollution include improper waste disposal practices, sand mining along the river banks, as well as brick laying around the buffer zone area thus, and runoff loaded with pollutants and sediments runs directly to the receiving river Rwizi

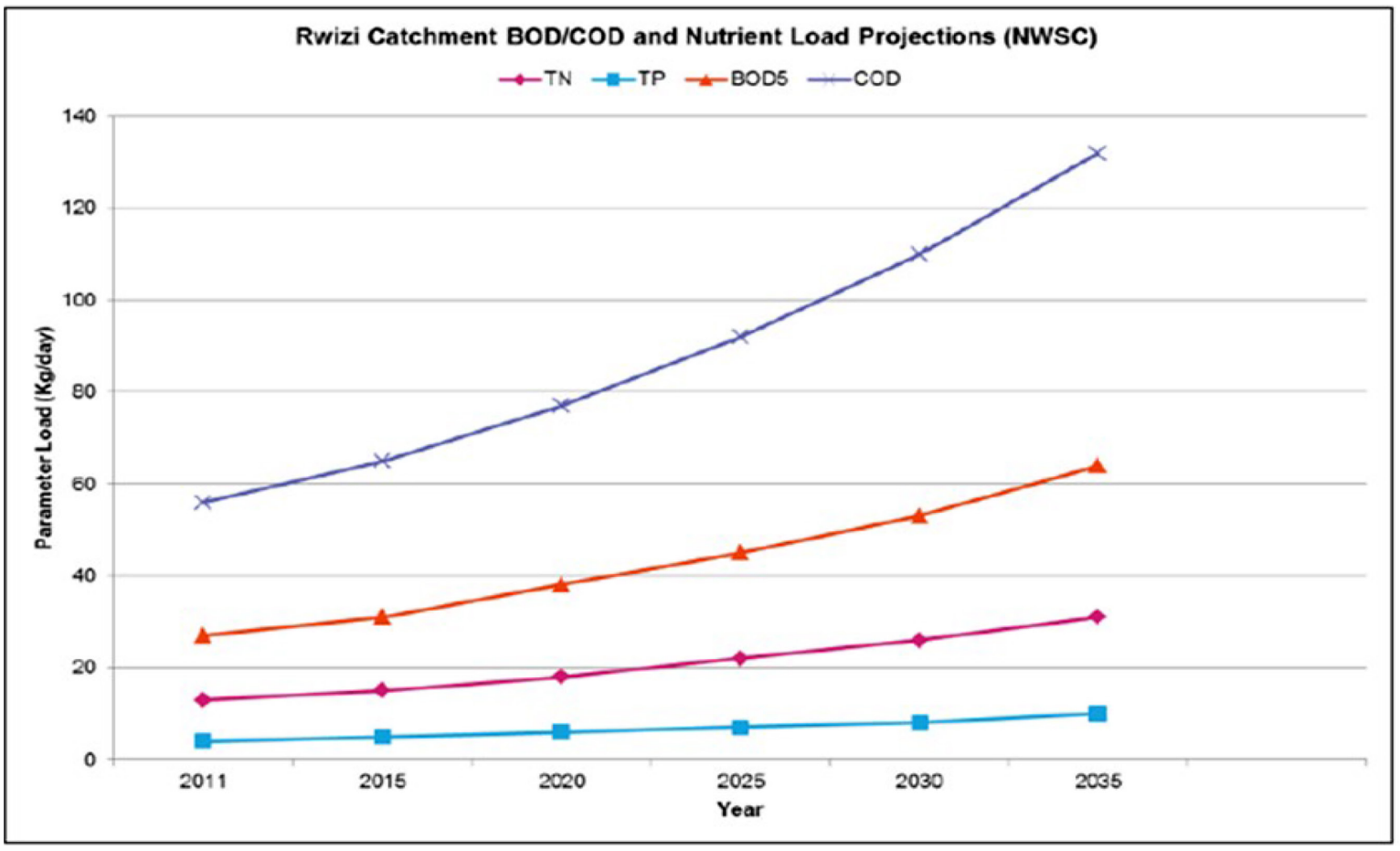


Figure 6.5: Nutrient load projections of River Rwizi. Source: (Data obtained from NWSC monitoring 2018)

The figure indicates that the Pollution loads in River Rwizi are expected to continue growing if no intervention is undertaken. The graph shows the projected gradual increase in the concentration of BOD and COD which represents concentration of organic matter in the water. Other parameters plotted on the graph include TP and TN which represent the projected gradual increase of nutrient concentration in the water.

The main source of pollution to the river is due to increasing industrial and domestic wastewater discharges as well as from surface water runoff from agricultural land and urban areas.

The high levels of pollution in the river has led to increasing nutrient loads which in turn has led to the flourishing of invasive species such as the water hyacinth, *Eichhorniacrassips*. This has escalated in the last two years and currently covers the entire midstream sections of the river.

Plate 6.1: Water hyacinth (Eichhorniacrassips) mat in Mbarara Municipality section of the river in November 2019

The projected water demand for the Rwizi catchment as demonstrated in Figure 6.6 may not be met if River Rwizi which is the major source of water in the catchment is polluted and destroyed. Already there are signs of decreasing water in the river as demonstrated in Fig.6.2 yet the river is threatened to pollution.

Plate 6.2: Evidence of river recession as seen by the exposure of the previously sub-merged measuring staff gauge pillars and the brown color of the river point to a water risk

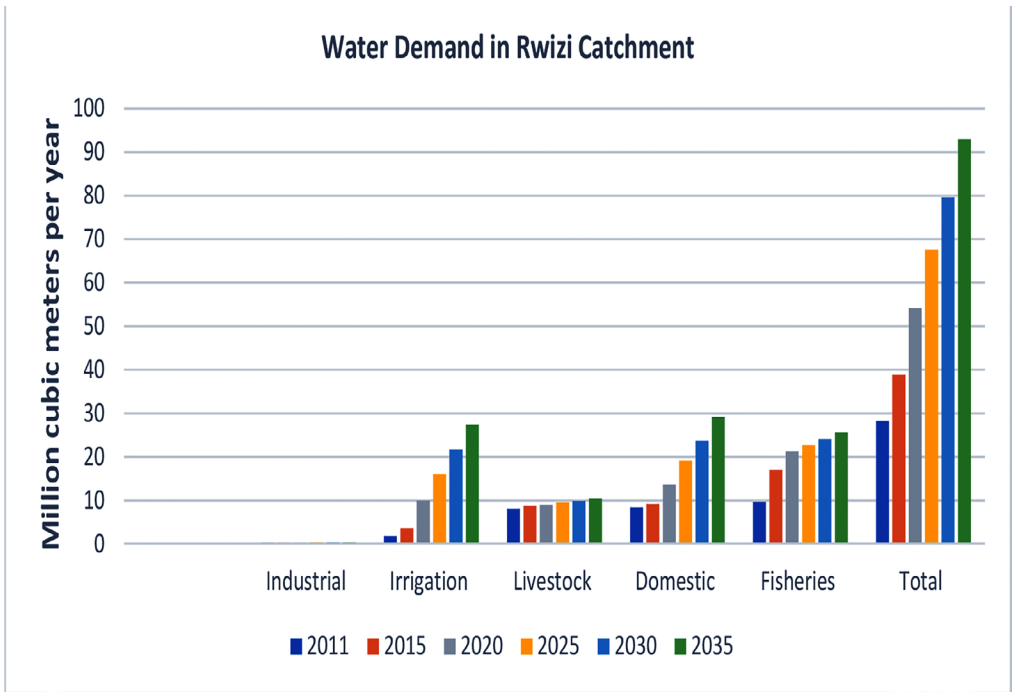


Figure 6.6: Total consumptive water demand by different sectors for Rwizi catchment. Source: (DWRM, 2016)

From the graph, it is projected that the total water demand in the catchment will increase steadily throughout the years to 2035. The total consumptive water use projections for Rwizi catchment is about 39MCM. The total water supply is expected to rise from about 39MCM in 2016 to an estimated 92.90 MCM/ year in 2040. Figure 6.6 provides sectorial breakdown of this projection. Crop irrigation is projected to become even more dominant in future, when plans for new irrigation projects are implemented while water for industrial consumption represents the lowest projected demand over the years.

6.3.2. Pollution threat on River Nyamwamba catchment

Kilembe Mines is a copper and cobalt mine in Uganda located in Bulembia division, Kasese Municipality Kasese district. The mine lies in the valley between River Nyamwamba and Nyarusenghe stream. River Nyamwamba discharges its water into Lake George. The mine is located on the foot hills of Rwenzori Mountains in western Uganda. Tibet Hima mining company obtained a lease in 2013 to operate this mine. However, in 2016, the government of Uganda decided to suspend the activities of Tibet Hima Mining Company Ltd due to failure to adhere to the agreement as previously negotiated. These operations have left a number of environmental challenges to the area, one of which is pollution emanating from the mining activities.

Environmental pollution by Kilembe Mines Stock Piles and the mine water could cause elevated levels of heavy metals in the different components of the environment in the area. A rapid assessment carried out by NEMA and the key lead agencies in January 2018 evaluated the impact of Kilembe Mines on the environment around Kasese area. Focus was mainly on heavy metal pollution into R-Nyamwamba and its catchment areas as a result of the mining activities in Kilembe and the degradation of landfills (tailings and unprocessed ore stockpiles) by floods, enhanced by human activities that have opened up previously covered tailing stockpiles for gardening, road construction and playground areas.

Plate 6.3: Colored water oozing out of the mines.

Plate 6.4: Unprocessed ore piles at Kilembe

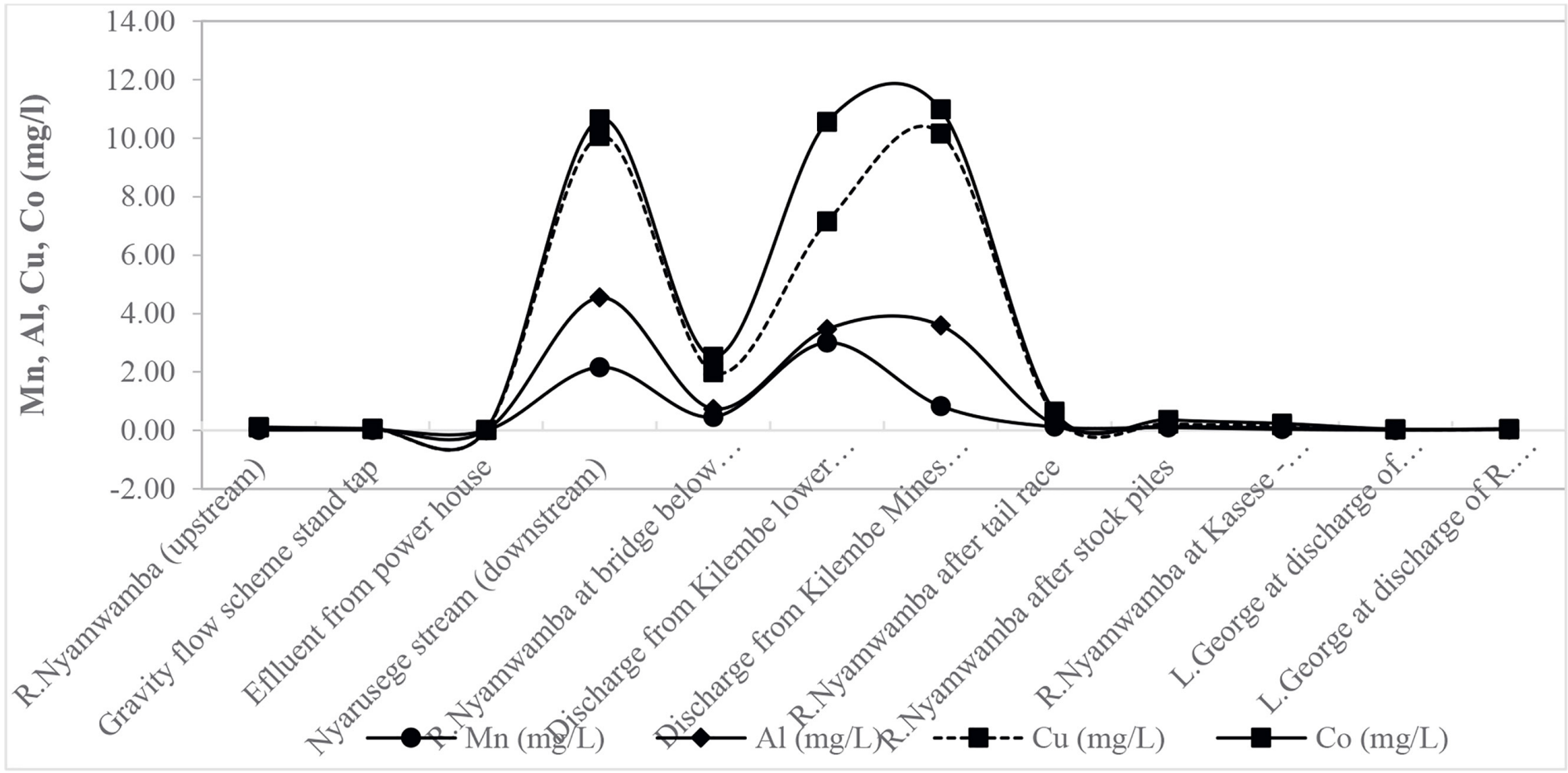


Figure 6.7: Summary of results for heavy metals from upstream to downstream Nyamwamba River.

From the rapid assessment, it was realized that the Kilembe mining area adds Cu to Nyarusenghe stream which consequently pollutes Nyamwamba River. The water in the section of Nyarusenghe stream considered under this study is polluted by Cu and Fe. The results show that there is no heavy metal contamination in Lake George and this is attributed to the natural filtration from the wetlands before R. Nyamwamba discharges into Lake George and this wetland requires continued protection.

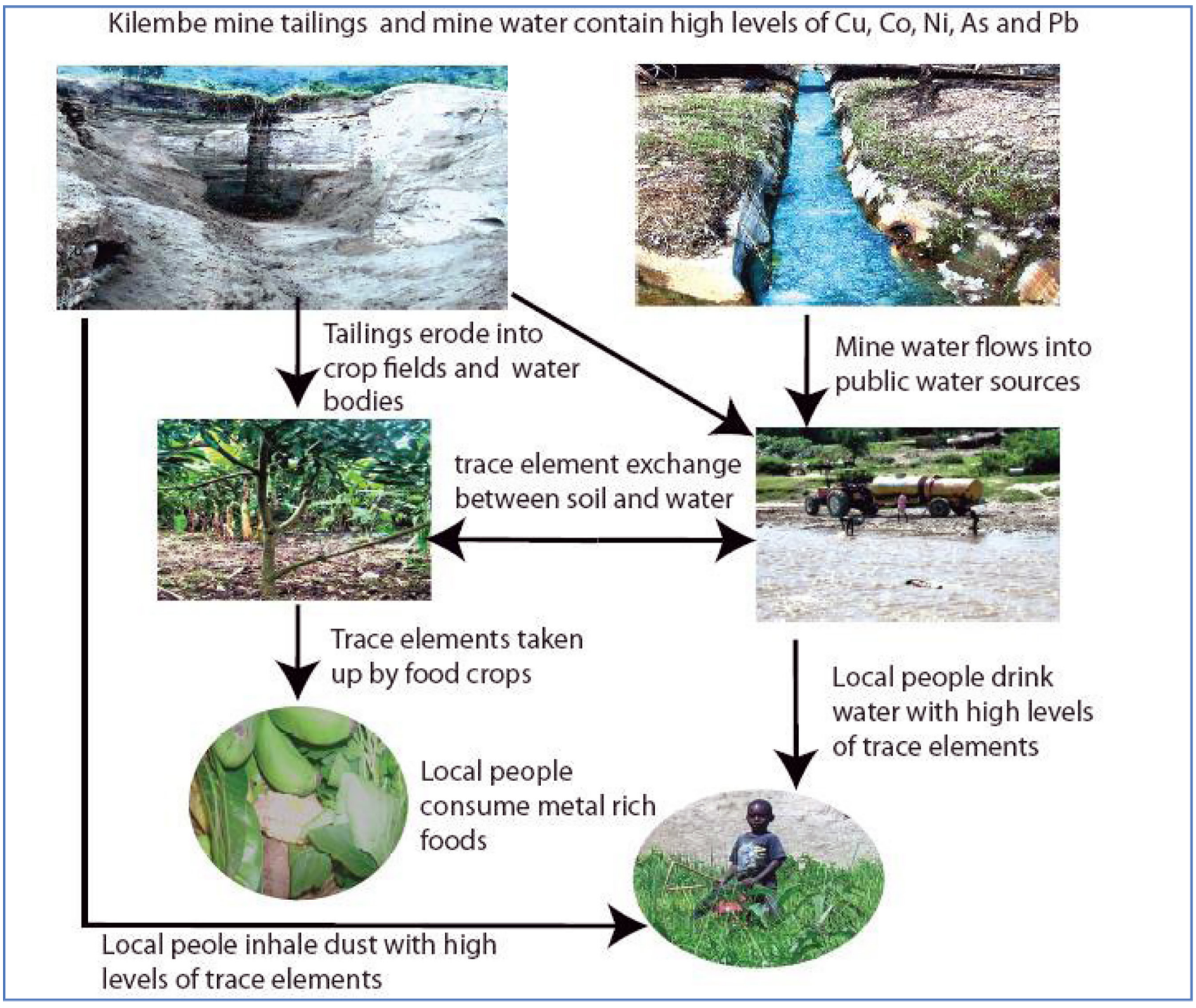


Plate 6.5: Kilembe mine tailings and mines (Source Mwesigye R Abraham 2015)

The concentration of Co, Cu, Zn and Pb in vegetables (Amaranthus) grown within the Kilembe catchment were higher than control vegetables. However only Co, Zn and Cu ($p<0.05$ were significantly higher. In addition, over 26% of the vegetable samples exceeded Cu thresholds of 20 mg /kg recommended by European Community (2006) for human consumable vegetables. Zn concentrations exceeded WHO/FAO thresholds of 99.4 mg kg-1 in 36% of vegetables while Pb concentrations were higher than the WHO/FAO threshold value of 0.3 mg kg-1 in 47% of vegetable samples.

Table 6.1: Expossure pathway of Kilembe populatons to mine metals and wastes in (mg/kg).

Food crop	Co	Ni	Cu	Zn	Pb
Maize Range	0.01-0.47	0.12-3.11	1.48-16.2	16.3-40	0.00-0.07
Cassava Range	0.15-1.41	1.56-2.98	2.99-20.47	15.4-36.2	0.06-0.1
Banana Range	0.01-0.5	0-1.1	2.03-5.06	6.7-19.3	0.01-0.37
Mangoes Range	0.26-0.41	4.4-5.3	5.58-7.1	7.14-7.5	0.19-0.24
Amaranthus	**0.01-81**	**0.33-9.1**	**1.95-35.4**	**25-846**	**0.08-2.7**
Cassava and Banana guidelines	-	67.9	73.3	99.1	0.3
Guideline for vegetables	50	66.9	20	99.4	0.3

Source: (Mwesigye R Abraham, 2015)

6.3.3. Pollution threat on River Mpanga catchment

Mpanga River originates from the Rwenzori Mountains and runs south east draining into the swamps of Lake George in Queen Elizabeth National Park. There are numerous tributaries such as Mitoma, Nyankoma, Niguta, and Kazizi among others that are found within the forest and wildlife reserves.

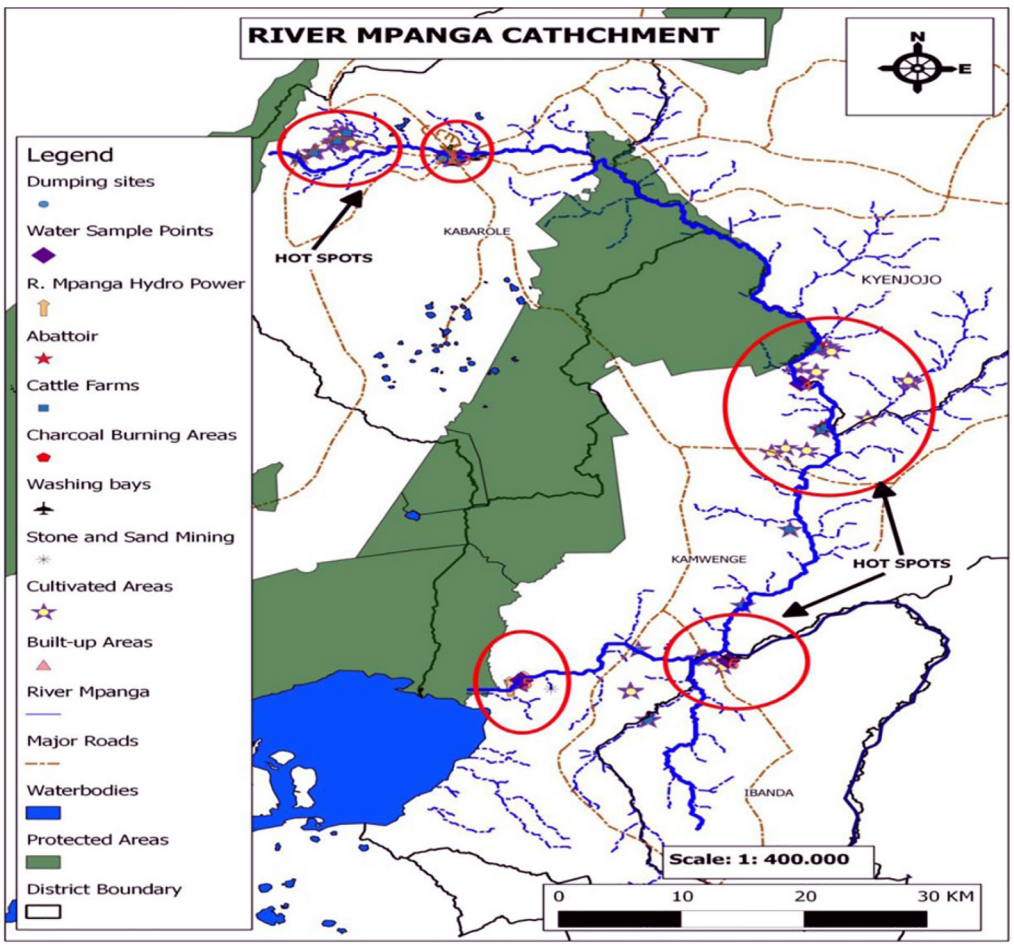


Figure 6.8: Location of major hot spot areas within the catchment Source: River Mpanga Sub Catchment (MWE 2019)

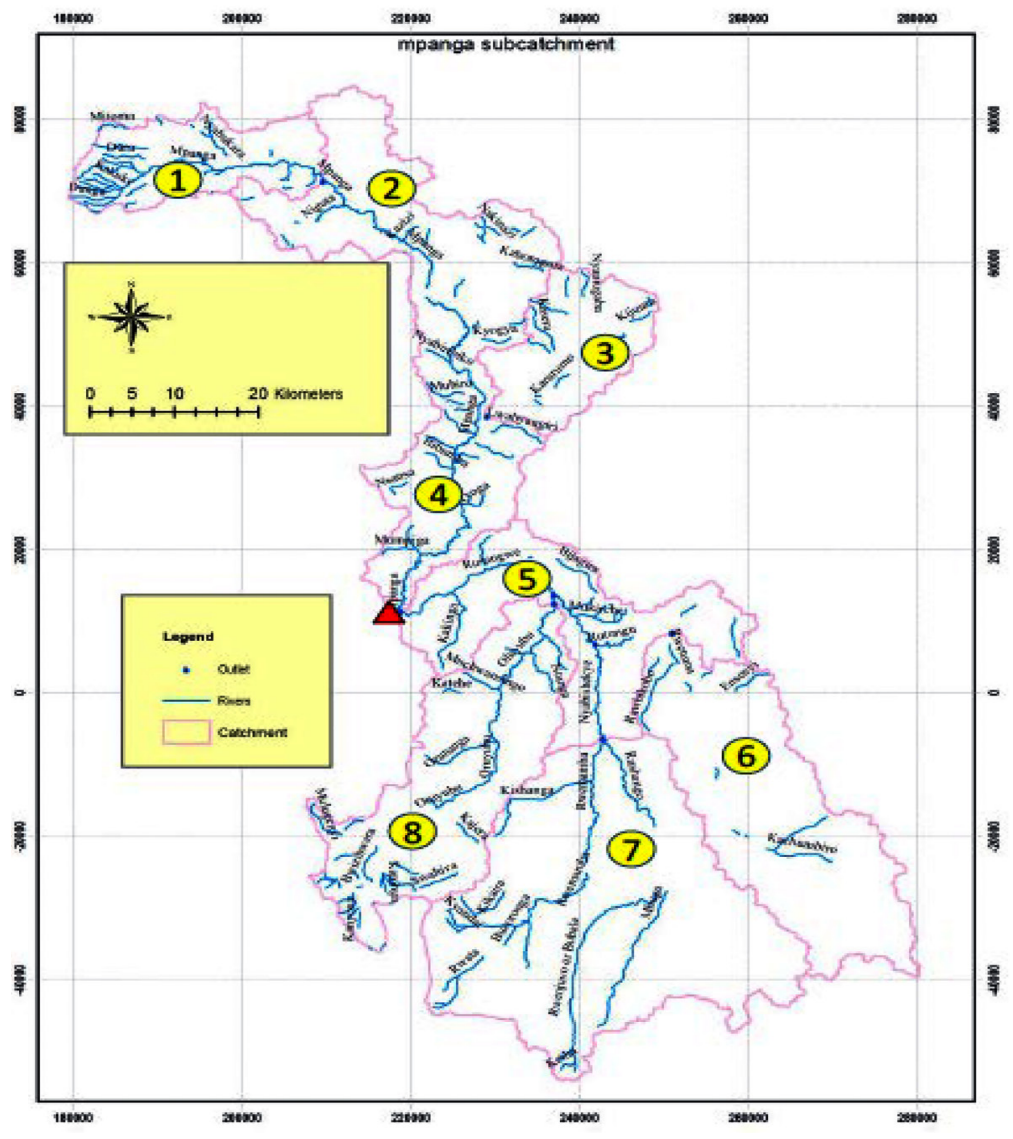


Figure 6.9: Location of sample points within the catchment. Source: River Mpanga Sub Catchment (MWE 2019)

Description of study points

P0 to the last point when the river leaves Fort portal town
P1 is the point just before the effluent from the national water and sewerage treatment ponds enters the main river
P2, P4, P5, P6, P8 and P9 are points where numerous washing bays and tree nursery activities are undertaken
P3 is the abattoir
P7 is the point where storm water from the hospital enters the river water P10 Point where

Water quality assessment

The main causes of water quality deterioration were identified during the assessment as; poor farming (agricultural and livestock) practices, commercial activities operating along the river with no treatment system in place and poor sanitation. The assessment also involved the collection of water samples from the major hotspots along the river course and the parameter which were tested included temperature, PH, conductivity and total dissolved solids. Some chemical parameters of interest were also analyzed and these included Nitrates and phosphates. Heavy metals specifically aluminum, copper and lead were analyzed and all results were compared with the National Environment (Waste water standards for discharge of effluent into water or on land) 1999.

During the assessment, the BOD results showed an increase at the point where the river receives effluent from an abattoir (P3) and the hospital wastewater (P7). Wastewater from an abattoir contains blood, animal dung, urine among others which have the potential to increase the demand of oxygen in a river when discharged without appropriate treatment. In addition, the observed spike in BOD from the hospital waste poses a health threat to the river users downstream. This hence calls for an immediate attention by the hospital management to ensure that the wastewater is treated to the required standards before discharge.

Similarly, COD shows a same trend as BOD where spikes in COD concentrations along the river course were observed at the points where the river receives the abattoir effluent and the hospital wastewater. Effluents with high chemical oxygen demand pose a threat to the receiving water by depriving it of its oxygen as microorganism's breakdown both the organic and inorganic substances.

However it is also important to note that at P3 and P7, the river had a high COD which was even higher that the discharge standards into the environment.

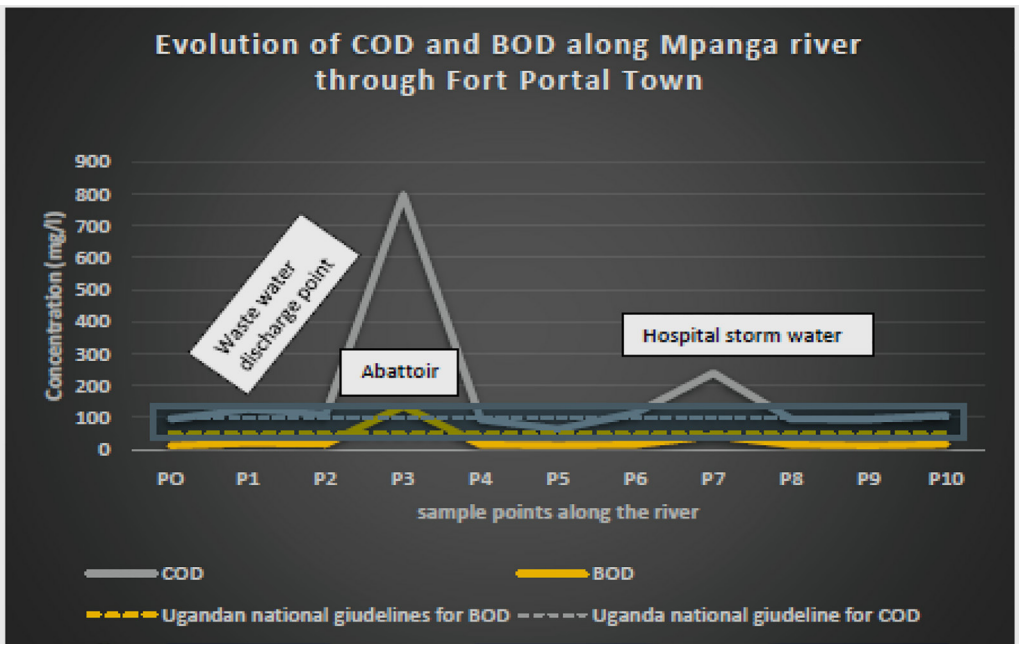


Figure 6.10: Evolution of COD and BOD along a section of River Mpanga

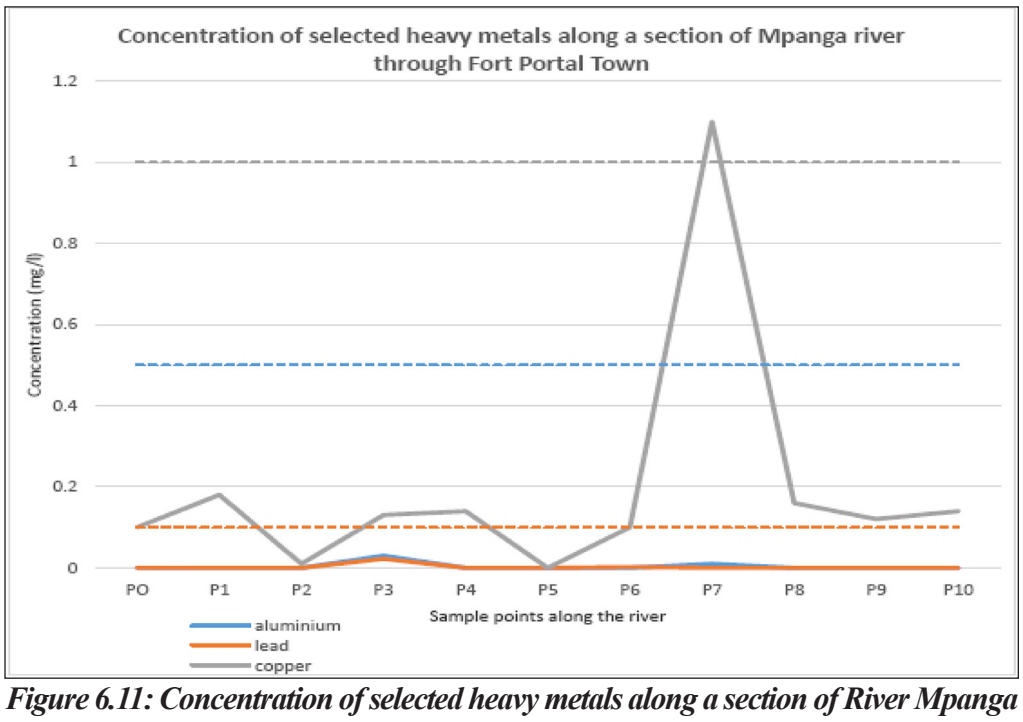


Figure 6.11: Concentration of selected heavy metals along a section of River Mpanga

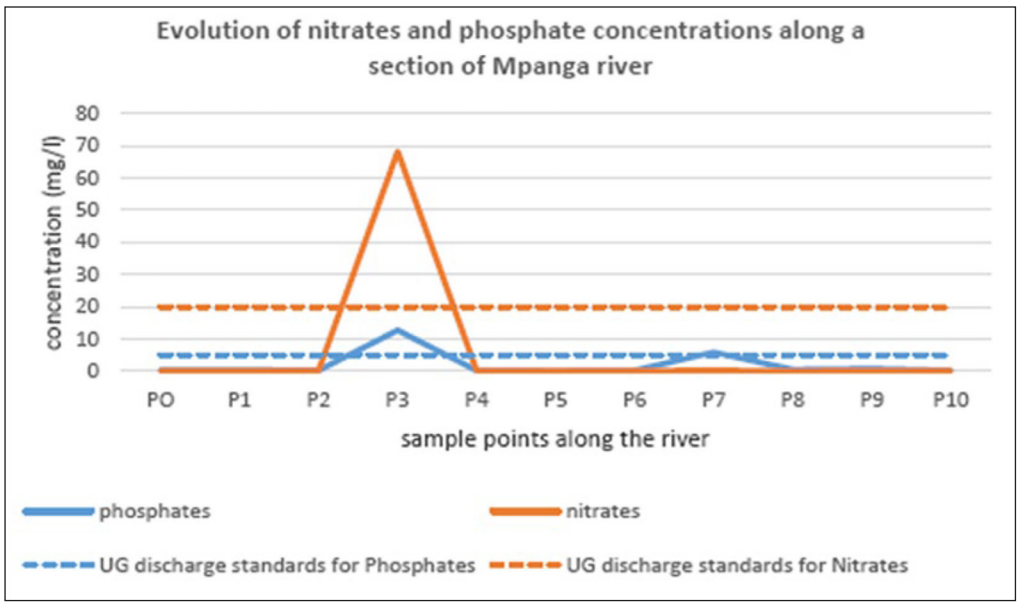


Figure 6.12: Shows evolution of nitrates and phosphate concentrations along River Mpanga

The trend for phosphates is still the same as observed for BOD and COD at points P3 and P7; while for nitrates, the trend is only similar to that observed for BOD and COD at point P3. The levels are all below the limits at all points except the abattoir and the hospital. There is a very high nitrate loading at the abattoir which could be attributed to the urine from the slaughtered animals which is high in ammonium. At the same point the phosphates are also very high due to washing and clean-up activities from the abattoir after slaughtering the animals. At point P7 (hospital) there is no evidence of nitrates but there is a sharp increase in phosphates, although the increase is still below the guideline. The increase in phosphates could be due to the use of detergents as the hospital is being cleaned or washing of garments by both patients and staff.
From the graph, phosphorus is the least abundant pollutant in the river water and the little concentrations observed could be from the numerous washing bays surrounding the river system where cars are washed and soapy water is introduced into the system. It is thus the most limiting factor for the growth of aquatic plants. An increase in phosphates directly triggers eutrophication.

Despite earlier beliefs that the surrounding garages and washing bays were releasing waste rich in heavy metals, there was no evidence to support this claim. However, analysis for oils which is a major outcome was not done due to laboratory limitations. Analysis of some heavy metals indicated a very low load in the river except for copper which goes beyond the limit at the hospital point (P7). This could be attributed to the materials used in the hospital. Also, Copper concentrations in water can be as a result of corrosion of interior copper plumbing. Therefore, from the discussion above the main pollution sources upstream include: Kabundaire abattoir; where waste is directly deposited in the river untreated; Kabarole main referral hospital; The sewage treatment ponds and Mpanga market area where there is high risk of waste from the market entering the river, and areas where farmers are cultivating near the river banks or planting Eucalyptus trees e.g. in Mugoma and Kamengo. The main form of pollution is the deposition of polyethene bags into the drainage channels causing unnecessary blockage and flooding of areas around the market.
The population has always been dependent on the catchment ecosystem, however, rising population combined with poor land use practices, deforestation is placing considerable strain up the catchment.

6.4. Policy Response

There is need for strong community participation in the management of water resources within the sub catchments. According to the key principles of IWRM, the success of its implementation will be related to the potential that decisions can be taken including the lowest levels.
At the same time many of the problems as described below are directly driven or accelerated by the communities own actions and their drive for livelihood improvement. Therefore, their inclusion in the problem analysis and their proposals being part of the potential solution is critical. Significant indigenous knowledge is already present on the ground that in many cases can be converted into key principles for potential solutions. Active participation in the bottom up planning processes is highly important.
The problems were identified through observation during transect survey, and interview with various stakeholder institutions. In addition, stakeholder's workshops held corroborated the general observation of the problems experienced within the catchment.
River Mpanga catchment is increasingly facing challenges that may be summed up under the following categorized theme areas:

1. Catchment degradation
2. Water Source pollution
3. Low compliance and respect for the water resources regulations
4. Low social capital

The issues and challenges are closely related, however, they are considered to be most practically addressed under these four theme areas.

6.4.1. Pollution sources of River Mpanga and its catchment.

The pollution of River Mpanga is contributed by two sources, namely point and non-point sources pollution as indicated in the Pollution status of the Mpanga River as illustrated in the "Assessment of Water Use and Demand in Lake Albert Basin of Uganda" under a consultancy funded by DWRM. The surveys conducted also included point and non-point sources of pollution, and solid waste disposal. An assessment of wastewater disposal systems was also carried out.

Plate 6.6: Settlements within River Mpanga Catchment.

6.4.2. Point Source of Wastewater pollution into the River Mpanga

The water quality survey in the Mpanga Catchment indicated that there is considerable pollution from point sources. These are highlighted in the sections presented below:

a) Municipal Wastewater. There are a number of fast-growing rural growth centers and markets within the sub-catchments, some of which are situated very close to the River/tributaries. There is no sewerage system in these centers and the most common mode of human waste disposal is pit latrines with a few individual septic tanks. Oil from garages, polythene bags and unregulated sewerage flow from NWSC -Fort Portal find their way into the River.

b) Domestic Wastewater. Septic tanks are a common means of wastewater disposal in secondary schools, lodges and hotels in the basin. However, most of them are not properly designed. Due to the nature of soil septic tanks and pit latrines tend to fill up with water and overflow in the rainy season.

c) Cattle Dips. These are mostly communal facilities for controlling ticks and other parasites on cattle. Some of the cattle dips are situated adjacent to the River.

d) Slaughter houses. Almost all the market centers possess a slaughter house and the number of animals slaughtered daily depends on the size of the market. In some centers there is a pit for the condemned parts of the carcass and the blood, but the water used for washing and cleaning the slaughter houses is disposed off overland, which is eventually washed into the river during the rains.

e) Car washing. Car washing is common in the sub catchment near human settlements. An important exception is that runoffs, after washing cars, often drain into water sources which are utilized by people and livestock downstream.

f) Solid Waste Disposal. Solid wastes are generated by domestic (from residential areas), commercial (market centers, hotels), industrial, healthcare and Hospital and agricultural activities (agricultural packages, tins and chemical containers). The wastes which include, garbage and litter accumulate on the streets and other public places like markets. During storm events, they are washed into the River

Plate 6.7: Garbage dumped close to a market near River Mpanga Catchment

6.4.3. Non - point Sources of Wastewater pollution into the River Mpanga

Sources of pollution are scattered across residential, agricultural, forested and urban landscape. Pollutants are transported to receiving water bodies in runoff following storm events or carried in irrigation return flows. Non-point source pollution is mainly by inappropriate land use and therefore can be controlled by improved land use management. The identified non-point source pollution in the basin includes the following:

(a) Small scale subsistence farming. The middle and lower Mpanga sub catchment is dominated by small scale subsistence farms. The farms are smaller and farmers use agro-chemicals to increase crop yields. This is more manifested in the numerous tea estates within the basin. Pollution is caused by poor agricultural practices (misuse of agro-chemicals, farming on steep slopes, and soil and water conservation structures).

(b) Overgrazing. This is rampant in lower Mpanga where cattle rearing are the preferred activity due to the prevailing climatic condition. The animals water directly from the river and create cattle tracts which facilitate soil erosion.

(c) River bank erosion. Encroachment of riparian land through riverine cultivation and quarrying along River Mpanga contribute to the release of total suspended solids (TSS) into the River.

(d) Deforestation and cultivation of wetlands. The encroachment of forest areas has exposed those areas to extensive soil erosion and surface water run-off.

(e) Urban storm runoff. Within the fast growing urban centers there are large areas with impervious surfaces like roads and pavements. In these areas water does not easily infiltrate into the ground and instead water runs off into storm water drains. The water in these drains carries wastes directly to the River.

(f) Road construction and quarrying. Construction generates loose soils which are washed in to the River when it rains. Sand mining, quarrying particularly at the hill tops accelerate hill top degradation which results into soil erosion.

(g) Bathing in the river. This is very common in parts of the catchment and residents even carry household goods, clothes, utensils to wash in the river.

The baseline data, observations and community level focus group discussions reports indicate that the unsustainable quarrying and sand harvesting happen due to the high demand for building materials and high poverty incidences. Similarly, from the stakeholder's workshops, it was reported that the effect of this activity is increasing siltation of the River, degradation of environment, soil erosion, and pollution. It also leads to lowering of water table.

Stakeholders also identified poor solid waste management generated from the urban centers, industrial centers, hospitals and agricultural activities as serious problem.

6.5. Recommendations.

1. Containment of tailings erosion is vital to minimize soil and water contamination.
2. There is need for demarcation, isolation and treatment of underground mine water and leachate before it is discharged into the natural water resources.
3. Highly contaminated soils should be mapped and cultivation or grazing animals on such soils discouraged or prohibited.
4. Bio-accumulator plants such as *Thilaspitheluscens* should be planted on highly contaminated soils as part of phytoremediation initiatives. These methods have been used before in other areas faced with mine contamination.
5. An extension and awareness program should be developed targeting communities and public sites where trace elements were exceeding thresholds.
6. Analysis and risk assessments of animal products from grazers within Kilembe mine catchment should be conducted to establish the levels of metals therein.
7. Enforcing waste management regulations and protocols is vital to prevent future negative impacts on water resources.
8. Oil companies should put in place adequate waste management facilities to prevent pollution of drinking water for humans and animals with the toxic metals.
9. It is also recommended that relevant government agencies enforce relevant waste management regulations in the Albertine Graben to minimise pollution of the water resources and the environment.
10. Strengthen institutional set up for water catchment management zones and trans boundary area at local levels.
11. Strengthen enforcement of the existing legal frameworks.
12. Expand the Integrated Water Resources Management (IWRM) framework to include other aspects like poverty eradication and disaster preparedness in addition to provision of drinking water and sanitation.
13. Support DWRM to fill the data gaps and also ensure they have up-to-date data to carry out better informed analysis of the status of water quality and quantity
14. DWRM is building capacity in terms of field monitoring equipment and refurbishing the Laboratories to be able to timely handle water quality and quantity in the entire country.

Bibliography

Directorate of Water Resources Management, DWRM (2016). State of Water Resources Basin Report for Victoria Water Management Zone (Analysis of Data into Information) Phase 1, Volume 1

Chapter 7: Soils

7.1 Introduction

This chapter discusses the soil conditions of Uganda. Soil is looked at from the perspective of its supportive role as a provider of nutrients, a control of nutrient cycling, a substrate for anchorage, and ultimately its contribution to primary productivity. The chapter briefly describes the dominant soil types, discusses soil health, illustrates soil degradation and associated drivers, lists responses to stem soil degradation, and recommends actions to improve soil health and productivity.

7.2 Distribution of selected soil chemical properties and soil types

Recently, Vital Signs collected 1,149 soil samples across the country, processes 1,059 samples for key soil properties, namely particle size, pH, nutrient availability and nutrient content, and used machine learning techniques to create high resolution soil nutrient maps (Figure 7.1). These maps embody the only existing contemporary record of soil nutrient information for the entire country, needed to guide agricultural investments and intervention, because of the data describing the state of soil fertility. Nitrogen, phosphorous and potassium, which are key soil nutrients, are not everywhere in high concentrations. For instance, although potassium concentration is highest in the northeast of the country, total organic nitrogen is low (Figure 7.1). This suggests that a farmer here needs a blend of fertilizers with a high proportion of nitrogen. This is different for a farmer in Luweero, where potassium and phosphorous are generally low (Figure 7.1). The fear of aluminum toxicity is in the mountainous and upland areas of Uganda, while that of iron is in the east (Figure 7.1). It is also important to note the relationship between the spatial distribution of boron, calcium, copper, potassium, magnesium, sodium and pH, in the first 30 cm of the soil (Figure 7.1).

The differences in soil nutrient distribution are wholly a function of pedogenesis, but at farm-level, they reflect the long-term effects of agriculture and other human disturbances. Generally, climate, geomorphology, organisms have interacted on a geologically stable landscape for a long time to create the reddish to brown Acrisols, Ferralsols, Lixisols, Nitisols, Alisols, Arenosols, and Regosols, which make up most of the highly weathered surface of Uganda (Figure 7.2), with acidic soils having low activity clays. These soils are largely of medium and low agricultural productivity, with inherently low fertility (Ssali 2000), owing to low base saturation. However, they can respond to fertilizers, organic manure and irrigation. A medium rating of productivity implies that the soils will give high crop yields under good management, including use of organic manures or inorganic fertilizers during the cropping phase, practicing crop rotation, fallowing, and controlling soil erosion using appropriate soil and water conservation techniques.

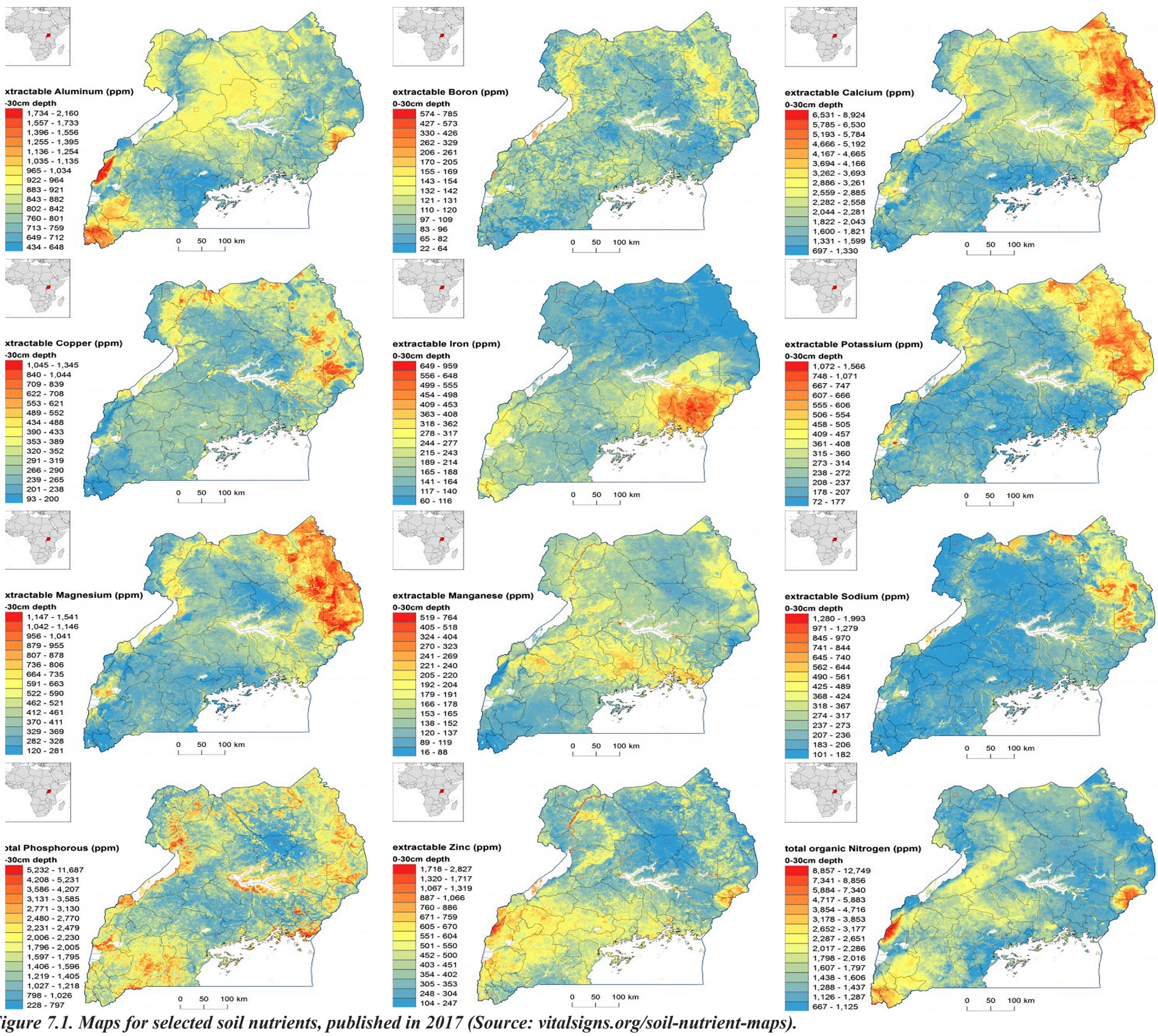


Figure 7.1. Maps for selected soil nutrients, published in 2017 (Source: vitalsigns.org/soil-nutrient-maps).

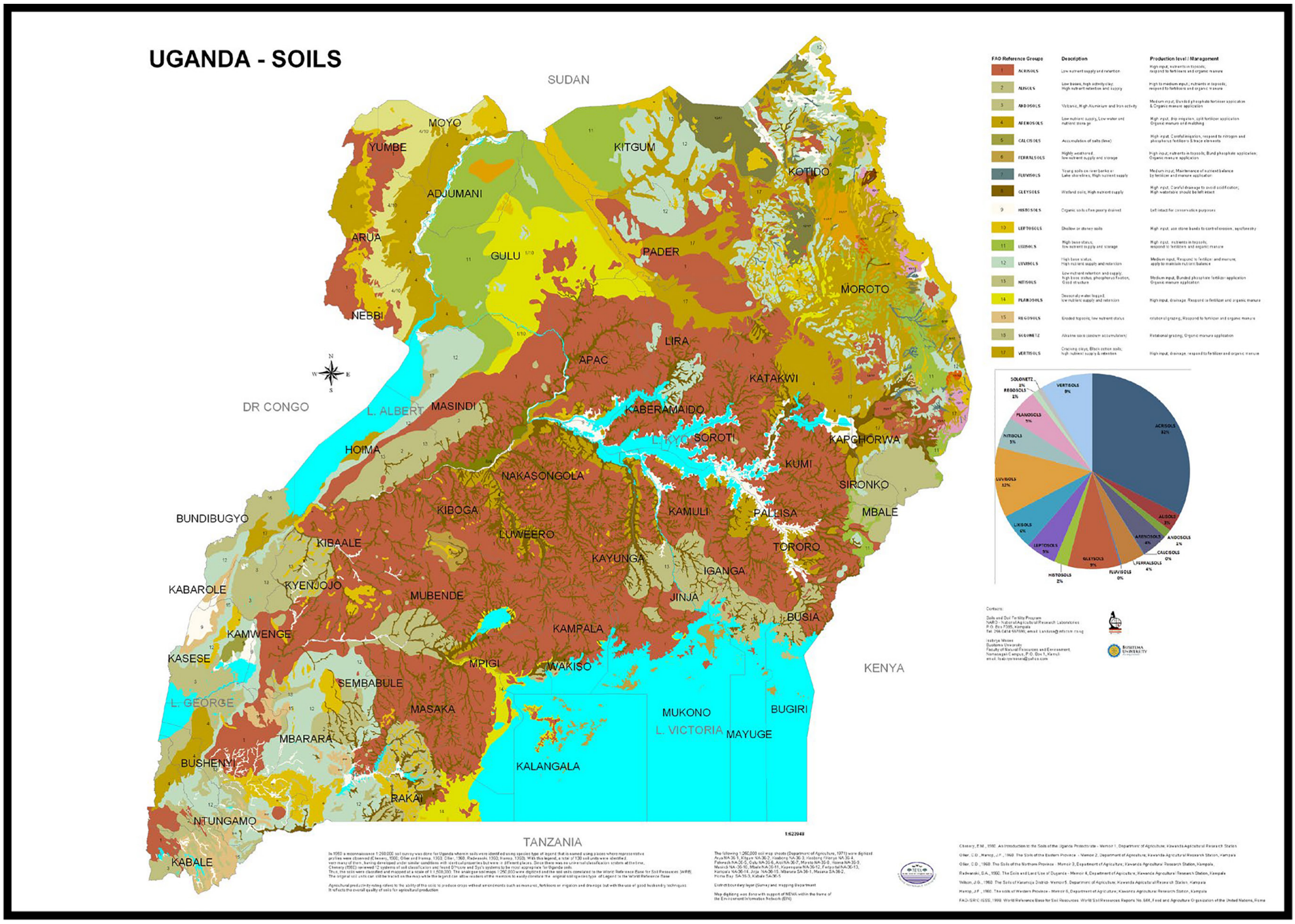


Figure 7.2. The distribution of major soils in Uganda.

7.3 Soil health

Soil health is an assessment of how well soil performs all its functions. Indicators of soil health can be physical, chemical, and biological properties and processes in soils. Soil organic carbon and soil pH are key indicators of the status of soil health, with the former influencing soil nutrient retention, hence soil fertility, soil structure and stability, and soil erosion, while the latter impacts soil activity, with consequences on plant available nutrients, potential for nitrogen and potassium loss through leaching, and ability to fix, adsorb or release pollutants.

Soil organic carbon is a derivative of living organisms in the soil, and is an indicator of sustainability in a soil management system, because of its central role of maintaining soil fertility. It is one of the most important parameters in a soil because of its influence on soil nutrients and their availability, and its control of soil physical properties that affect rainwater infiltration and water retention, aeration, root penetration, and soil structural stability. Unfortunately, because it is mainly within the top 20 cm of a soil profile, it is susceptible to losses through erosion, once vegetation cover is removed, and by oxidation, following tillage. In Uganda, soil organic matter is low to medium in most places, and is declining due to increased erosion and poor land management practices (Nandwa 2001; Zhang et al. 2017), with negative impact on fertility (Musinguzi et al. 2015) and productivity. For our soils to remain productive, they must therefore be properly managed to maintain organic matter at reasonable levels, preferably above 3%.

Soil pH is a measure of the acidity or alkalinity in soils, and is an important soil parameter, given its role in influencing chemical activities and the attendant effect this has on availability of nutrients for plants, mobility of potential contaminants in soils, and aggregation of soils. For instance, optimum availability of nutrients is when soil pH is in the range 6.0 and 7.0 (Brady 1990), but nutrients, including most heavy metals and pollutants, are locked up when soil pH is above 6.5. The pH of Uganda's soils vary, owing to a climate gradient, but has a narrow range between 4.8 and 6.3 (Figure 7.3). High soil pH is mainly in the Karamoja region, where conditions are generally dry (Figure 7.3); otherwise the rest is low because of wet conditions. Soil pH is also affected by human activities (Grieve 2001; Holland et al. 2018), such as continuous cultivation, draining of acid sulphate soils in swamps for agricultural purposes, and use of soil acidifying fertilizers, such as DAP and urea (Bekunda et al. 1997).

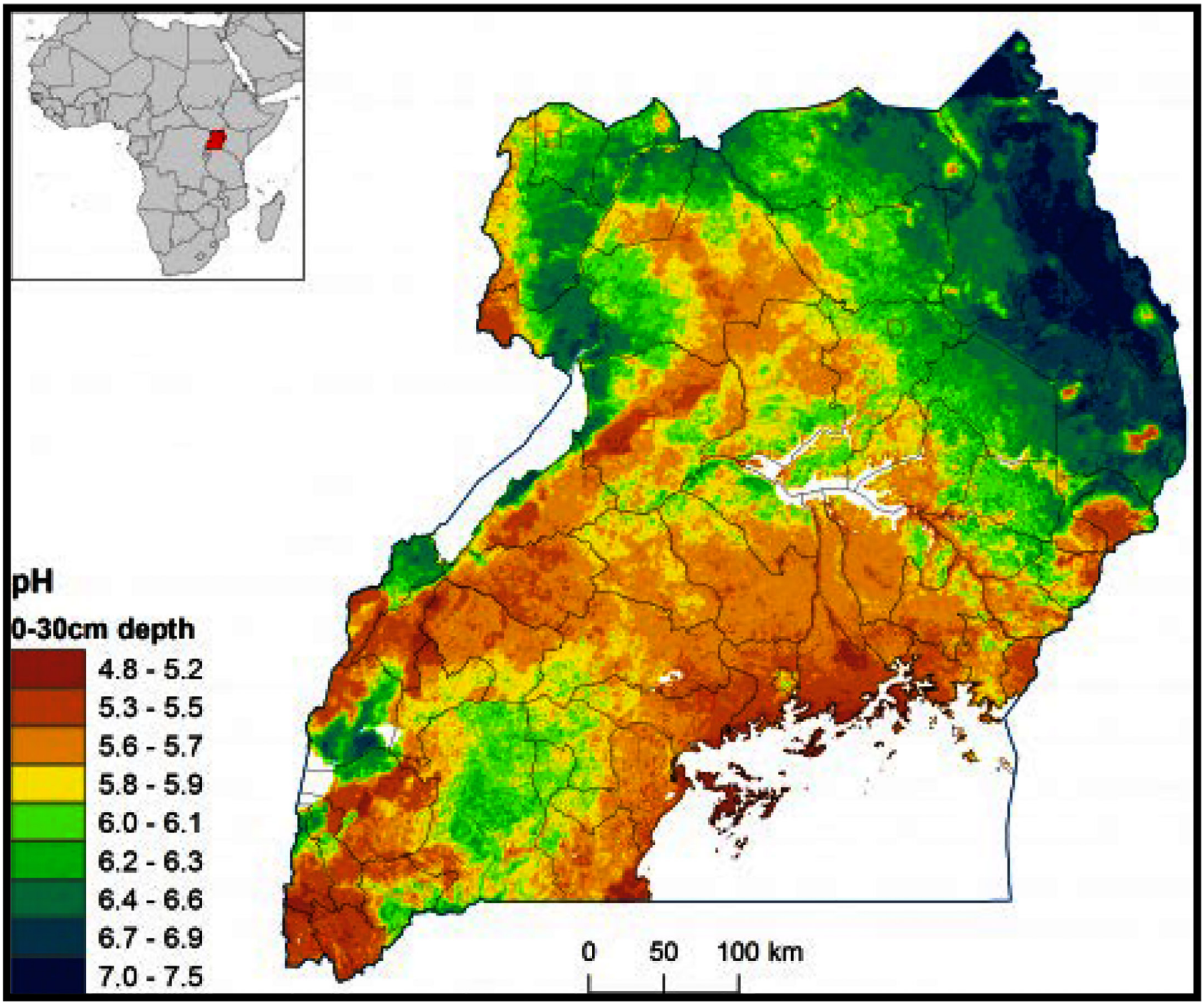


Figure 7.3. The distribution of soil pH in the soils of Uganda (Source: vitalsigns.org/soil-nutrient-maps).

7.4 Soil degradation

Soil degradation refers to the decline in soil quality (Goss et al. 2017), due to poor land management practices (Bhattacharya 2019), and is characterized by depletion of soil nutrients and degradation of soil physical properties. Soil degradation is a major threat to food security in Uganda and is responsible for siltation and pollution of lakes, rivers and open water sources, which has affected livelihoods. Major causes of soil degradation in Uganda are nutrient depletion and soil erosion, which are on the increase because farmers are not using external sources of nutrients (Okoboi and Barungi 2012) and are not adopting recommended soil and water management practices.

In Uganda, soil erosion is widespread but extreme in highland areas, the cattle corridor, and the northeast of the country, where predicted erosion rates are over 10t ha-1yr-1 (Figure 7.4). Generally, highlands are predisposed to erosion, owing to steepness and massive devegetation. Erosion is also exacerbated by abandonment of conservation structures (Figure 7.5 and Miiro 2001), on the one hand, and lack of adoption of recommended soil and water conservation practices by most farmers (Kagoya et al. 2018), on the other. The latter is attributed to lack of information (Mugonola et al. 2013; Kagoya et al. 2018; Barungi et al. 2013), possibly due to a weak extension system, and uncertain land rights (Mugonola et al. 2013). In addition, the technologies are perceived to limit acreage (Barungi et al. 2013; Byamukama et al. 2019; Miiro 2001), are labor intensive and tedious (Miiro 2001), and are seen to be expensive (Barungi et al. 2013; Esabu and Ngwenya 2019). Further, poor land husbandry practices, such as over grazing in the cattle corridor, denude land exposing it to the elements causing erosion (Karamage et al. 2017). Figure 7.6 is evidence of erosion and Box 7.1 illustrates the magnitude of erosion in selected parts of the country, where erosion rates were estimated using different methods.

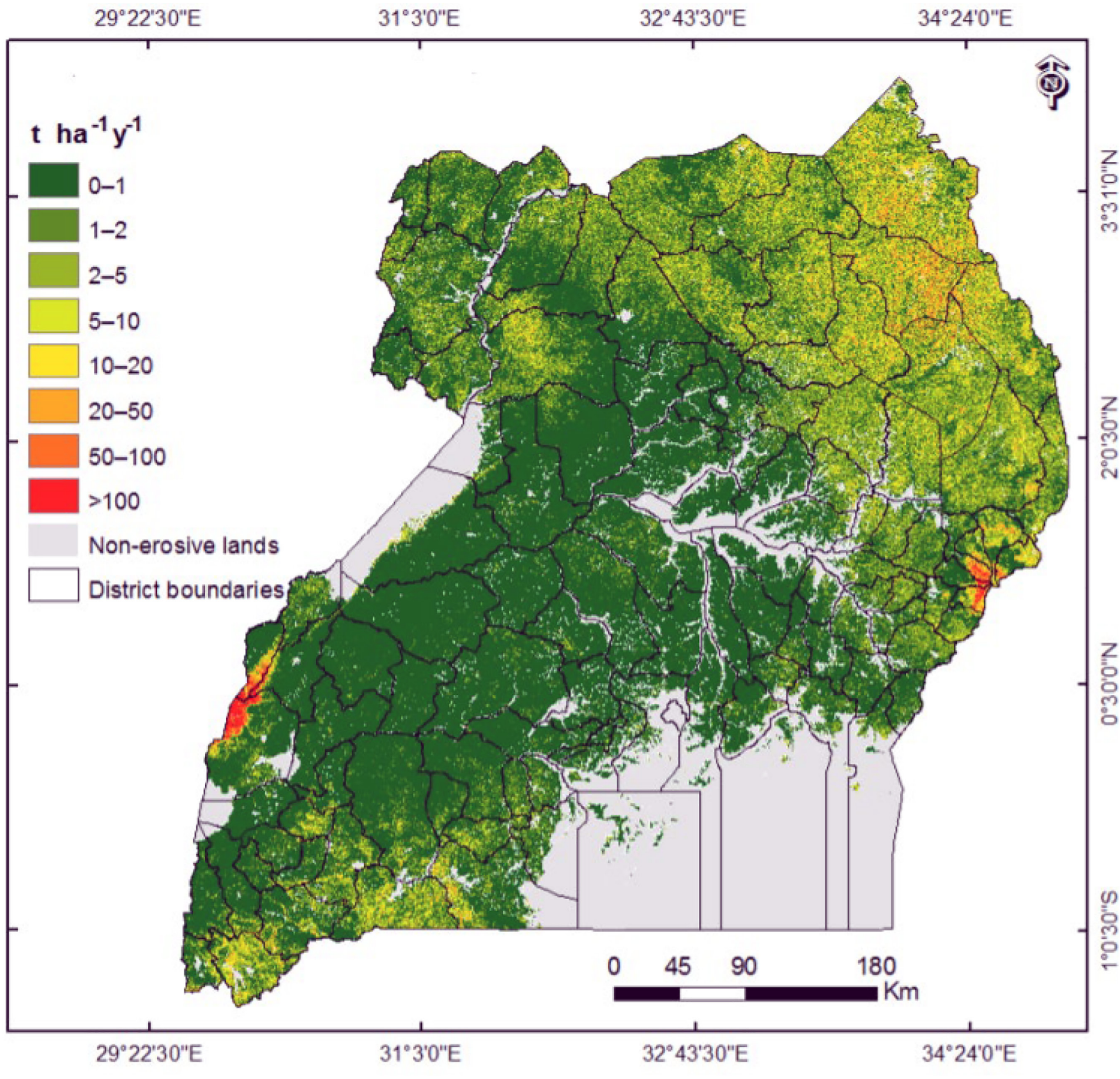


Figure 7.4. Estimated soil erosion risk in Uganda (Source: Karamage et al. 2017).

Figure 7.5. Rills are signs of soil erosion which is a result of destruction of terraces through land consolidation. Pictures taken at Kyokyezo, Rubanda District (Photo credit: Kaizzi Cranmer).

Figure 7.6. Exposed tree roots are a common feature in the cattle corridor (Photo credit: Kaizzi Cranmer), and gullies are common in the sandy soils of Kalangala (Photo credit: Isabirye Moses).

Box 7.1 illustrates the magnitude of erosion in four agro-ecological zones, pointing to the threat of erosion on the country's agricultural sector. Moreover, there is a danger of eutrophication of freshwater systems by nutrients in the eroded soil.

Case Study 1: Evidence of Soil Erosion in Uganda

Table 1. Soil erosion evaluated in three land degradation hotspots namely: eastern highlands, cattle corridor and south western highlands (Figure 7.7), using Fallowout RadioNuclides (FRN) – Caesium – 137.

Agro ecological zone	Site	District(s)	Erosion rates (t ha^{-1} $year^{-1}$) Mass Balance Model 1
Mt. Elgon High Farmlands	Atari River	Bulambuli and Kween	26.3
	Manafa River	Bududa and Manafwa	5 - 60
Lake Victoria Crescent	Cattle corridor -Wabinyonyi	Nakasongola	9.5
South western highlands	Kyokyezo	Rubanda	156.4
	Kyokyezo	Rubanda	11.7 – 51.2[$]

[$] Mass Balance Model 2

Source: Kaizzi et al. 2018

Deposition rates in Butalejja District are in the range 2 - 40 t/ha/yr

Table 2. Erosion rates in different areas and under different land use systems evaluated using experimental plots.

Area / Zone	Land use system	Erosion rates (t ha^{-1} $year^{-1}$)	Source
Mt. Elgon area	Banana / coffee	7.5	Bamutaze et al. 2010
	Annual	24	
	Banana/coffee	6.6	Semalulu et al., 2012
	Annual	38.5	
Cattle Corridor	Cattle	27.7 - 86.7	Majaliwa et al., 2005
L. Victoria Crescent	Banana / coffee	1.0 – 2.0	Isabirye, 2010
	Annual	27	
	Settlement	25	
	Groundnut	1.0	

It is important to note the fair correspondence between the results in Tables 1 and 2, especially in respect to rates for the Elgon region. Generally, erosion rates are high, suggesting the need to encourage farmers to adopt better land management practices.

Figure 7.7: One of the sites in Kyokyezo, Rubanda District, where soil erosion was evaluated using Cs- 137. Also note the absence of terraces in an area where they used to be common (Photo credit: Kaizzi Cranmer).

7.5 Pressures and impacts

The degradation of the soil resource in Uganda is attributed to population growth and the attendant effect on land ownership and fragmentation, land tenure, adoption of inappropriate land and soil management practices, and the low use of fertilizers and organic manure. These factors are discussed in detail below.

7.5.1 Population pressure

The recent population explosion seems to out-match farmers' ability to find arable land (Figure 7.8), with the consequence that continuous tillage is the norm (see Umezaki et al. 2000). Indeed the cross-over, indicating the mis-match between population growth and farmers ability to find additional arable land, happened around 2013. This is worrying because just over 50% of the land is rated to have soils of medium productivity (Harop 1970), yet the other available land is protected and legally inaccessible. This means that any expansion of arable land over the years has been by putting to use marginal land and encroachment of protected land in places (Figure 7.9).

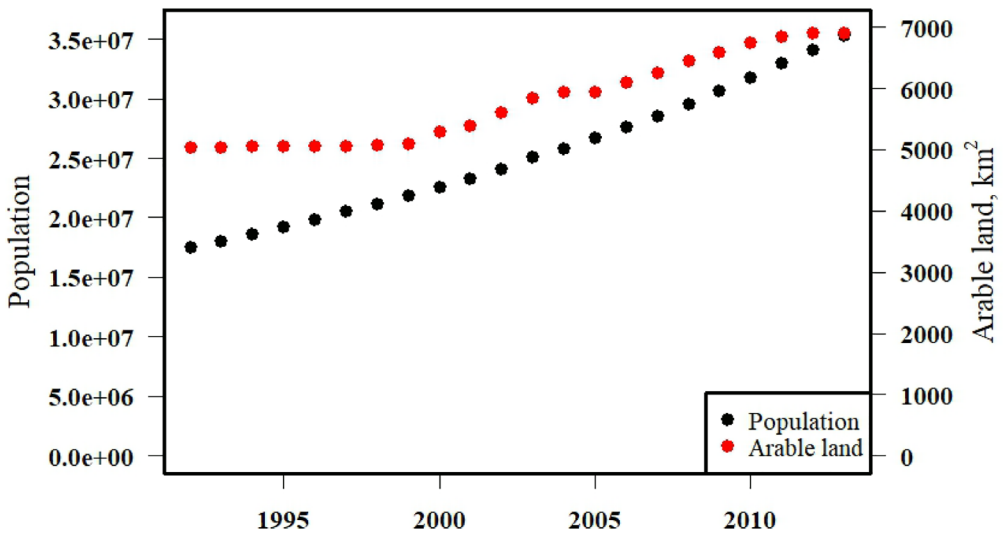


Figure 7.8. Population growth and changing size of land under arable farming over the period 1993 to 2013. Source: FAO data and Statistical Abstracts for Uganda – 1990 to 2015).

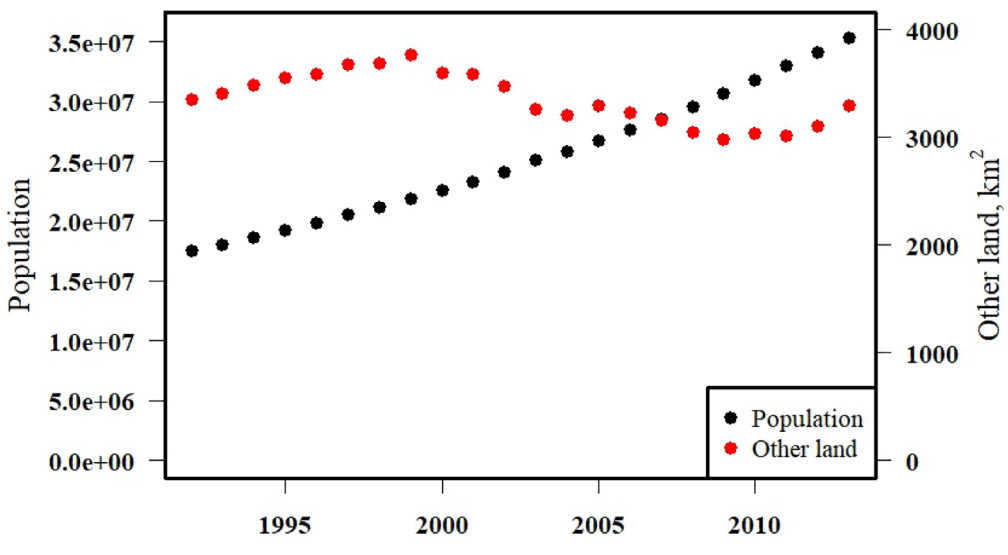


Figure 7.9. Population growth and changing size of other land (marginal and protected) over the period 1993 to 2013 (Source: FAO data and Statistical Abstracts for Uganda – 1990 to 2015).

7.5.2 Land fragmentation

The growing population has exerted pressure on land, especially where arable land is increasingly becoming limited. This has contributed to land fragmentation, consequently affecting soil health, because size of landholding limits adoption of soil conservation practices(Mango et al. 2017) and investment in fertilizer use (Barungi et al. 2013) by farmers.

7.5.3 Land tenure

The constitution recognizes four land tenure systems – mailo, freehold, leasehold and customary. Mailo and customary land tenure systems pose challenges to land management and development. For bibanja holders on mailo land, insecurities usually deter investment in proper land management (see Mugonola et al. 2013), while for customary tenure, communal ownership provides no incentives for individual actions to promote appropriate land management practices. Moreover, communal land cannot readily be exchanged (see Kirunda 2016) for capital to invest elsewhere or even for collateral to access loans to purchase fertilizers (Kayoga et al. 2018) to improve soils and land productivity.

7.5.4 Nutrient mining

Nutrient mining refers to losses of soil nutrients caused by crop harvest and soil erosion. Usually it is balanced by use of inorganic fertilizers and organic manures. Low levels of use of fertilizers in Uganda (Okoboi and Barungi 2012) suggests an imbalance that is partly responsible for soil nutrient depletion and degradation in the country.

7.5.6 Low adoption of appropriate soil management practices

Several factors limit adoption of good soil management practices by farmers. Consequently, the soils are degraded and become less productive. This situation is illustrated in Box 7.1.

Box 7.1 illustrates low, stagnant and declining crop yields as another indicators of poor soil health, and hence unsustainable production practices. Crop yield on farmers' fields in Uganda are low compared to the potential yield given by breeders. The average maize, rice and bean yields over the years 2008/09 to 2017 are in the range 2.2 – 2.5, 2.3 – 2.5 and 1.2 – 1.7 t ha^{-1} compared to the yield potential for maize 2.5 – 5 and 7 – 14 t ha-1 for open pollinated varieties (OPV) and hybrids, respectively; while 3.5 – 5 t ha^{-1} for rice and 1.5 $^{-3}$ t ha-1 for bush beans, given by Nalweyo Seed Company (NASECO 2017). The main contributing factors are poor inherent soil fertility, land degradation, non- or low use of external sources of nutrients, such as, inorganic fertilizers, which is exacerbated by soil fertility depletion and other biophysical factors. Bananas, cereals, pulses, root and oil crops are important crops for smallholder farmers. Unfortunately, the average yield of these crops has remained constant over the years as presented in Figure 7.10, for banana, cereals, pulses and oil crops, respectively.

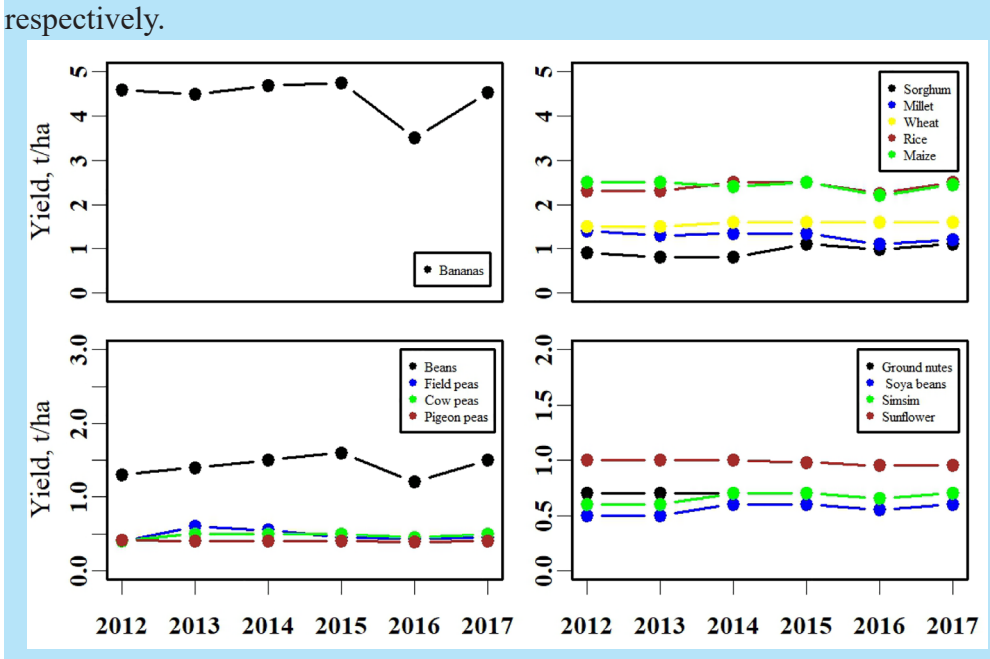


Figure 7.10. Average yield (t/ha) of all types of plantain bananas (top left), cereals (top right), pulses (bottom left), and oil crops (bottom right) for the period 2012 to 2017. For the period 2008/09, average yield (t/ha) was as follows: bananas = 4.69; sorghum = 1.11; rice = 2.54; maize = 2.33, beans = 1.50; field peas = 0.38, cow peas = 0.46; pigeon peas = 0.38; ground nuts = 0.71; soya beans = 0.65; and simsim = 0.58.

7.5.7 Low use of inorganic fertilizers and organic manure

Fertilizer use in Uganda is low, ranging from 1.2-2.9 kg ha-1 year-1, over the period 2008 to 2016 (Figure 7.11), far below the average usage of 8 kg ha-1 in Africa south of the Sahara (IFDC 2011; Bekunda and Kaizzi 2008). Inorganic fertilizers and manure are applied on only 1.0% and 6.8% of the parcels of agricultural land, respectively (UBOS 2006). This is due to: (i) the false belief by many Ugandans that soils in the country are sufficiently fertile (see Ssali 2000); (ii) limited awareness of the potential of fertilizers to increase crop yield, owing to little emphasis on fertilizer use promotion; (iii) many NGOs and 'organic and environmental groups' advocating against the use of fertilizers using the wrong argument that "fertilizers spoil soils"; (iv) limited knowledge of fertilizer use by extension staff; (v) lack of expertise to produce correct mixes of fertilizers by agro-input dealers; (vi) conservatism of some farmers who continue to use blanket recommendation which aim at maximizing yield rather than profits; and (vii) limited fertilizer products on the market. In box 7.2, maize yields are used to illustrate the importance of fertilizers in the replenishment of soil nutrients (Wortmann and Kaizzi 1998).

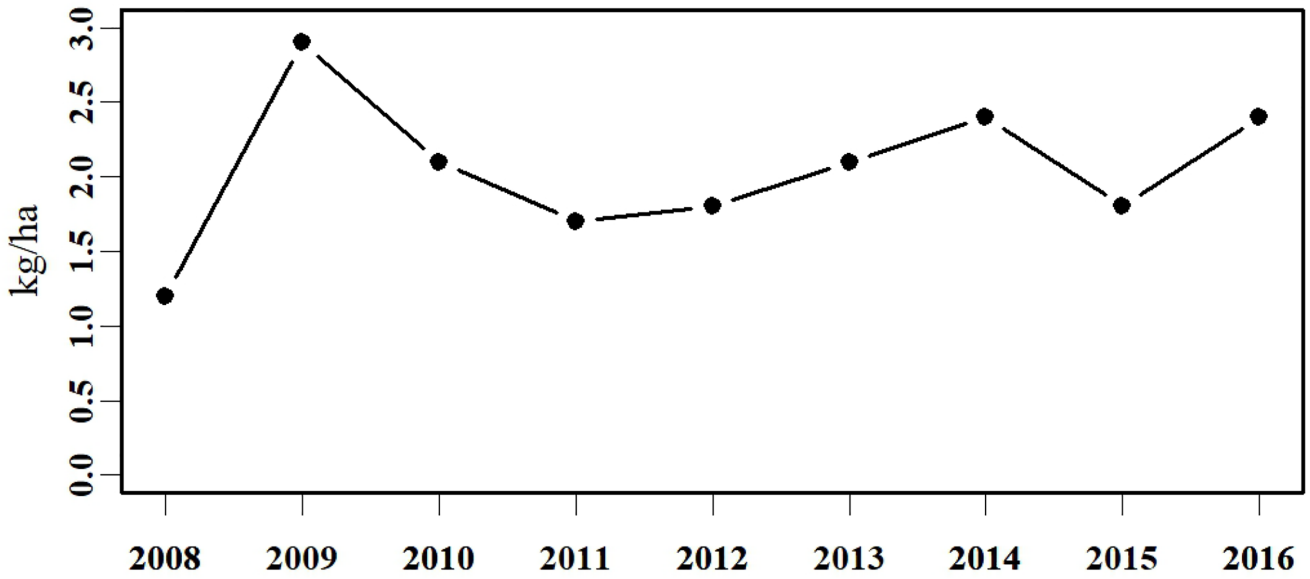


Figure 7.11. Fertilizer consumption in Uganda (Source: Statistical Abstracts for Uganda – 1990 to 2015).

Box 7.2 demonstrates nutrients replenishment. Figure 7.12 below, is based upon derivations of NPK uptake vs replacement using data of maize production, reported in the Statistical Abstracts 2017-18 (UBOS, 2017), and the findings in (Palm et al. 1997), which show that 80 kg N, 18 kg P and 60 kg K is required to produce 2 t of maize grain and 3 t of stover . It goes a long way to suggest that if nutrients removed with the harvest are not replenished using inorganic fertilizers or manure, the soils will have a negative nutrient balance, hence long-term decline in soil fertility and crop yield, which is not sustainable.

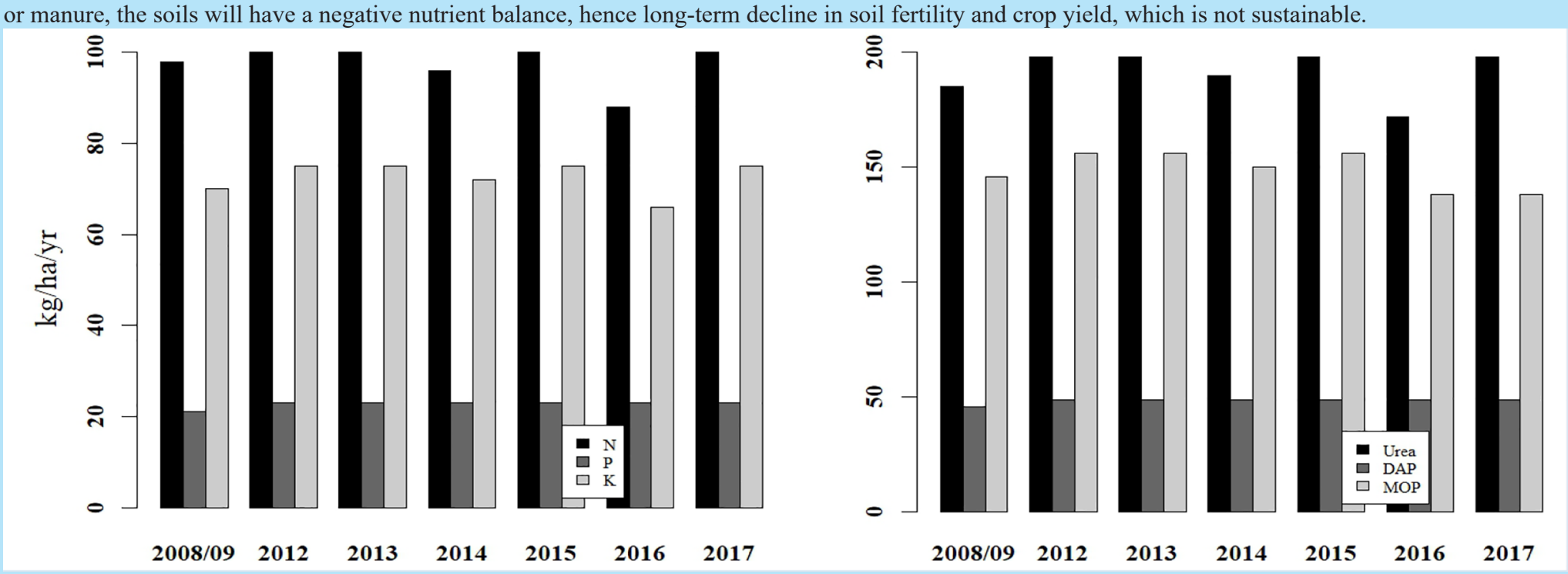


Figure 7.12. Amounts of nutrients removed from the soil (left) and amount of fertilizers required to replenish the soil.

Recently, there has been a drive towards the use of organic manure. However, its use is affected by limited quantities available due to competing uses, such as animal fodder. Further, for green manure, land has to be kept out of production for some seasons, which is not a viable option due to limited arable land. Use of livestock manure is limited by quality, which varies with fodder, availability of fodder, and drudgery, associated with the application of manure in gardens.
Generally, farmers do not profit from the use of fertilizers and manure because they have failed to adopt good agronomic practices. These include timely field preparation, early planting, and use of improved seeds, timely weed control, pest and disease control, and soil and water management. Further, farmers and their advisors are not aware of the 4Rs nutrient stewardship, including applying the ***Right Source*** of nutrients, at the ***Right Rate,*** at the ***Right Time***, and using the ***Right Method***. Boxes 7.4 further illustrate the importance of fertilizer usage and box 7.5 is an economic analysis of fertilizer use to for three main crops (maize, rice and beans) grown in Uganda.

Box 7.4 shows that crop yield can be increased through the use of inorganic fertilizer and organic manures, in what is referred to as an integrated soil fertility management framework. This is intended to address the inherent low and declining soil fertility. However nutrient replenishment should be supplemented with appropriate soil and water conservation strategies and GAP.

The importance of fertilizers in replenishing soil nutrients and increasing crop yield, hence productivity, is demonstrated in figures 7.13 and 7.14. Significant increase in crop yield in response to application of organic manures and inorganic fertilizers has been reported in several studies conducted across the country. For instance, there was significant increase in yield of beans in response to application of beans-specific-NPK blends, with mean increase of 1.4 t ha-1 and in the range 0.9 to 1.5 t ha-1, during the first (2018A) and second rainfall (2018B) seasons. There was significant increase in yield of maize in response to application of maize-specific-NPK blends, with mean increase of 3.1 t ha-1 and 2.5 t ha-1 during the first and second rainfall seasons, and with range of 2.0 to 4 t ha-1 across seasons. Rice paddy yield increased by 2.8 t ha-1 due to the use of rice-specific-fertilizer blends.
There was a significant increase in maize yield in response to application of maize-specific-fertilizer blend, MAAIF (125 kg DAP ha-1 at planting and 125 kg urea ha-1) and Fertilizer Optimization Tool (FOT) recommendation (rate of 45 kg DAP/ha and 35 kg MOP at planting followed by 85 kg urea/ha after the second weeding), with mean increase of 3.4, 2.2 and 1.8 t ha-1 for the two seasons. This is evidence that the three recommendations are effective in increasing maize yield.

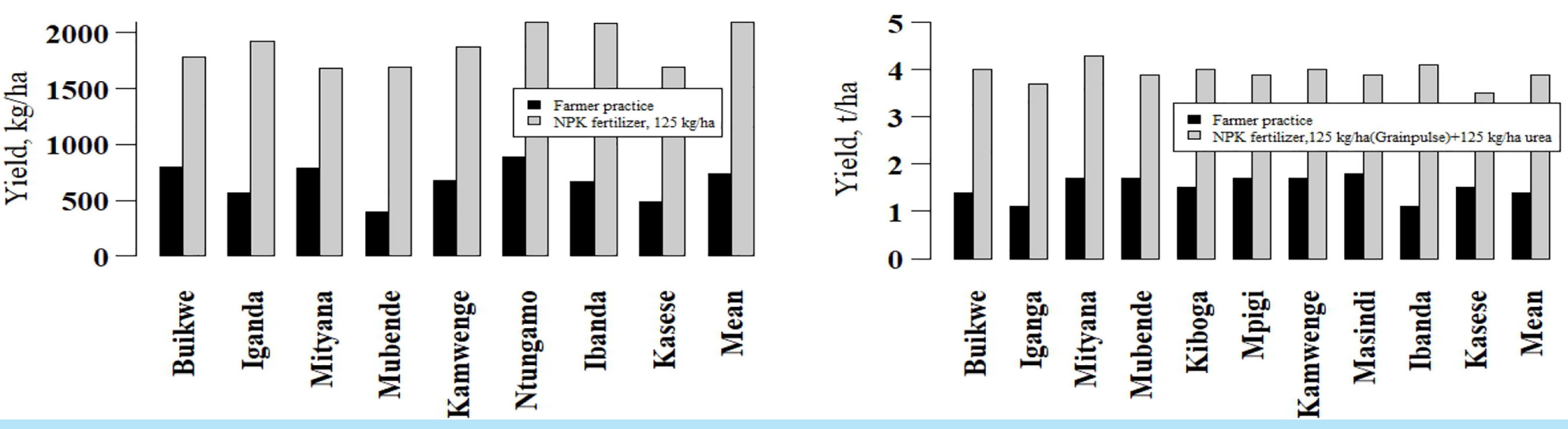


Figure 7.13. Average yield of beans (left) and maize (right) over two seasons (2018A and 2018B) in response to fertilizer application.

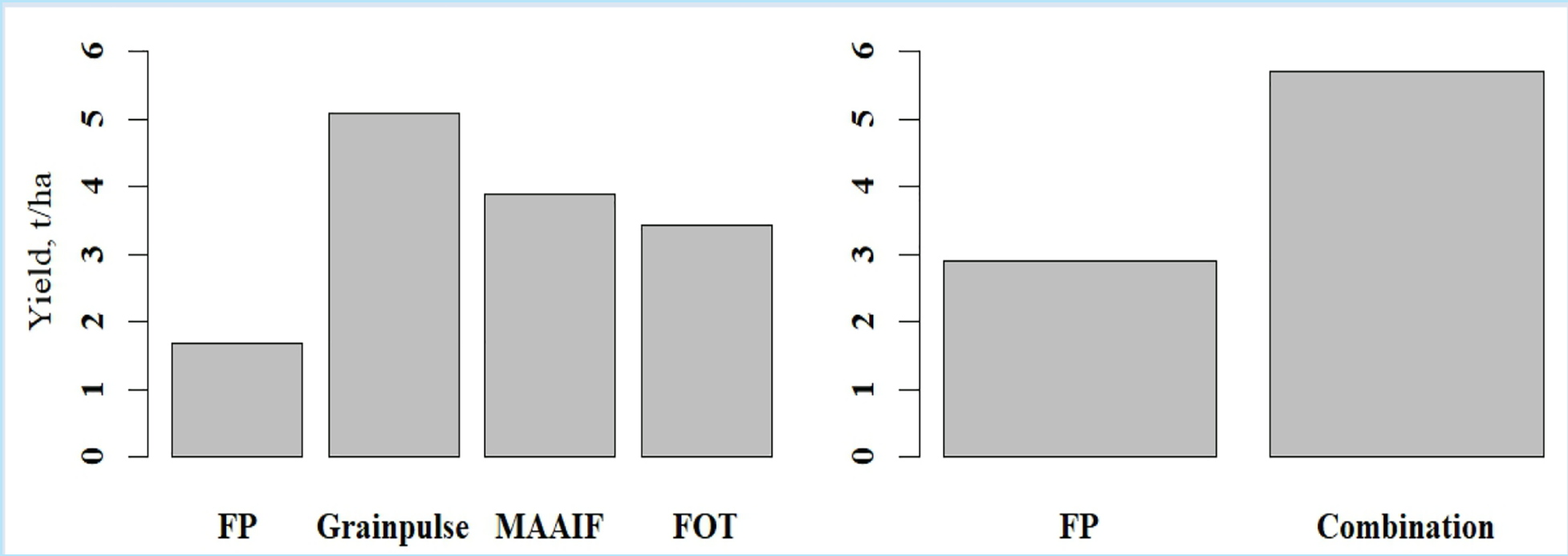


Figure 7.14. Average yield of maize (left) and rice (right) over a season (2018B) in response to fertilizer application. FP (left) is farmer practice without any amendment, FP (right) is farmer practice involving the use of 375 kg/ha urea + 125 kg/ha DAP. Grainpulse refers to a use of NPK fertilizer 250 kg/ha (Grainpulse) + 125 kg/ha urea; MAAIF is 125 kg/ha DAP + 125 kg/ha urea; FOT is 45 kg/ha DAP + 5 kg/ha HCL + 85 kg/ha urea (FOT); and combination here refers to NPK fertilizer 250 kg/ha (Grainpulse) + 250 kg/ha urea.

Box 7.5 Economic analysis of fertilizer use

The benefit to cost ratio (B/C) of applying maize-, beans- and rice-specific fertilizer blends is above 1, implying that the return to fertilizer application is sufficient for farmers to recoup the money invested in fertilizer use. However it is only in rice that the B/C ratio was above 2, a recommended ratio for technology adoption by farmers. Resource-poor farmers need large returns on the small investments they make, often requiring B/C of 2 within a six to twelve month period.

Fertilizer use is more profitable on rice, followed by beans and maize. This is attributed to the higher farm gate prices of rice compared to beans and maize. Therefore, the amount of fertilizers to apply, or the economically optimum fertilizer rate depends on the cost of nutrients (N, P, K) to farm gate price of the produce. That is, the quantity of produce a farmers has to sell to buy one kilo of nutrients. Therefore, a policy interventions is required to address challenges facing fertilizer usage in Uganda.

7.5.8 Challenges facing delivery of extension services

Prior to 1993, the organization structure for extension was fragmented – there were extension staff for everything related to agriculture, those for individual commodities, and those working on specialized programs and projects. This caused supervision problems and was financially wasteful, especially during this time when funding was limited. A harmonized organizational setup was adopted in 1993, but had little impact (Tibezinda 1996). The Plan for Modernization of Agriculture (PMA) was a response to this failure, and saw the creation of the National Agricultural Advisory Services (NAADS), in 2001, with a mandate to develop a demand-driven, farmer-led agricultural service delivery system targeting poor subsistence farmers, with emphasis on women, youth and people with disabilities. NAADS changed the landscape of delivery of extension services, culminating in a dominant government-led machinery of extension service delivery after 2008. It is variously reported that NAADS organized farmers and empowered them, increased adoption of agricultural technologies, and in some ways improved food security. Unfortunately, the program was derailed by politics, and to a large extent corruption, which increased the cost of service delivery, affecting quality of inputs and participation of farmers in government programs. In a way, this reversed any gains and explains the current trends in adoption of appropriate soil and land management practices.

7.6 Actions and policy responses

Within the National Agriculture Policy (NAP) framework, the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) developed the Agriculture Sector Strategic Plan (ASSP) with the mission of transforming the sector from subsistence to commercial agriculture. One of the four priority objectives of the ASSP is, "increasing access to critical farm inputs", within which enhancing access to and use of fertilizers for all categories of farmers is a strategic intervention. In line with this, Government prioritized increasing fertilizer use from the current low levels 0.23 -3.0 kg to 20.0 kg of nutrients per hectare by 2020, by putting in place the requisite policy and regulatory framework, including the National fertilizer Policy, Strategy and Regulations. To realize this, Government enacted the National Fertilizer Policy and the corresponding strategy in 2016, to address constraints to fertilizer use.

The Government also revived the Directorate of Agricultural Extension (DAES) and recruited extension staff to strengthen extension service delivery to farmers.

7.7 Recommendations

7.7.1 Soil mapping

a) Government should support efforts to develop a detailed soil map and associated maps of indicative soil properties, preferably at a scale of 1:50000, to guide land management. The soil data which was recently collected should be used together with legacy data to create a higher resolution soil map of the country within the framework of digital soil mapping, and the approach used to create maps in figures 7.1 and 7.3 should be adopted to create soil property maps at least every after ten years.

b) Government should support efforts to develop a detailed soil erosion risk map to guide the review of existing regulations to control soil erosion. The framework is well elaborated in Karamage et al. (2017) and has been tested by NEMA in southwestern Uganda to generate fairly high-resolution predictions.

7.7.2 Fertilizer production and usage

a) The National Agricultural Research Laboratory should be supported to produce nutrient deficiency maps required to guide the private sector in the production of balanced soil- and crop-specific fertilizers.

b) The National Agricultural Research Laboratory should be supported to intensify fertilizer research and guide fertilizer (both organic and inorganic) use, especially the promotion of fertilizer use along the 4Rs, use of balanced fertilizers and training of extension staff and other stakeholders in the areas of fertilizer use.

c) The National Agricultural Research Laboratory should partner with fertilizer blending companies in developing formulations of balanced fertilizers.

d) The National Agricultural Research Laboratory should be supported to develop fertilizer recommendations aimed at maximizing economic benefits.

e) The National Agricultural Research Laboratory should support the use of agricultural lime, because sometimes it is low pH and not nutrients that limit crop yield

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7.7.3 Legislation and review

a) NEMA should review the National Environment (Minimum Standards for Management of Soil Quality) Regulations, 2001, to update criteria for determining soil quality and consider other uses of soil beyond agriculture.

b). NEMA should review the National Environment (Hilly and Mountainous Area Management) Regulations, 2000, to consider emerging science in the areas of mapping and soil conservation.

7.7.3 Enforcement

a) Local Governments should enforce the adoption of appropriate soil and water conservation strategies as required by the relevant regulations and guidelines. It is important the Zonal Agricultural Research and Development Institutes support this effort.

b) MAAIF should enforce regulations to protect farmers from fake fertilizer products.

Bibliography

Barungi, M., Ng'ong'ola, D. H., Edriss, A., Mugisha, J., Waithaka, M., & Tukahirwa, J. M. (2013). Factors influencing the adoption of soil erosion control technologies by farmers along the slopes of Mt. Elgon in Eastern Uganda. Sustainable Development, 6(2), 9-25.

Bekunda, M. A., Bationo, A., & Ssali, H. (1997). Soil fertility management in Africa: A review of selected research trials. In R. J. Buresh, P. A. Sanchez, & F. Calhoun (Eds.), Replenishing Soil Fertility in Africa (Vol. SSSA Special Publication Number 51, pp. 63-79). Madison, WI: American Society of Agronomy and Soil Science

Bekunda, M. A., & Kaizzi, C. (2008). Soil health program country report, Uganda. Backgound for AGRA investment in Uganda.

Bhattacharya, A. (2019). Chapter 1 - Global Climate Change and Its Impact on Agriculture. In A. Bhattacharya (Ed.), Changing Climate and Resource Use Efficiency in Plants (pp. 1-50): Academic Press.

Brady, N. (1990). The nature and properties of soils (10th ed.): Macmillan Publishing Company, Cranbury.

Byamukama, W., Ssemakula, E., & Kalibwami, R. (2019). Factors influencing the uptake and sustainable use of soil and water conservation measures in Bubaare micro-catchment, Kabale District, western Uganda. Journal of Environment and Health Science, 5(1), 26-32, doi:10.15436/2378- 6841.19.2432.

Esabu, A., & Ngwenya, H. (2019). Socio-economic Factors Influencing Adoption Of Conservation Agriculture In Moroto District, Uganda. South African Journal of Agricultural Extension, 47, 105-117.

Goss, M. J., Carvalho, M., & Brito, I. (2017). Chapter 1 - Challenges to Agriculture Systems. In M. J. Goss, M. Carvalho, & I. Brito (Eds.), Functional Diversity of Mycorrhiza and Sustainable Agriculture (pp. 1-14): Academic Press.

Grieve, I. C. (2001). Human impacts on soil properties and their implications for the sensitivity of soil systems in Scotland. Catena, 42(2), 361-374, doi:https://doi.org/10.1016/S0341-8162(00)00147-8.

Harop, J. (1970). Soils. In J. D. Jameson (Ed.), Agriculture in Uganda (pp. 43-71). Oxford: Oxford University Press.

*Holland, J.
., Bennett, A. E., Newton, A. C., White, P. J., McKenzie, B. M., George, T. S., et al. (2018). Liming impacts on soils, crops and biodiversity in the UK: A review. Science of the Total Environment, 610-611, 316-332, doi:https://doi.org/10.1016/j.scitotenv.2017.08.020.*

IFDC (2011). The Africa Fertilizer Summit: How much progress has been made in the last five years? . In L. Thigpen (Ed.), IFDC Report. Volume 36, No. 2:15 & 17.

Kagoya, S., Paudel, K. P., & Daniel, N. L. (2018). Awareness and adoption of soil and water conservation technologies in a developing country: a case of Nabajuzi watershed in Central Uganda. Environmental Management, 61(2), 188-196, doi:10.1007/s00267-017-0967-4.

Karamage, F., Zhang, C., Liu, T., Maganda, A., & Isabwe, A. (2017). Soil Erosion Risk Assessment in Uganda. Forests, 8(2), 52.

*Mango, N., Makate, C., Tamene, L., Mponela, P., & Ndengu, G. (2017).
Awareness and adoption of land, soil and water conservation practices in the Chinyanja Triangle, Southern Africa. International Soil and Water Conservation Research, 5(2), 122-129, doi:https://doi.org/10.1016/j.iswcr.2017.04.003.*

*Miiro (2001). Factors enhancing terrace use in the highlands of Kabale District,Uganda. In D. E. Scott, R. H. Mohtar, & G. G. Steinhardt (Eds.), Sustaining the global farm: selected papers from the 10th International
Soil Conservation Organization Meeting held May 24-29, 1999, at Purdue University and the USD-ARS National Soil Erosion Research Laboratory (pp.356-361).*

Mugonola, B., Deckers, J., Poesen, J., Isabirye, M., & Mathijs, E. (2013). Adoption of soil and water conservation technologies in the Rwizi catchment of south western Uganda. International Journal of Agricultural Sustainability, 11(3), 264-281, doi:10.1080/14735903.2012.744906.

Musinguzi, P., Tenywa, J. S., Ebanyat, P., Basamba, T. A., Tenywa, M. M., Mubiru, D. N., et al. (2015). Soil organic fractions in cultivated and uncultivated Ferralsols in Uganda. Geoderma Regional, 4, 108-113, doi:https://doi.org/10.1016/j.geodrs.2015.01.003.

Nandwa, S. M. (2001). Soil organic carbon (SOC) management for sustainable productivity of cropping and agro-forestry systems in Eastern and Southern Africa. Nutrient Cycling in Agroecosystems, 61(1), 143-158, doi:10.1023/a:1013386710419.

NASECO (2017). Nalweyo Seed Company: Crop varieties. Unpublished data.Okoboi, G., &

Barungi, M. (2012). Contraints to fertilizer use in Uganda: insights from Uganda census of agriculture 2008.9. [Article]. Journal of Sustainable Development, 5(10), 99-113.

Palm, C. A., Myers, R. J. K., & Nandwa, S. M. (1997). Combined use of organic and inorganic nutrient sources for soil fertility maintenance and replenishment. In R. J. Buresh (Ed.), Replenishing soil fertility in Africa (Vol. SSSA Special Publication 51, pp. 1993-1217). Madison, WI: SSSA.

Ssali, H. (2000). A century of soils research and development in Uganda. Uganda Journal of Agricultural Sciences, 5, 22-27.

Tibezinda, J. (1996). Measures of extension impact: a comparative study of three agricultural extension programs in Hoima District, Uganda. Ohio State University,

UBOS (2006). Statistical Abstract. Kampala: Uganda Bureau of Statistics (UBOS).

UBOS (2017). Statistical Abstract. Kampala: Uganda Bureau of Statistics (UBOS).

Umezaki, M., Yukio, K., Taro, Y., & Ohtsuka, R. (2000). Impact of population pressure on food production: an Analysis of land use change and subsistence pattern in the Tari Basin in Papua New Guinea highlands. Human Ecology, 28(3), 359-381.

Wortmann, C. S., & Kaizzi, C. K. (1998). Nutrient balances and expected effects of alternative practices in farming systems of Uganda. Agric Ecosystem Environ, 71(1), 115-129.

Zhang, F., Zhan, J., Zhang, Q., Yao, L., & Liu, W. (2017). Impacts of land use/cover change on terrestrial carbon stocks in Uganda. Physics and Chemistry of the Earth, Parts A/B/C, 101, 195-203, doi:https://doi.org/10.1016/j.pce.2017.03.005.

Chapter 8: Environmental Hazards and Disasters

8.1 Introduction

An environmental hazard is a substance, a state or an event which has the potential to threaten the surrounding natural environment/ adversely affect people's health, (https://en.wikipedia.org/wiki/Environmental_hazard 1-09-2020); while an environmental disaster is an incident which takes place due to naturally or human actions which result in harmful impact upon the natural environment (https://en.wikipedia.org/wiki/Environmental_disaster 1-09-2020).

The hazards that have devastated the country can be classified as Hydro-meteorological hazards (droughts, floods, hailstorm, windstorm and lightning), Geological hazards (earthquakes, landslides/ mudslides and rock falls), Biological hazards (pests/vectors and diseases, human epidemics and invasive species), and Human induced hazards (accidents, fires, terrorism, internal displacement of persons, human-animal conflicts and land conflicts).
This chapter presents major hazards reported to have caused destruction in the different parts of Uganda. It is structured to show the current status and trends of natural hazards and disasters including occurrences and distributions, pressures and impacts on the environment and society, human responses in terms of actions and recommendations for mitigation and adaptation. A Desinventar was the main source of disaster related data and information (https://www.desinventar.net). The trend of disasters was examined from 2008 to 2018.

8.2 Status and Trends, Pressures and Impacts

The hazards and disasters are each discussed in terms of status, trends pressures and impacts.

8.2.1 Drought

Drought continues to affect the livelihood of many people in Ugandan. The droughts experienced are seasonal and meteorological in nature, they are characterized by low humidity, high temperatures, strong dry winds, reduced water levels, displacement of people, migration and death of animals, reduced soil moisture, cracking of soils and wilting of plants. These normally last for about 3-4 months especially from December to March of each year.

Figure 8.1 shows that Karamoja and West Nile sub regions have the highest number of drought incidences in the country followed by the south western and northern sub regions. The most affected districts were; Karenga and Kaabong in Karamoja sub region, Arua, Madi-Okollo, Nebbi, Packwach and Zombo in West Nile sub region. Mbarara in the south western sub region, Kiboga in Central sub region and Lira in the Northern sub region.

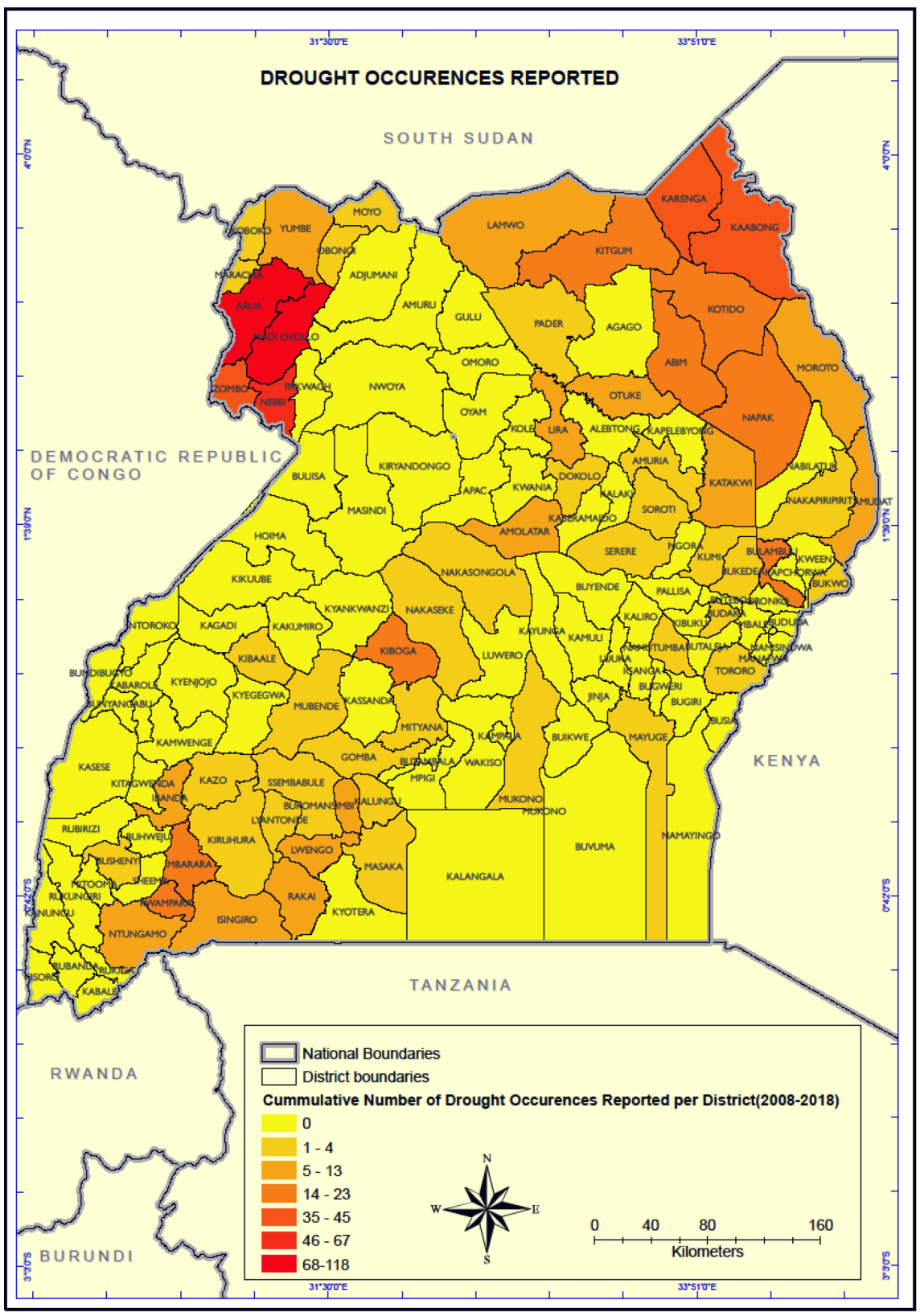


Figure 8.1: Drought incidences in Uganda

The trend of drought (Figure 8.2) shows an increase in incidences from 33 in 2017 to 48 in 2018.

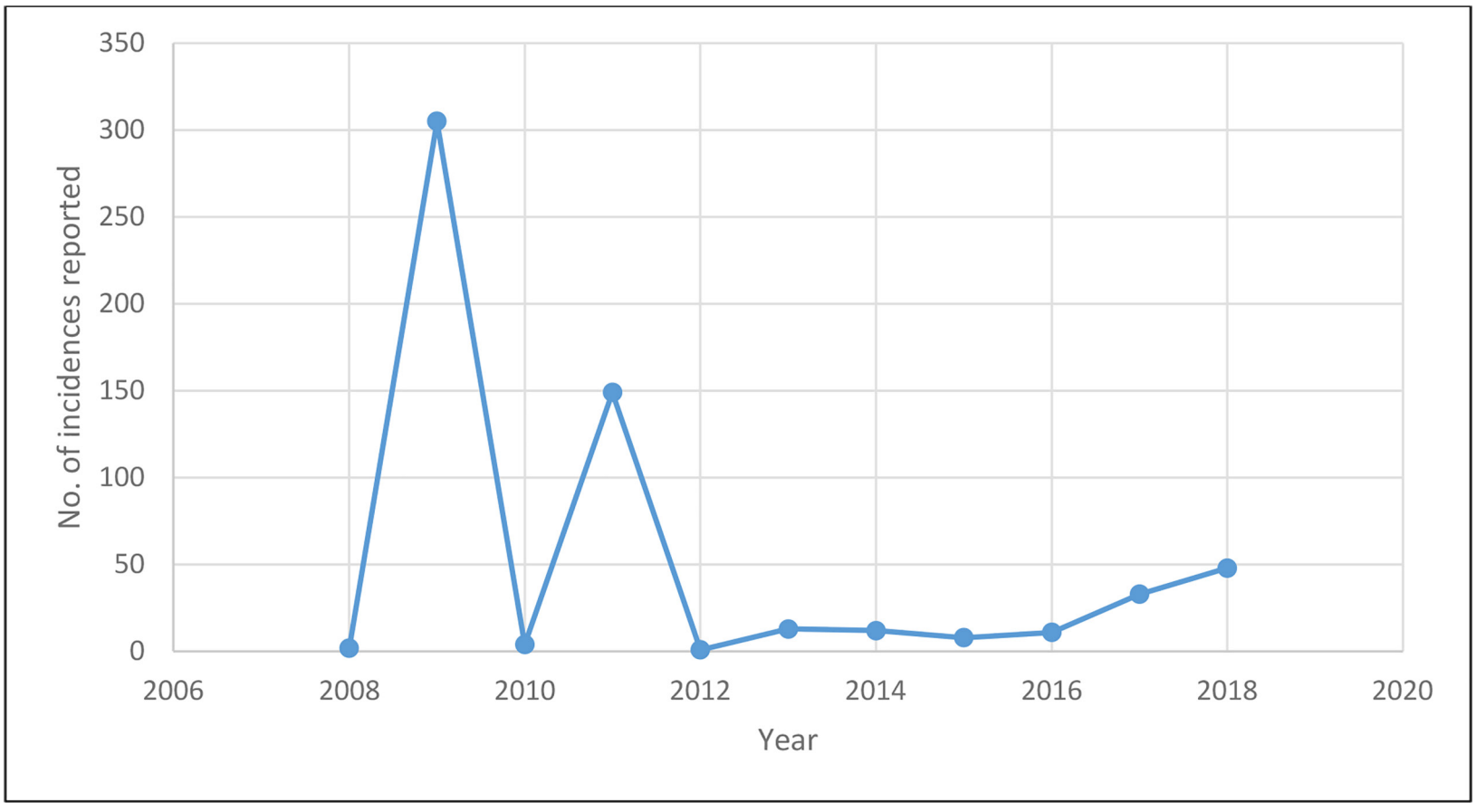


Figure 8.2: Trend of Drought incidences in Uganda

Natural and anthropogenic factors trigger the occurrences of droughts in Uganda. The major causes are climate change and environmental degradation. Uganda has suffered from severe droughts periodically for the past 2 years. Droughts have greatly affected Uganda's agricultural sector, environment and functionality of water based facilities. In Karamoja, drought caused food scarcities especially in the months of April, May and June (Akwango et al., 2017). The reported drought was attributed to climate change and human activities such as bush burning, deforestation and wetland degradation. Raising temperatures have threatened the availability of water for crops and animals.

According to the latest Integrated Food Security Phase Classification (IPC) analysis, conducted in Karamoja and in Teso sub regions, about 475 000 people (18 percent of the population of the two sub regions) were estimated to be severely food insecure between January and March 2019. The most affected districts were; Abim, Kaabong, Kotido and Moroto districts in Karamoja sub region and Bukedea, Kumi and Ngora in Teso sub region. The food insecure caseload increased by more than 70 percent from late 2018, when it was estimated at 277 000 people due to substantial crop production shortfalls in 2018. Caravani (2019) also reported that over the past two generations, livestock loss and hunger, caused by drought, has driven many transhumant agro-pastoralists living in central Karamoja to resettle in unpopulated areas more suitable for agricultural production.
Rain-fed dependent farmers are the most affected.

8.2.2 Floods

Over the years, Uganda continues to experience a series of devastating floods, much as it takes actions against climate change and its impacts as required by Sustainable Development Goal No. 13. Flash floods that are seasonal in nature are the most common and are more pronounced in the months of April/May and October/November of each year.

Figure 8.3 shows that the most affected districts were Kasese, Kabale, Kisoro, Nebbi, Katakwi, Amuria, Butaleja, Tororo and Sironko. Regionally, south western, eastern and Karamoja sub regions had the highest number of reported cases of floods.

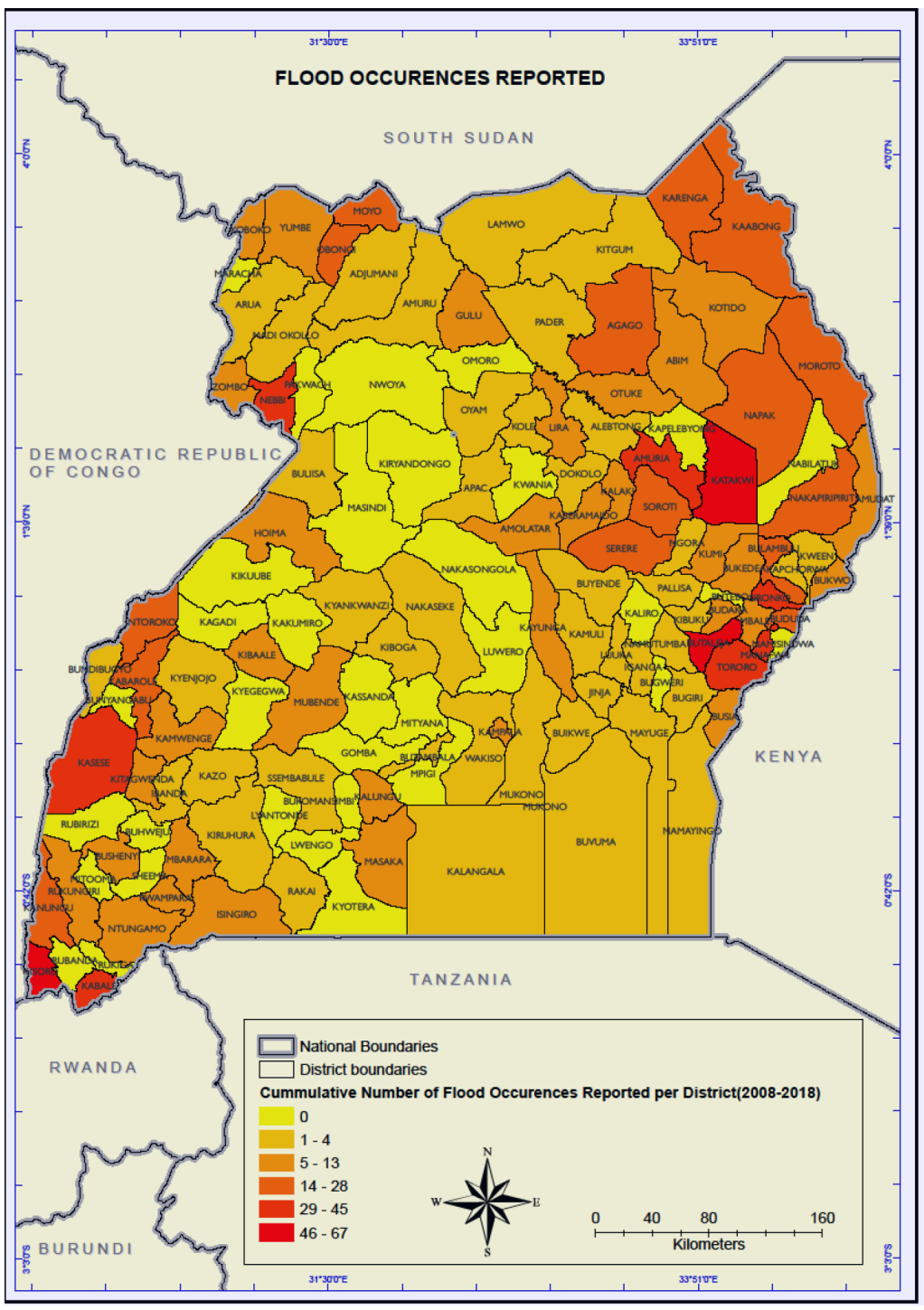


Figure 8.3: Status of floods in Uganda

The trend of occurrence (Figure 8.4) of floods is on the increase from 93 in 2017 to 113 in 2018.

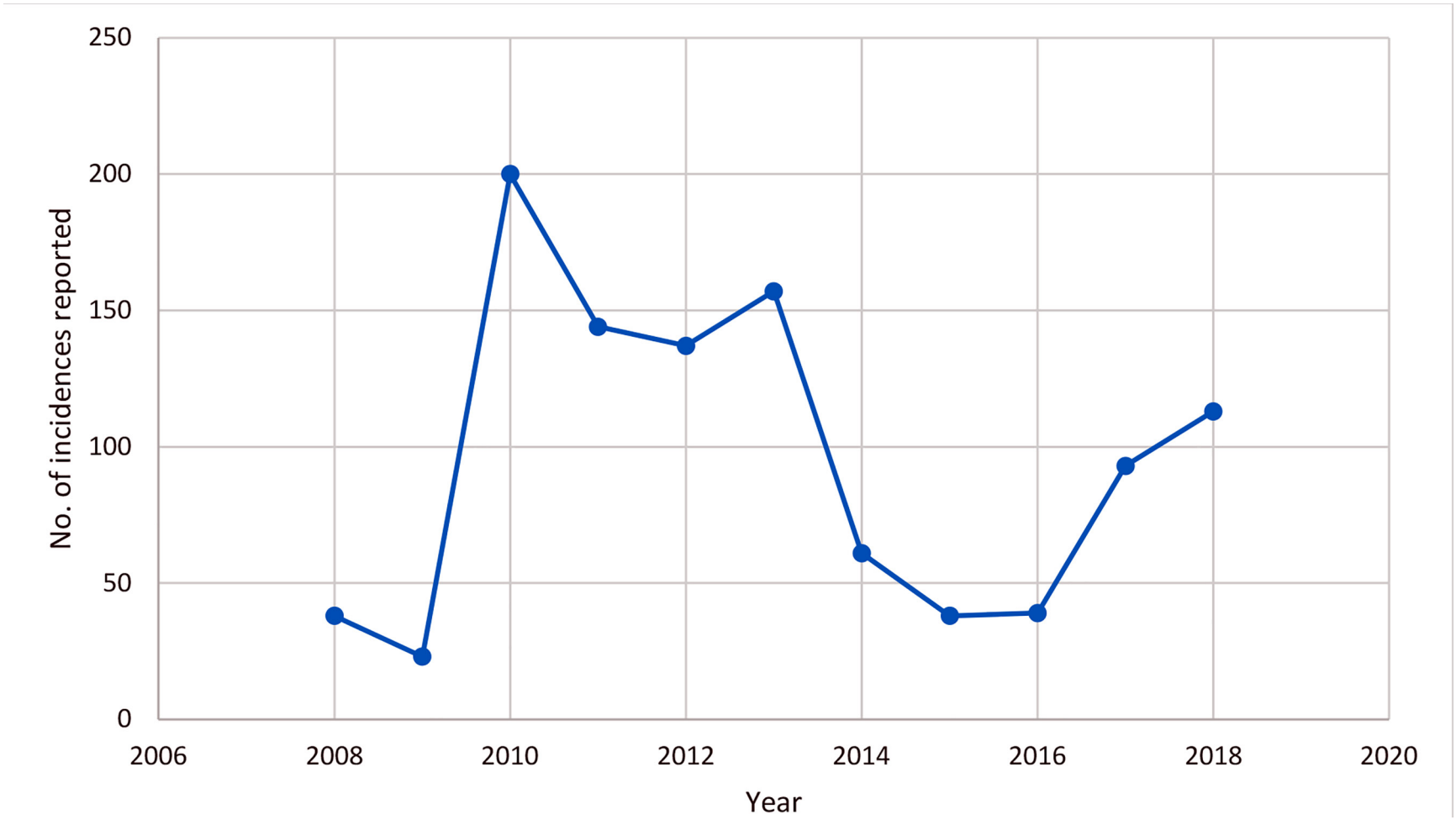


Figure 8.4: Trend of flood incidences reported between 2008 and 2018

Deforestation, wetland degradation, poor waste management, prolonged rains and climate change effects are the major factors that trigger frequent re-occurrences of floods in Uganda. The floods experienced today are more destructive than before and are associated with increases in water quantity, pollution of water and increased water table. The floods have also become unpredictable due to shifts in seasonal sea surface temperatures in the Indian Ocean.

The impacts of floods have been felt in various ways including; loss of lives(as in 2018 in Kampala and Teso sub region), destruction of settlements, vegetation, crops, Infrastructure (roads , bridges, hospitals, schools), displacement of people, outbreak of diseases like in Teso sub region. In Kampala alone over 500 households were affected. Schools too were affected and this had an impact on the education of children in the affected areas.
In 2017, Kiisizi hospital (Plate 8.1, 8.2) in Rukungiri District was also affected by floods interrupting water supplies and cutting off staff housing from the main hospital area.

Plate 8.1. Kiisizi hospital main in-patient area

Plate 8.2: Flooded area behind Maternity ward

Plate 8.3: Blocked drain

In Bugisu sub region Sironko district in 2019 the mass movement of soil down the hills into river Bugibuni prompted it to burst its banks there by causing flooding in the area.

In 2019 Namabasa Sub-County Mbale district, flash floods caused River Namatala and River Nabuyonga to overflow their banks. The impact directly affected 299 households in an area with a population of 1,803. The most affected villages were those adjacent to river Namatala; which includes Kibumbire Zone and Doko.

Plate 8.4: Flooding along Mbale - Butalejja Road

8.2.3 Wind and Hailstorms

Devastative periodic hailstorm events still occur in Uganda. Hailstorm threats are on the increase since the last decade. These have put the country at the risk of attaining Sustainable Development Goal No. 2 of ending hunger in the country, despite the government's effort to encourage communities to plant trees to protect crops from hailstorms. Hailstones (ice pelts) are associated with heavy rains. The hailstones consist mostly of water ice and measured between 5 millimeters (0.2 in) and 15 centimeters (6 in) in diameter.

The results in figure 8.5 show that the western region is the most affected by hailstorms followed by central and eastern regions. Districts that were prone included Mbarara, Rwampara, Ibanda, Kitagwenda, Kabarole, Bushenyi, Ssembabule, Kibaale, Kyankwanzi, Pallisa and Namutumba.

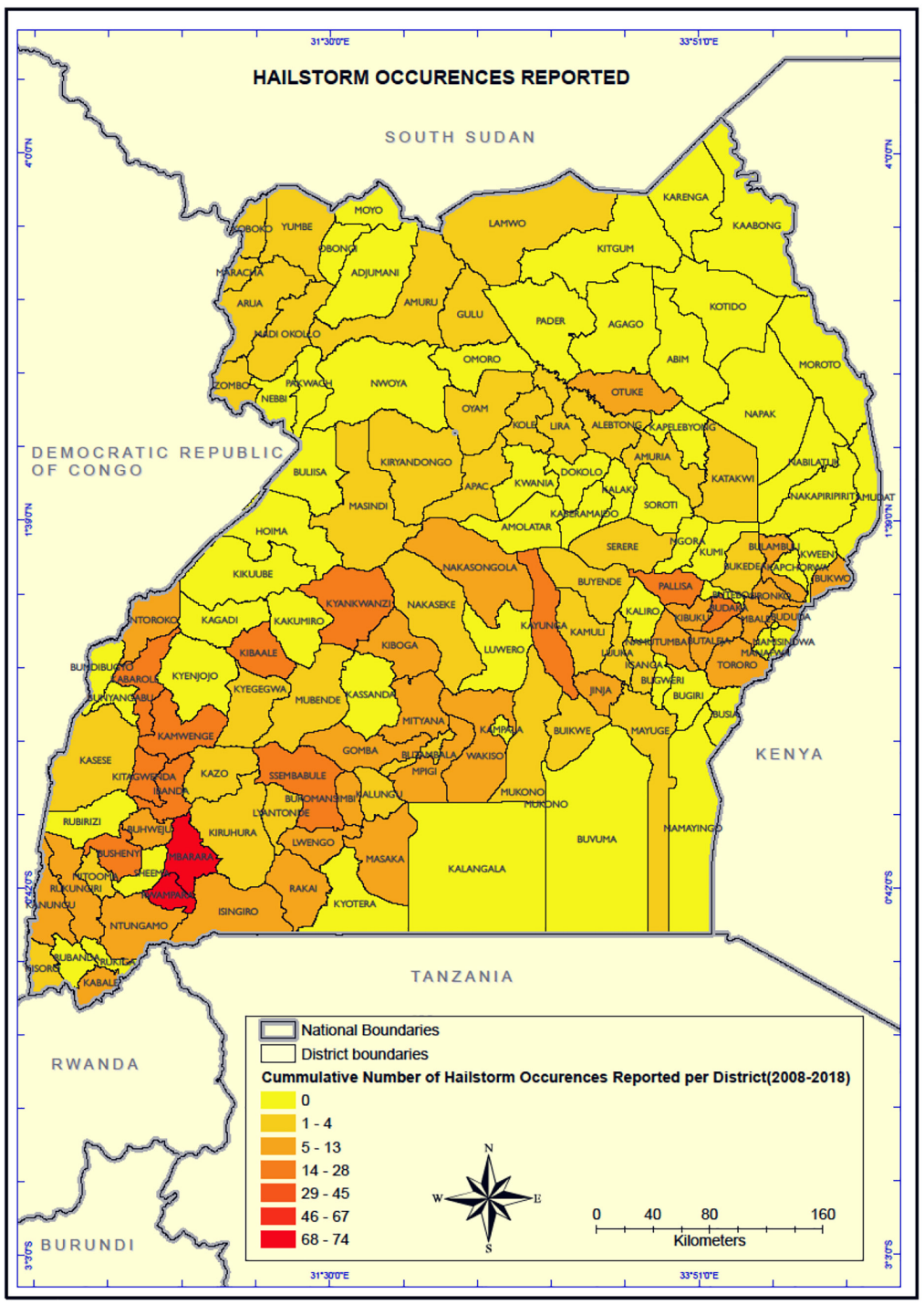


Figure 8.5: Hailstorm incidences recorded between 2008 and 2018.

The trend in figure 8.6 shows that the occurrence of hailstorm has been on the increase with 22 in 2017 and 74 in 2019.

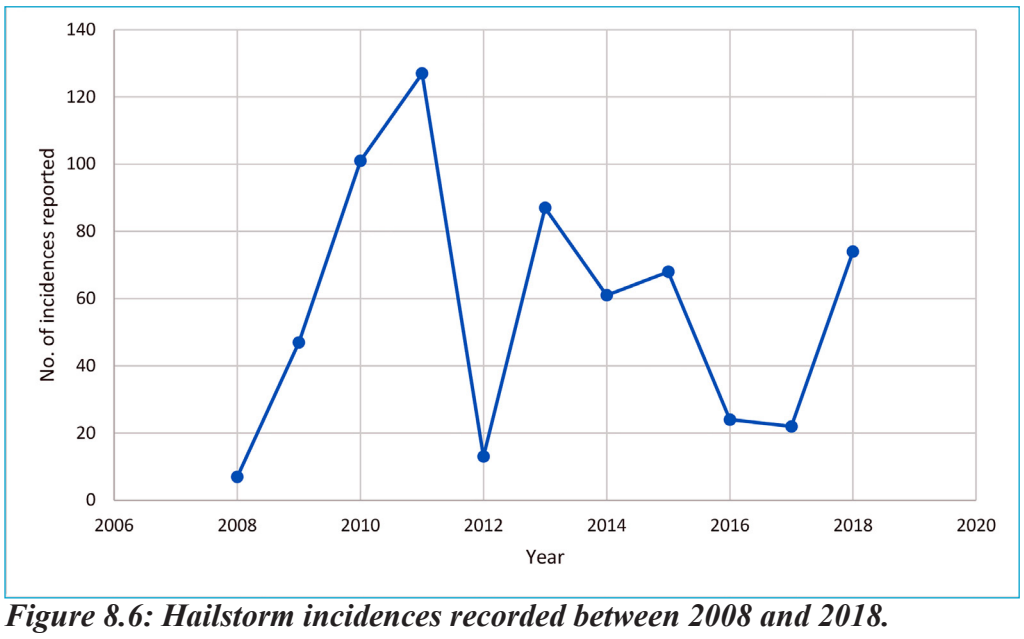


Figure 8.6: Hailstorm incidences recorded between 2008 and 2018.

The occurrence of strong winds is attributed to erratic changes in local and global climatic conditions and anthropogenic activities such as tree cutting. The blowing of winds is highly influenced by topography, water bodies and vegetation cover. Most of the winds were caused by differences in the atmospheric pressure.

At the peak of these winds and hailstorms, rural smallholder farmers are the most affected. They cause destruction of homesteads, churches (plates 8.7 and 8.8) vegetation, air pollution, migration and death of biodiversity, crops (plate 8.5 and 8.6) and spread of human diseases. They also modify local climatic conditions and affect the most critical sector (agriculture) that supports the livelihood of many (above 70%) Ugandans.

Plate 8.5: Cassava field destroyed by hail in Rwenzori region

Plate 8.6: Banana plantation damaged by hailstorm in Western Uganda

Plate 8.7: Windstorm effect on church house in Kyabarungira, Kasese district (Photo by Geo-observer)

Plate 8.8: A church in Kitholhu, Kasese destroyed by windstorm (Photo by Geo-observer Windstorm

Over the years, the incidences of windstorm are on the increase and are seasonal in nature (occur in dry and wet periods). Long-duration winds have various names associated with their average strength, such as breeze, gale, storm, and hurricane (NOAA, 2008).

Figure 8.7 shows that the most affected districts were Mbarara, Rwampara, Mitooma, Kazo, Kiruhura and Ntungamo.

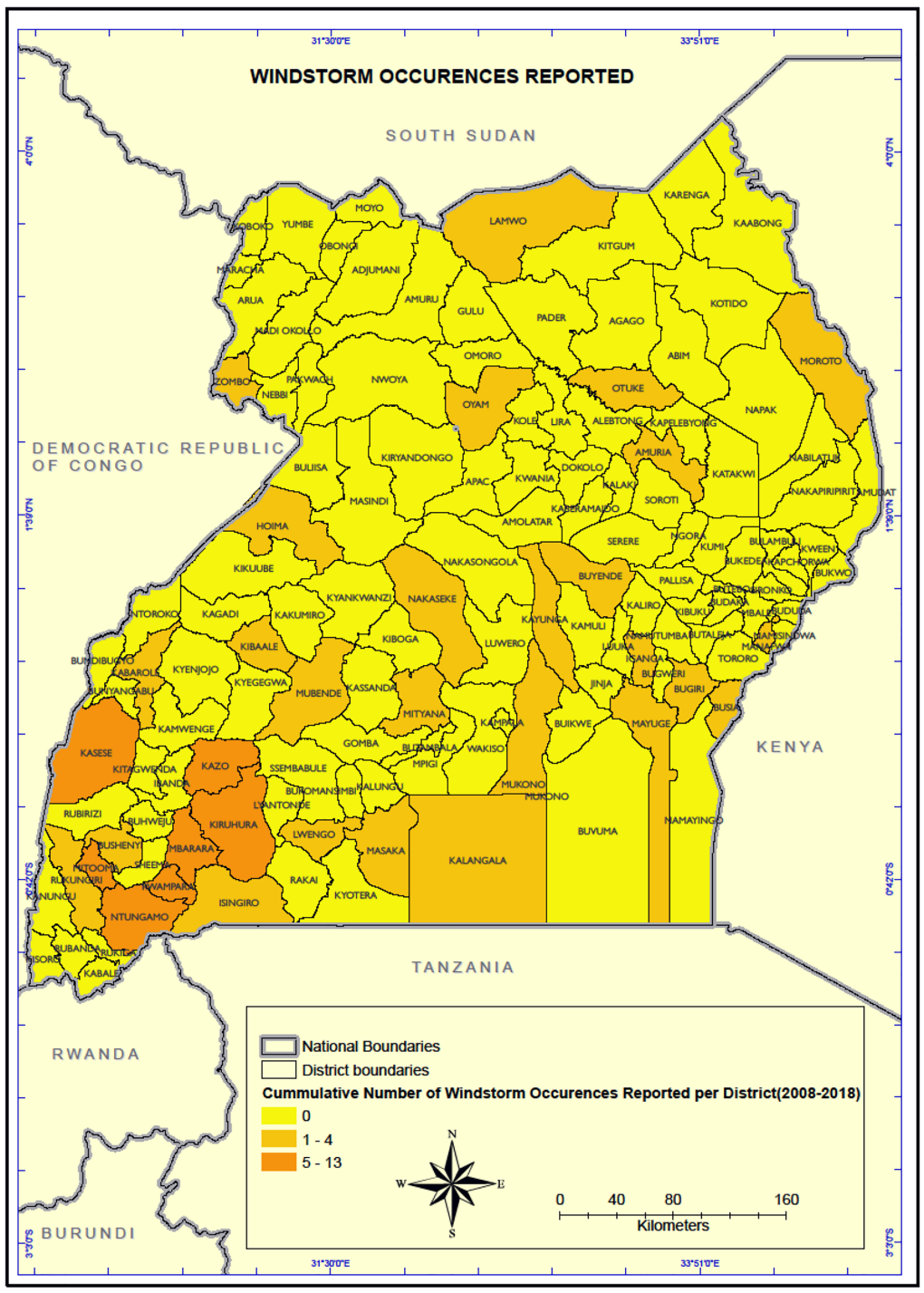


Figure 8.7 Windstorm incidences recorded between 2008 and 2018

The trend (Figure 8.8.) shows that the occurrence of windstorm has been on the increase for the last three years from 2016 to 2018.

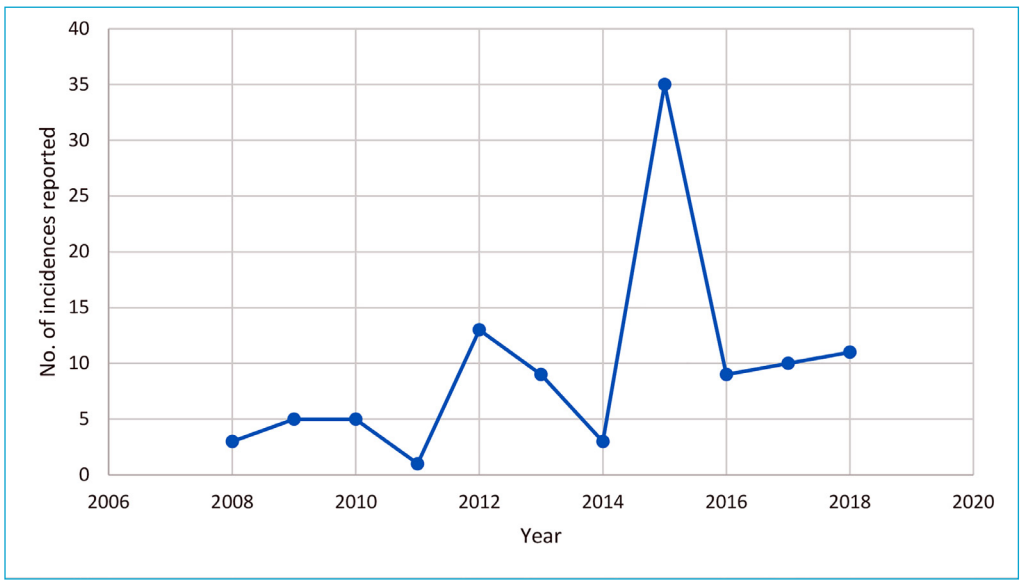


Figure 8.8: Windstorm occurrence from 2008 to 2018

8.2.4 Lightning

Uganda experiences one of the most lethal lightning strikes in the world. The country suffers approximately 70 lightning strikes in a year. Over the years, the numbers of reported lightning incidences have increased. The lightning strikes can be categorized into two types: i) Ground flash discharge between a cloud and the earth; and ii) Cloud flash discharge within a cloud or between clouds.

Nearly all the regions experience lightning strikes (figure 8.9). Severe cases are found in West Nile, Mid-western, Central, Eastern and Northern with the most lethal strikes recorded in the districts of Arua, Madi-Okollo, Hoima, Kibaale, Buikwe, Mayuge and Alebtong.

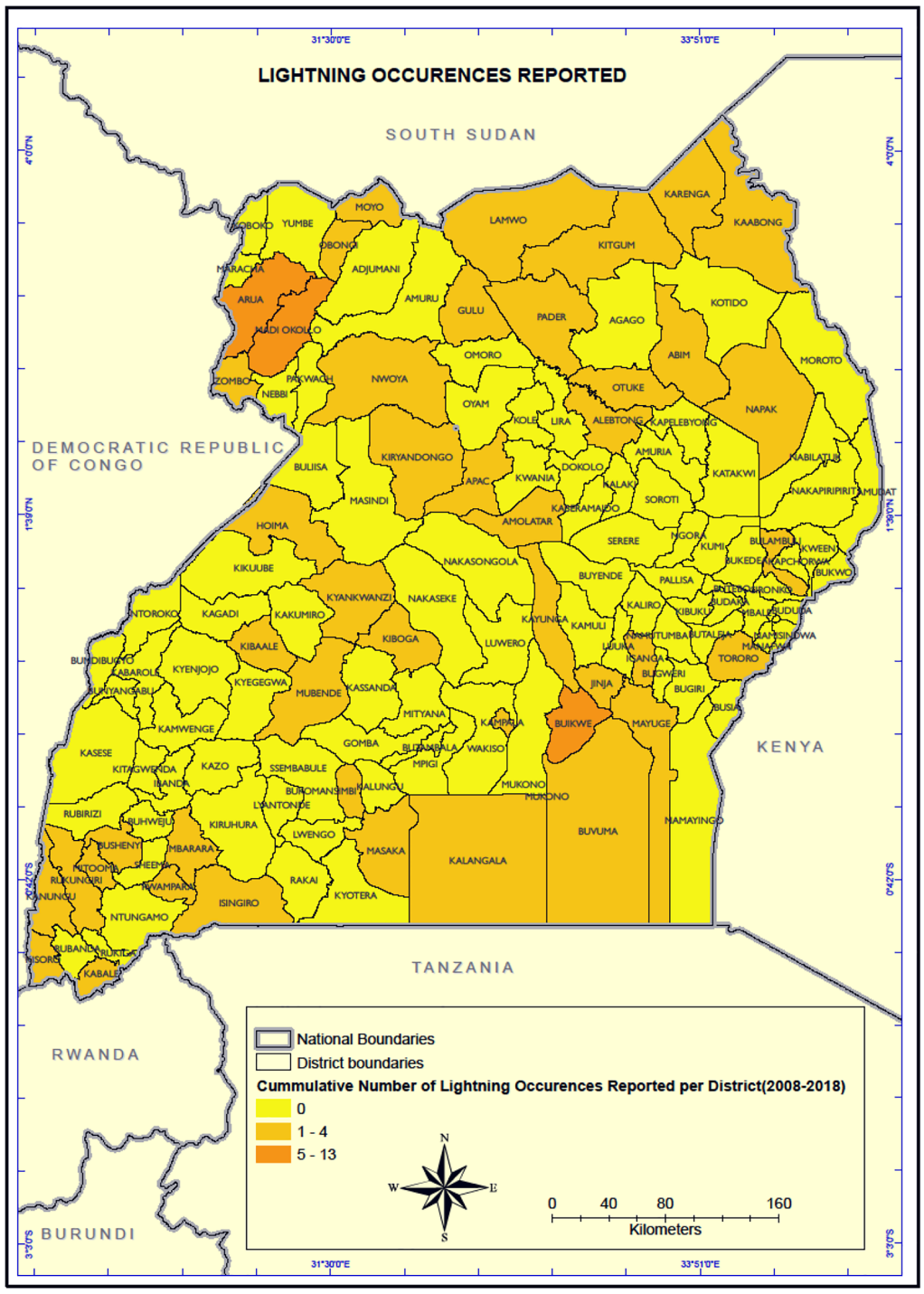


Figure 8.9: Lightning incidences between 2008 and 2018.

In terms of the trend Figure 8.10 shows a slight increase in the number of strikes in 2018 with no trends reported in 2017.

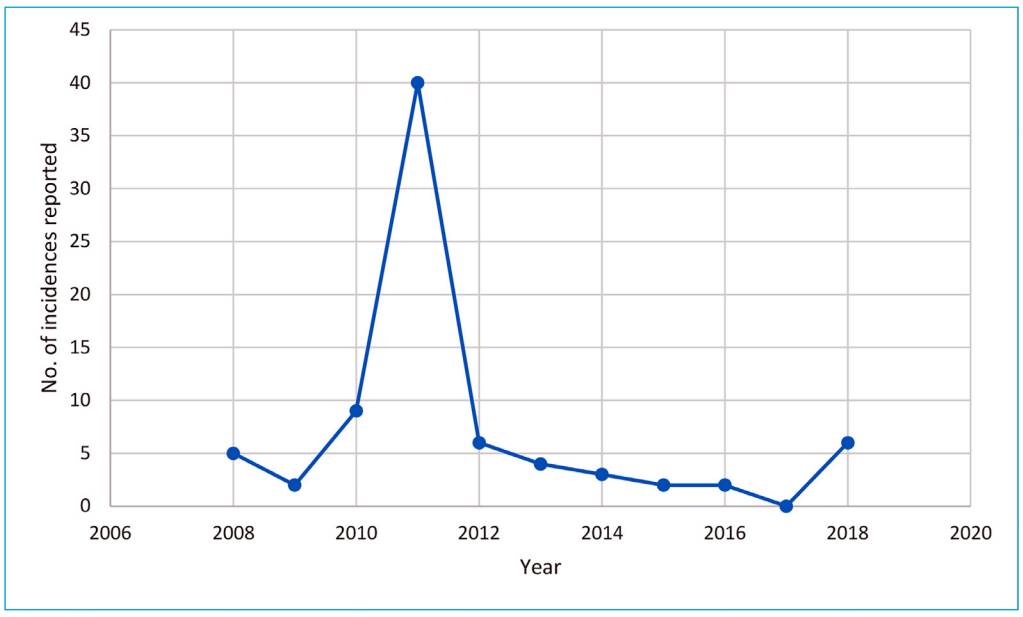


Figure 8.10: Lightning occurrence between 2008 and 2018.

Cloud formations is the main source of lightning threats. The causes of lightning damages can be classified into electrical (overvoltage), thermal (overcurrent), and mechanical (air expansion). In particular, the lightning incidences that occur in Uganda are majorly mechanical in nature influenced by the unusual surge of the moist air from the Atlantic Ocean and Congo air masses that occur during the rainy seasons.

The strikes are highly reported at the onset of rainy seasons. Lightning incidences are highly associated with deforested areas at high elevation levels.

The lightning incidences cause loss/injury of human beings and livestock, and destruction of vegetation, buildings (plate 8.9).

Between 2012 – 2015 over 395 children were lost to lightning signaling the largest gender group that is affected by lightning. 30 of these children were lost at one school in Iganga (*https://www.newvision.co.ug/new_vision/news/1409551/uganda-ranks-lightning-fatalities*). In 2016, eight pupils were killed in Bushenyi one of the districts prone to lightning (*https://www.newvision.co.ug/new_vision/news/1501449/people-killed-lightning-bushenyi*).

Plate 8.9: A house in Bundibugyo set ablaze by lightning

8.2.5 Earthquakes

Uganda continues to experience devastating effects of earthquake incidences whenever they occur. The western arm of the East African rift valley hosts the epicentre of earthquakes that have devastated the country. In Uganda, the western region is more prone to high risks of earthquakes. The most prone districts to earthquakes include Arua, Buhweju, Bundibugyo, Bunyangabu, Bushenyi, Ibanda, Kabarole, Kagadi, Kamwenge, Koboko, Kyenjojo, Maracha, Moyo, Nebbi, Ntoroko, Pakwach, Rubirizi, Yumbe and Zombo (OPM, 2019).

In the past two decades (1994-2017), a total of 95 earthquakes of Mag 3.7+ were recorded with the most severe being Mag 6.2 which occurred in 1994 in the Rwenzori region. Most earthquakes were recorded in 2002 with about 15 earthquakes of Mag 3.7+ followed by 2013 which recorded about 10 earthquakes of Mag 3.7+. In 2017, about 4 earthquakes of Mag 3.7+ were recorded including a big one of Mag 5.3 that caused buildings to collapse in Rakai. The frequency of earthquakes seems to be high and getting more severe than in the past. Figure 8.11 shows that between 2017 and 2018 the districts of Isingiro and Rakai were the most affected by the earthquake.

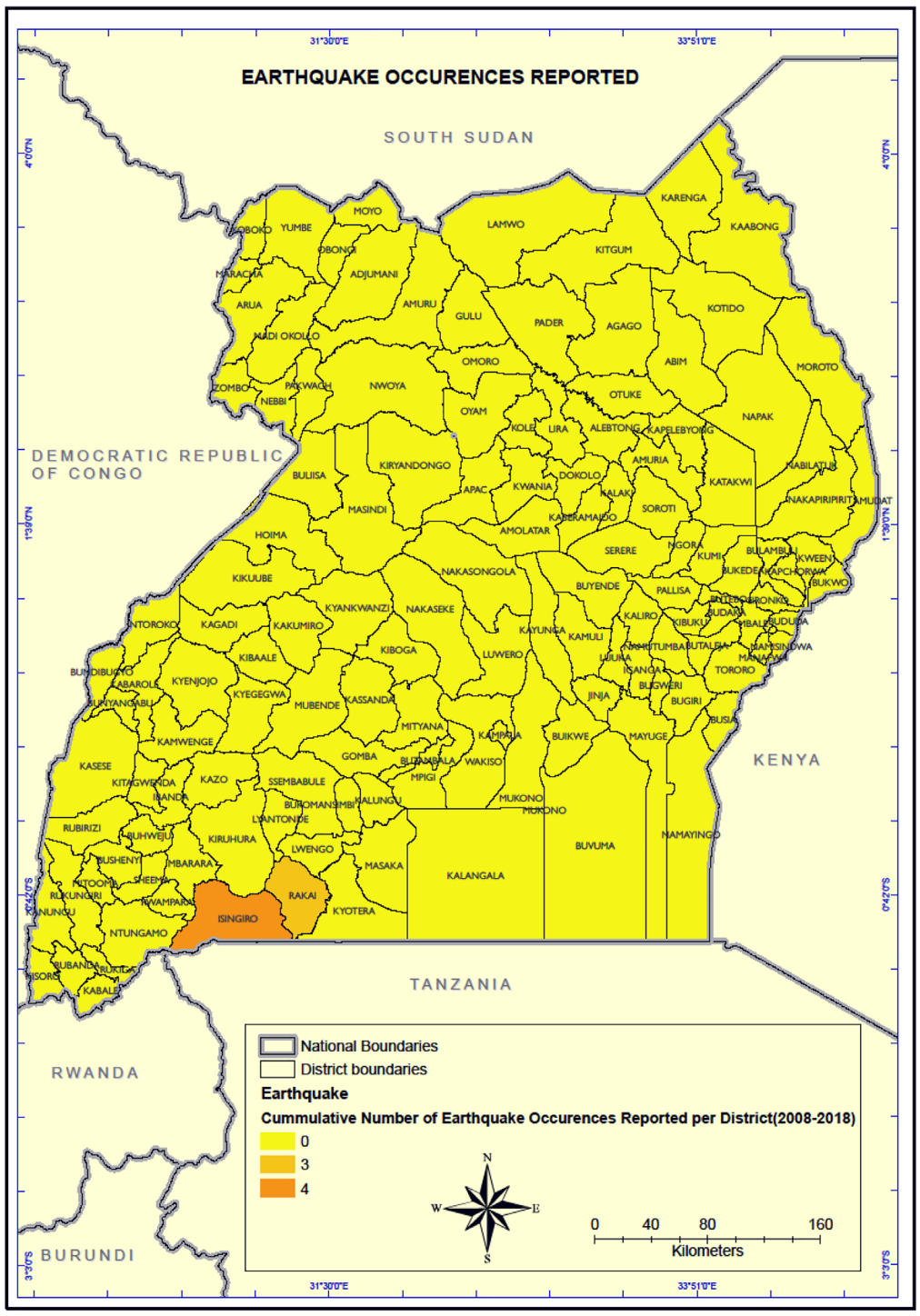


Figure 8.11: Earthquake incidences between 2008 to 2018.

The trend of earthquake occurrences is on the decrease from 4 in 2017 to 3 in 2018.

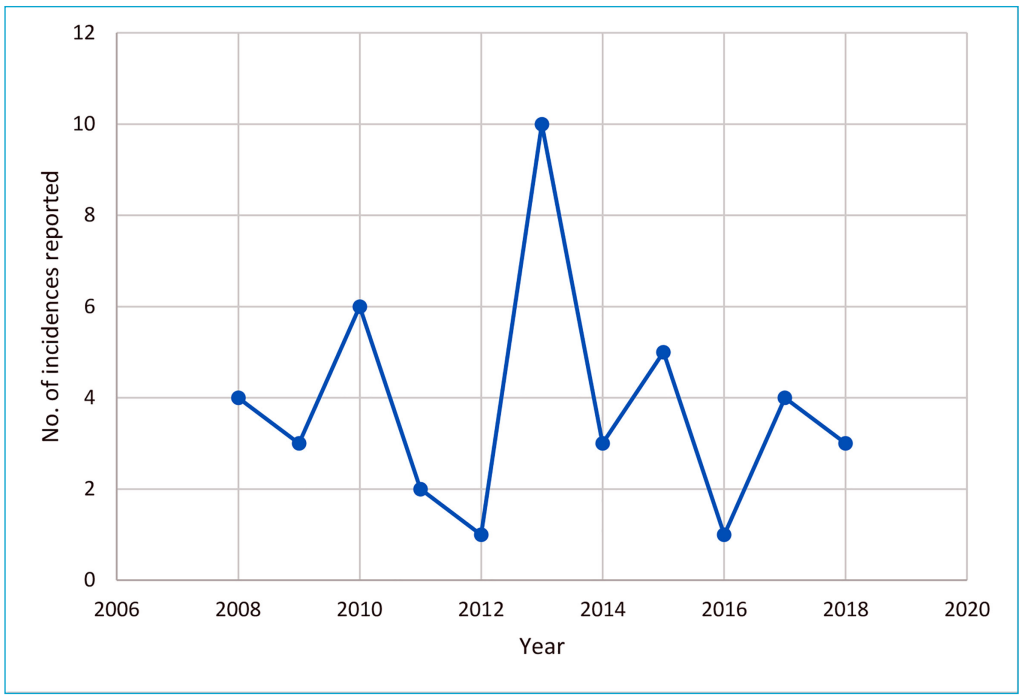


Figure 8.12: Earthquake occurrence between 2008 and 2018. Source: USGS

Earthquakes occurrences are triggered by volcanic eruptions. The earthquakes were caused mostly by rupture of geological faults, but also by other events such as volcanic activity, landslides, and mineral/stone blasts.
Earthquakes occurrences have destroyed human settlements, caused injuries and deaths of people and animals, destroyed infrastructure and environment. For example, the epicentre in Lake Victoria (Bukoba) basin recently caused losses and damages of property in the districts of Rakai (plate 8.10) and Isingiro in 2017.

It is important to note that the effects of earthquakes are more likely to re-occur unless effective early warning systems are installed to disseminate preparedness information.

Plate 8.10: Police station destroyed by an earthquake in Rakai District 2017

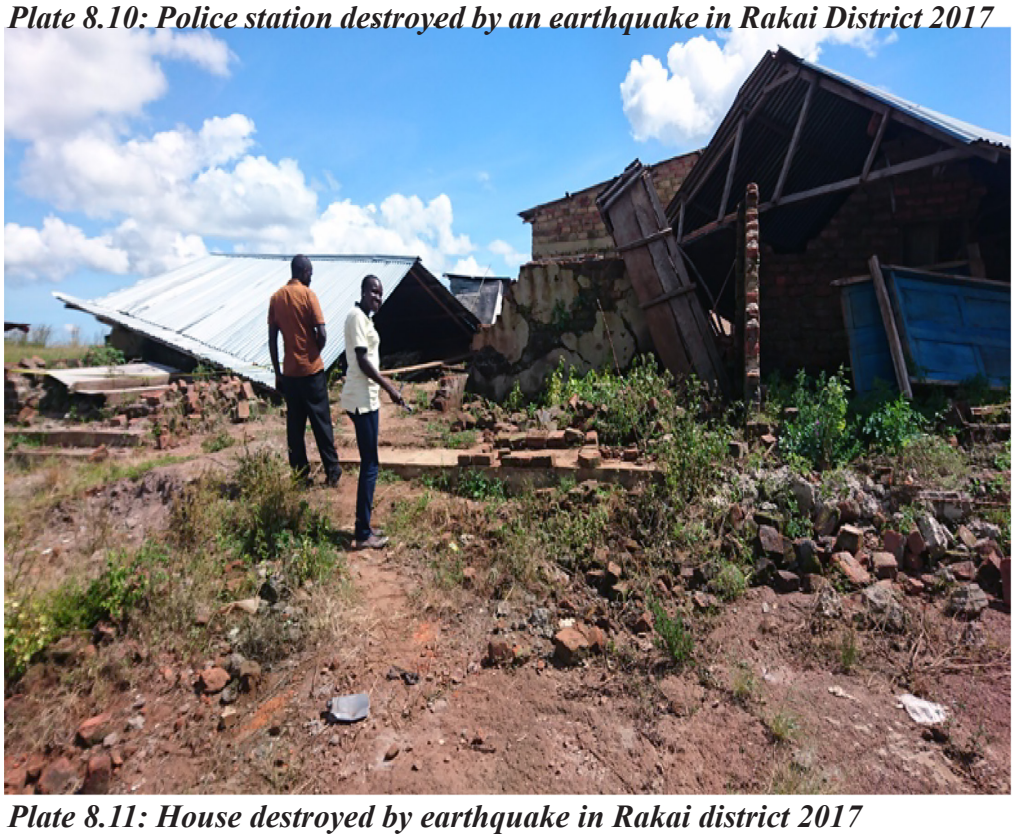


Plate 8.11: House destroyed by earthquake in Rakai district 2017

8.2.6 Landslides/mudslides

The occurrence of severe landslides has slightly reduced of recent as compared to the last decade. Nevertheless, these are still a threat to the attainment of Sustainable Development Goal No.3 that aims to ensure healthy lives and promote wellbeing.

The most affected regions are South western, Karamoja, and Mt. Elgon. Districts that reported the highest cases of landslides included Kisoro, Kabale, Namisindwa, Sironko, Bulambuli and Bududa according to Figure 8.13.
The most affected districts in the last 3 years are those located in the Elgon sub region; Bududa, Sironko and Bulambuli. The other most affected districts are in the Rwenzori sub region with Kasese and Bundibugyo highly susceptible to landslides (Jacobs et al., 2018).

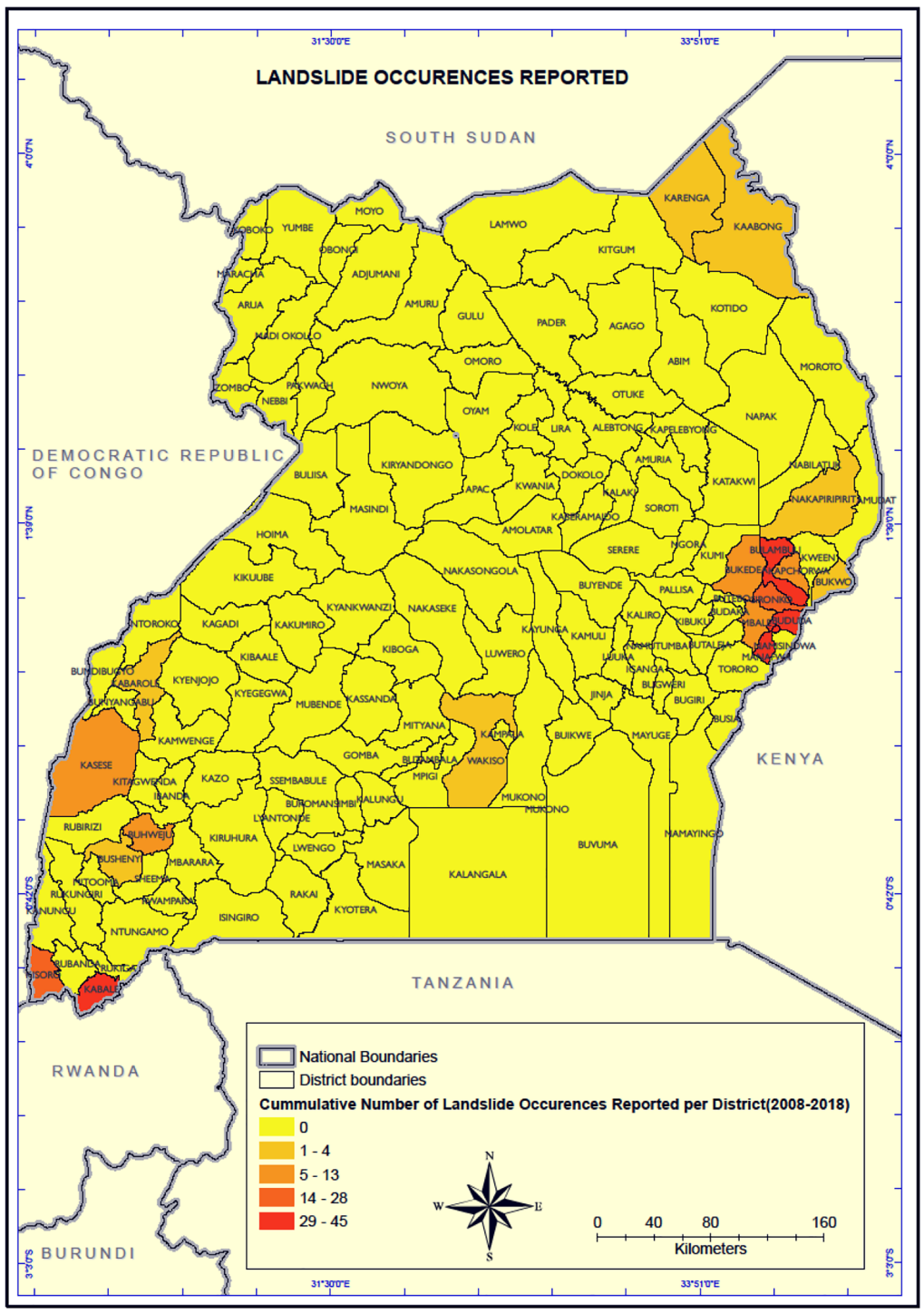


Figure 8.13: Landslide incidents between 2008 and 2018.

In the past decade (2008-2018), landslides incidences were most pronounced in 2010 recording 132 incidences country wide, followed by 2011 with 58 landslides incidences. Landslide occurrence decreased in the period 2012-2017 and increased in 2018 recording 30 landslides incidences country wide as shown in Figure 8.14.

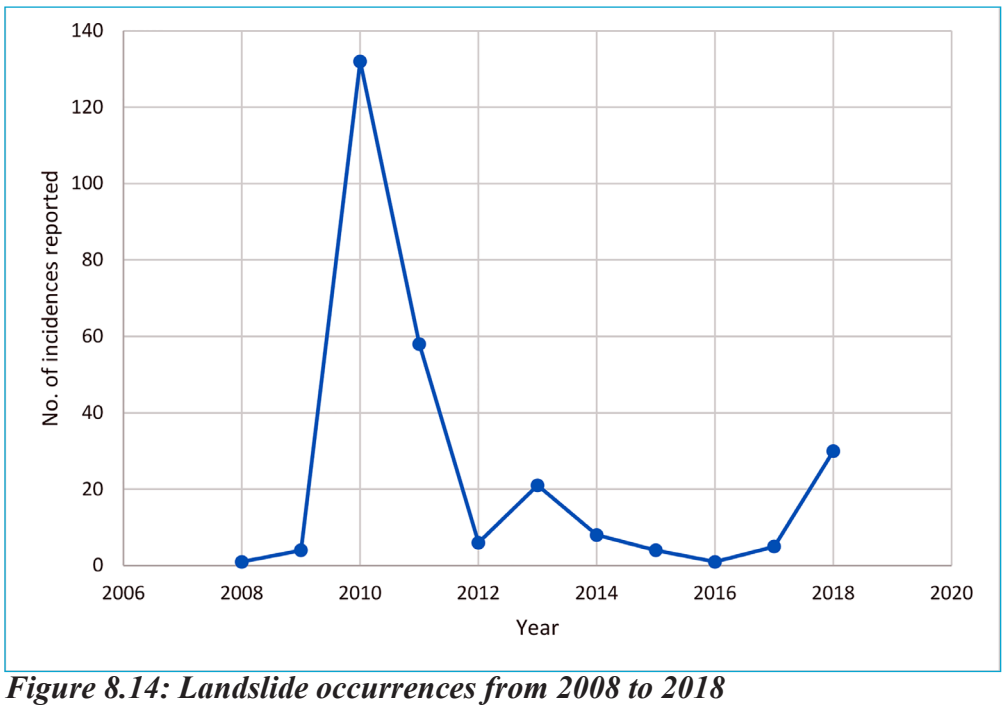


Figure 8.14: Landslide occurrences from 2008 to 2018

The factors that triggered the occurrences of landslides were a mixture of natural and man-made. Those that were majorly reported were deforestation, intensification of farming activities, climate change effects, and high population pressure. Mugagga et al. (2012) and Misanya and Øyhus (2015) in their studies of landslides in Elgon also found out that the causes of landslides in the Elgon area were attributed to slope disturbances, poor farming methods (over cultivation) and deforestation activities related to human population pressure. Landslide probability indicators observed in the risky prone areas include appearance of fault lines, long cracks on the ground, too much rainfall, steepness of the slope, and nature of farming practices (Kitutu, 2010).

The landslides resulted in displacement of people, loss of productive topsoil, destruction of crops, settlements, vegetation, livestock, loss of lives, destruction of infrastructure, siltation of water bodies, migration and death of biodiversity,. In 2018 the specific affected areas included; Mt. Elgon National Park in Bukalasi Sub County, Bududa District in which R.Suume (Plate 8.12) was blocked, Namisindwa district (plate 8.14 and 8.16) where heavy rains triggered landslides, Manafwa District in which the main road in Kaato Sub County from Buwangani to Shikunga was cut off (plate 8.13)

Plate 8.12: River Suume with burst banks.

Plate 8.13: Buwangani to Shikunga road cut off

Plate 8.14: Landslide scar in Bumwali Village, Bumbo Subcounty, Namisindwa District.

Plate 8.16: Cracks indicating a landslide risk area in Namisindwa Town Council

8.2.7 Bush Fires

Bush fires arise out of bush burning, a practice used by pastoral communities for regeneration of new grass, agriculturists to clear land for cultivation and hunting wild meat for consumption. It is important to note however that some fires that occur are uncontrolled and non-intentional such as burning of domestic waste that can spread and affect big chunks of land. Bush fires are common in Northern Uganda.

The most affected regions are Karamoja, Central and Mid-western. Districts with severe cases reported were Kaabong, Karenga, Moroto, Napak, Nakapiripirit and Masindi.

Bush fires have resulted into displacement of people, destruction of crops, settlements, vegetation, livestock, loss of lives, destruction of infrastructure, migration and death of animals.

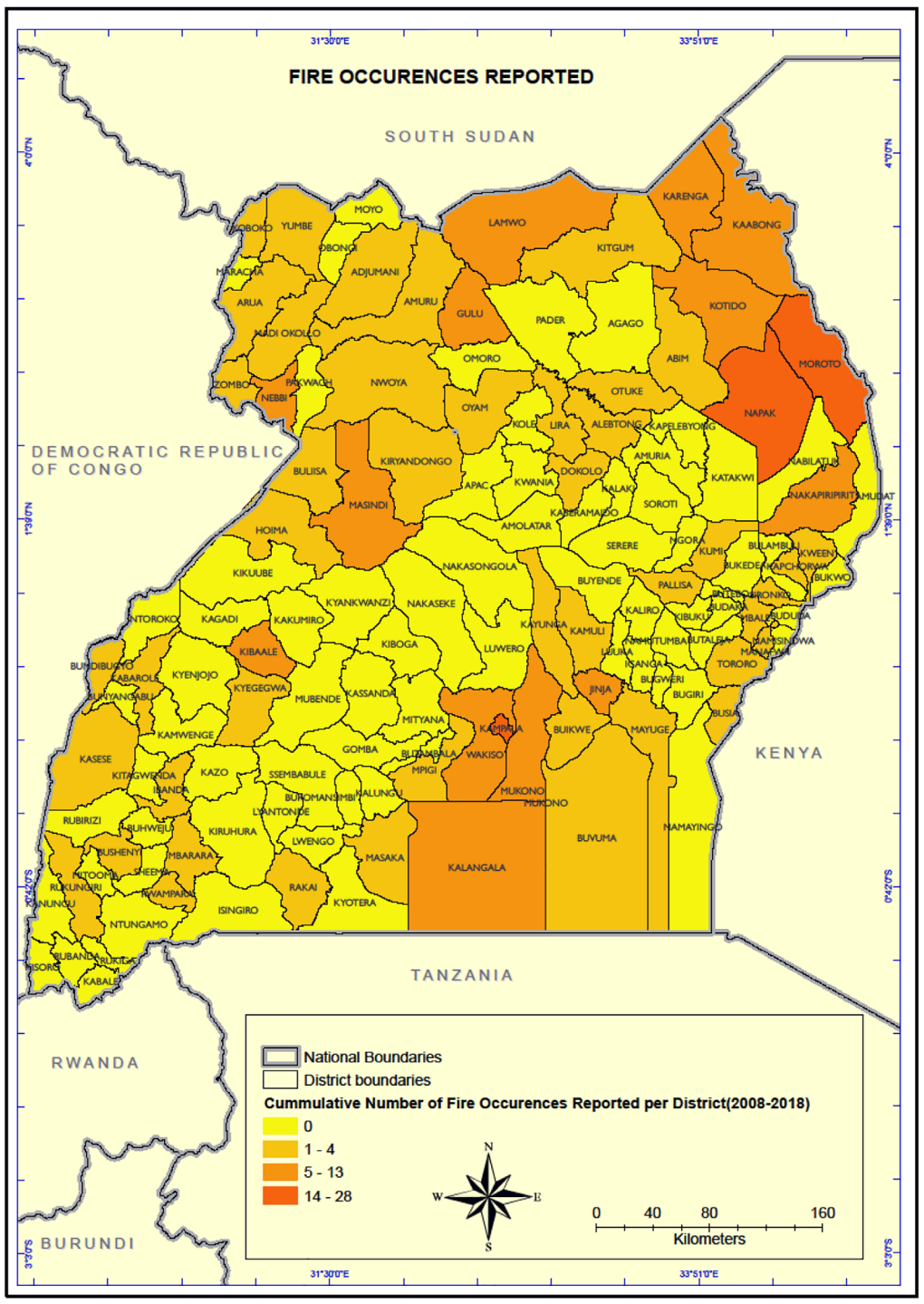


Figure 8.15: Fire incidences between 2008 and 2018.

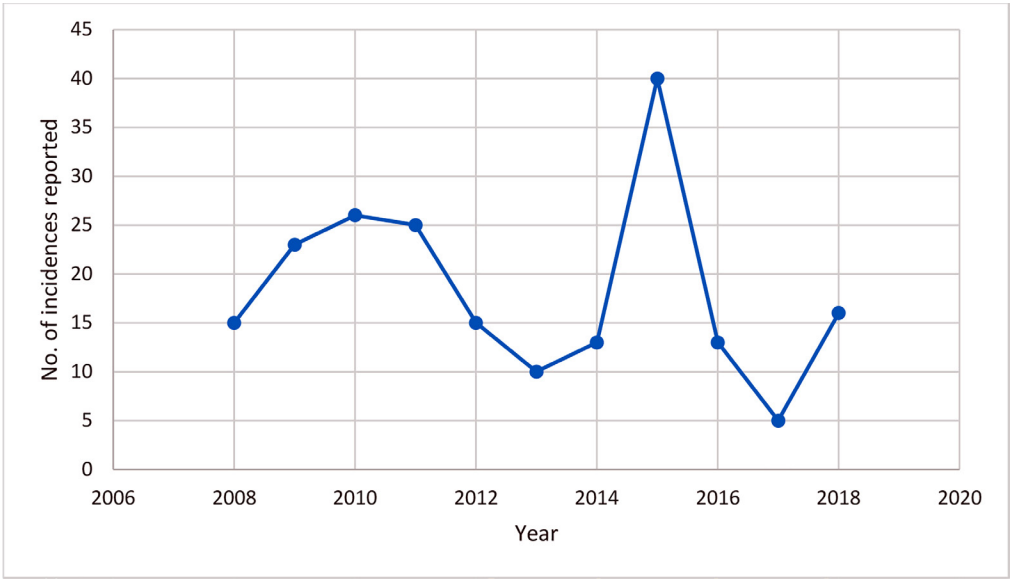


Figure 8.16: Fire occurrence between 2008 and 2018.

8.3 Impacts of disasters on population, built environment and crop production

The impacts of disasters are discussed in terms of impacts on; population, built environment (public facilities such as educational facilities, hospitals) and socio-economic activities (crop production). This classification was dependent on the availability of reported number of cases in the Desinventor.

8.3.1 Population

The disasters that affected people were windstorms, landslides, hailstorms and floods. Figure 8.17 represents the disasters and the populations of the people impacted by with in the areas of occurrence. These caused deaths, injuries and disappearance of the victims. In terms of deaths, the disasters that caused the highest numbers of human life loss were floods followed by hailstorms and landslides. For the injuries, the disasters that caused the highest impairment to people were windstorm and hailstorm followed by the floods.

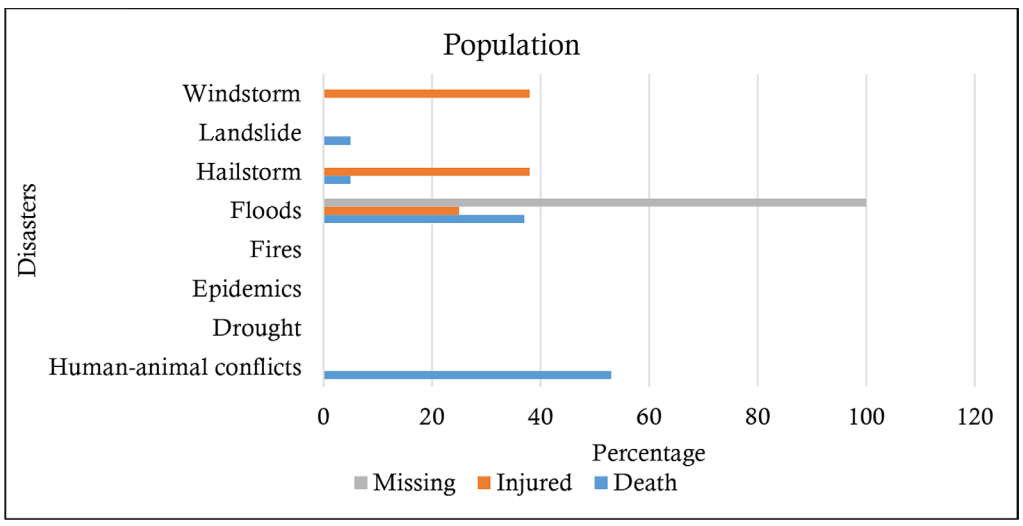


Figure 8.17: Types of disasters and percentage of the population impacted

8.3.2 Built Environment

In the built environment, disasters are caused by windstorm, landslides, hailstorms and floods. Figure 8.18 shows that landslides and floods followed by windstorms and hailstorms had a greater impact on the buildings. The most affected were vital public facilities including health and education facilities.

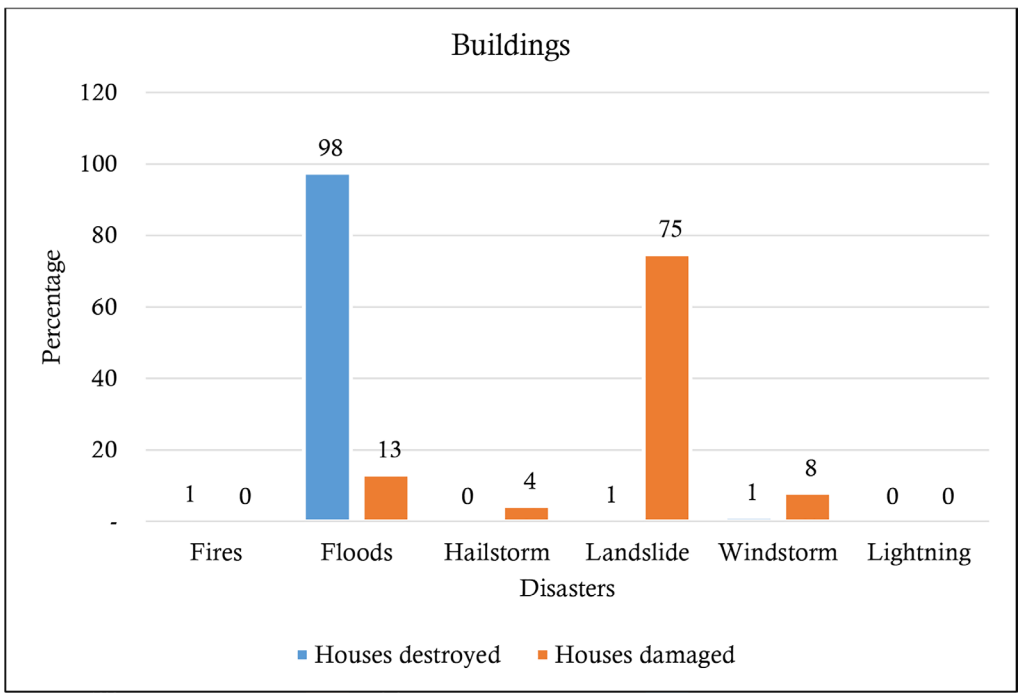


Figure 8.18: Impacts of disasters on the buildings

8.3.3 Crop production

The disasters that caused more impact to the agrarian communities were floods, hailstorm and landslides. Figure 8.19 presents the reported impacts of disasters on crop production

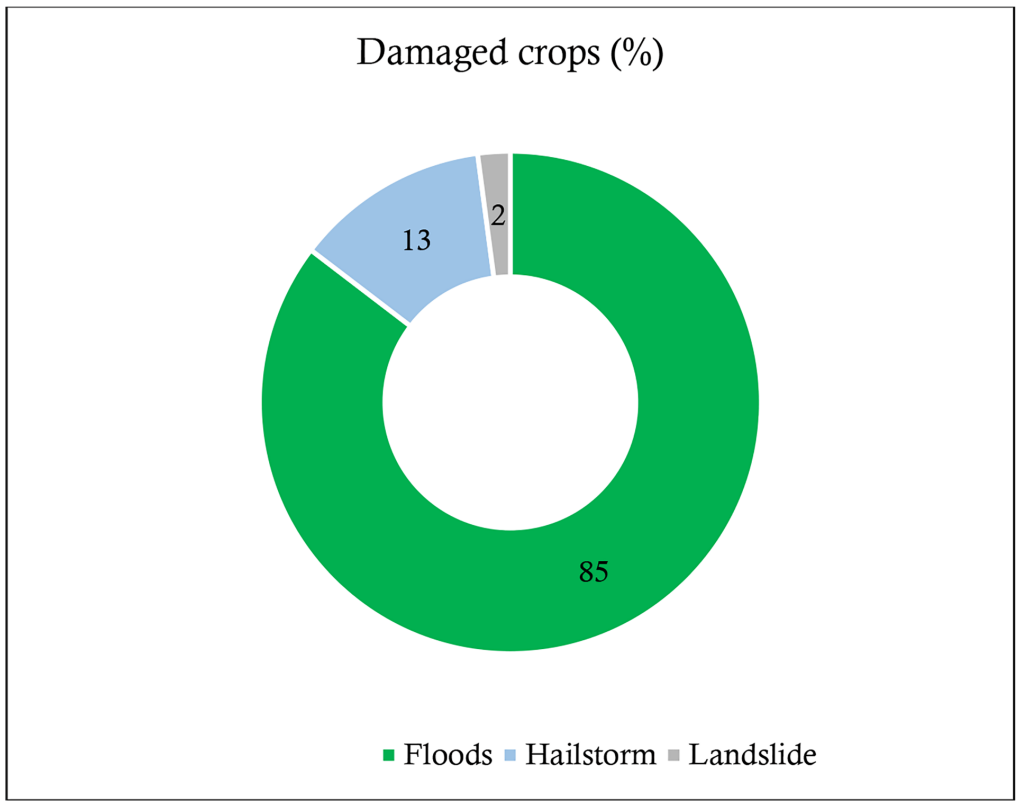


Figure 8.19: Impact of disasters on crop production

8.4 Policy responses

Over time government of Uganda has undertaken various activities to respond to disasters.

1) Overall government conducted 912 Disaster Risk Assessments in 126 district local governments, prepared 122 risk, hazard and vulnerability profiles and maps for all the district local governments. A National Disaster Risk Atlas for Uganda is under development (Ref. OPM)
2) In response to the occurrence of landslide, in 2019, the victims of landslides from Bududa were relocated to Bunambutye Resettlement in Bulambuli District to mitigate future risks.
3) Expansion of both community-based disaster preparedness (CBDP) programs and their evidence base have been prioritized.
4) Developed a Resettlement Plan of Landslide Prone Communities in the Elgon Sub Region. This was implemented by the Office of the Prime Minister in 2018.
5) As a disaster preparedness measure the government of Uganda conducted continuous media sensitization and awareness creation in Disaster Prone areas through the districts and Office of the Prime Minister (OPM)
6) Operationalisation of Disaster Management Committees and catchment management plans. About 44 District Disaster Management Committees (DDMC) were operationalised in the 112 districts as of 2018 in the Teso, Rwenzori, Karamoja, Elgon and Buganda sub regions. Secondly, catchment management committees and plans (i.e. Awoja, Mitano, Mpologoma, Mpanga, Semiliki) spearheaded by water management zones under Ministry of Water and Environment and NUSAF III have been established. In addition, the trans boundary water resources and rangeland management committees for example the Upper Lwakhakha and Mid Malaba sub catchment plans shared by Kenya and Uganda, Lakes Edward and Albert Integrated Fisheries and water Resources Management project shared by Uganda and Democratic Republic of Congo have been established and operationalized.
7) Provision of humanitarian relief and non-food items to the affected communities by OPM and Development Partners (Red Cross Society, EADEN) for example Elgon sub region and Elegu flood victims.
8) Compilation and dissemination of early warning materials by OPM such as National Integrated Early Warning Systems bulletin, seasonal forecasts advisories, installation and management of automated weather stations, surface and underground water gauges/elementary stations by Ministry of Water and Environment, installation of geo-observer network in Rwenzori by Mountains of the Moon University.
9) Capacity building and Research is ongoing by academic institutions such as Busitema University, Makerere University and Mountains of the Moon University to respond to hazards and disasters.
10) Establishment of small/large scale irrigation schemes and water reservoirs in drought and flood prone regions for example Mobuku II, Ngenge-Kween.
11) Approval of national irrigation policy 2017.
12) To mitigate floods, 2 bridges were substantially completed: Saaka swamp Phase II (Kaliro District)–99.1% complete and Kaguta bridge (Lira)

8.5 Recommendations

1) Implement the Integrated Disaster Risk Reduction (IDRR) framework for all disasters. This may include; Restoration of the degraded areas through tree planting and practise of better agricultural methods, strengthening early warning systems, integration of Disaster Risk Reduction measures in development planning processes, Capacity building of Disaster Management Committees, integration of DRM in the school curricula and programmes of higher education institutions, continued education and awareness programs, installation of lightning conductors on all public buildings, equipping and staffing of regional referral hospitals and health centres
2) Declare special conservation areas in line with the National Environment Act No.5 of 2019. This is especially for areas where these disasters have been repetitive such as in South Western Uganda.
3) Develop and undertake land use plan for areas prone to hazards and disasters in line with section 55 of the National Environment Act No. 5 of 2019. These land use planning solutions may include; excluding activities from areas exposed to hazards, manage flood plains and move people away from flood plains.
4) Strengthen the enforcement mechanisms of the National Environment Act No. 5 of 2019 and other related laws and regulations with regard to Management of Hilly and Mountainous places, Management and Utilisation of Wetlands and environment management of Lakes, Rivers and Natural Beaches.
5) Operationalise the Environmental Protection Force inline the National Environment Act No. 5 of 2019.
6) Formation of a disaster law and requisite financial guidelines that can empower government to provide the necessary financing and respond to disasters in Uganda.
7) Empower and support local governments to develop and implement their district physical development plans.
8) Undertake research to inform other interventions and decisions.

Bibliography

Akonya, I., & Eyama, J. (2019). Assessment of the Adequacy of the Uganda Seismic code in the design of non-structural elements. A case study of a masonry wall (Doctoral dissertation, Makerere University).

Caravani, M. (2019). 'De-pastoralisation'in Uganda's Northeast: from livelihoods diversification to social differentiation. The Journal of Peasant Studies, 46(7), 1323-1346.

Fadairo, O., Williams, P. A., & Nalwanga, F. S. (2019). Perceived livelihood impacts and adaptation of vegetable farmers to climate variability and change in selected sites from Ghana, Uganda and Nigeria. Environment, Development and Sustainability, 1-19.

Jacobs L., Kabaseke C., Bwambale B., Katutu R., Dewitte O., Mertens K., Maes J., Kervyn M. (2018). Geo-observer network: a proof of concept on participatory sensing of disasters in a remote setting

Jacobs, L., Dewitte, O., Poesen, J., Sekajugo, J., Nobile, A., Rossi, M., & Thiery, W. (2018). Field-based landslide susceptibility assessment in a data-scarce environment : the populated areas of the Rwenzori Mountains, 105–124.

Jacobs, L., Kabaseke, C., Bwambale, B., Katutu, R., Dewitte, O., Mertens, K., ... & Kervyn, M. (2019). The geo-observer network: A proof of concept on participatory sensing of disasters in a remote setting. Science of the total environment, 670, 245-261.

Kitutu Kimono Mary Gorretti (2010). Landslide occurrences in the hilly areas of Bududa district in Eastern Uganda and their causes (PhD Thesis)

Mugagga, F., Kakembo, V., &Buyinza, M. (2012). A characterisation of the physical properties of soil and the implications for landslide occurrence on the slopes of Mount Elgon, Eastern Uganda. Natural hazards, 60(3), 1113-1131.

Namusoke, M., & Atuhaire, S. (2019). Factors Contributing To Malnutrition among Under-Fives: A Survey of Mubende Regional Referral Hospital. Uganda. J Health Sci Stud, 1(2), 201.

Nseka, D., Bamutaze, Y., Mugagga, F., & Nakileza, B. (2019). The Fragility of Agricultural Landscapes and Resilience of Communities to Landslide Occurrence in the Tropical Humid Environments of Kigezi Highlands in South Western Uganda. In Agriculture and Ecosystem Resilience in Sub Saharan Africa (pp. 279-305). Springer, Cham.

OPM. (2011a). The National Policy For Disaster Preparedness And Management, (April).

OPM. (2011b). The National Policy For Disaster Preparedness and Management

Stanley, M. (2014). Hail Formation in Florida, (May).

Desinventar :(https://www.desinventar.net).

(https://en.wikipedia.org/wiki/Environmental_hazard).

https://en.wikipedia.org/wiki/Environmental_disaster

Chapter 9: Refugees and Environment

9.1 Introduction

This chapter provides the background for analysis of underlying and topical environment management issues in refugee settlements and host communities in Uganda. It presents information on population, land use and land cover changes, water resources management, biomass usage and waste management. It further highlights analyses of utilization of natural resources and, interventions undertaken as well as their impacts on refugee settlements and host communities and the environment.

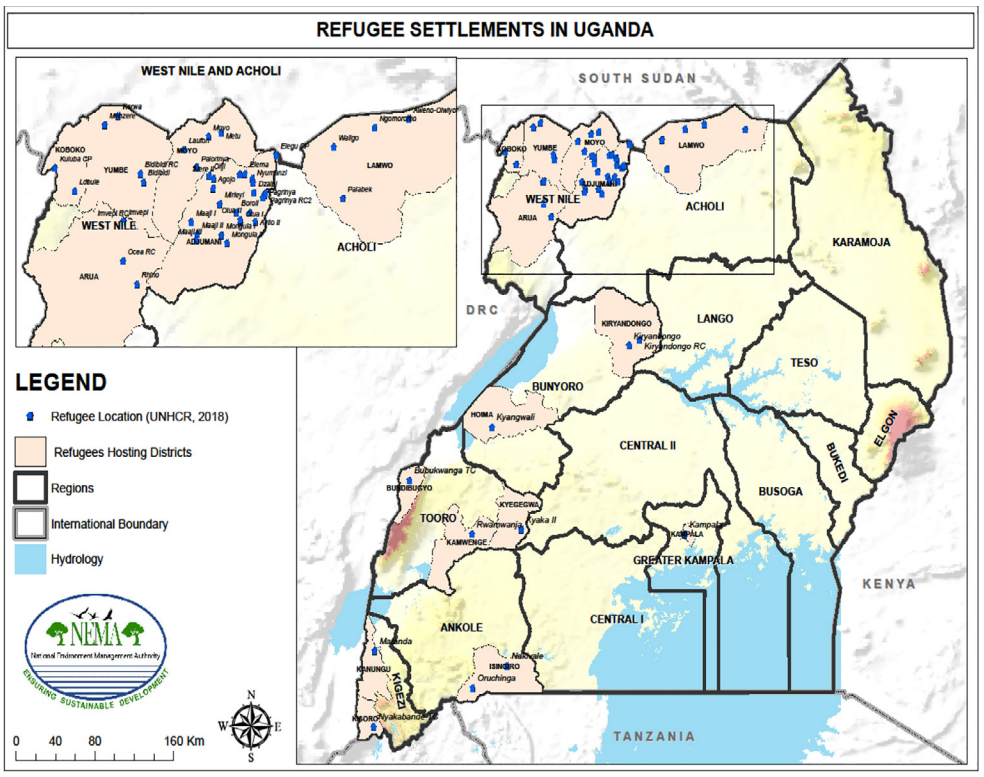


Figure 9.1: Location of refugee settlements in Uganda

9.2 State and trends

9.2.1 Refugees population trends in Uganda

Uganda is the largest refugee-hosting country in Africa with over 1.29 million refugees and asylum seekers (UNICEF, 2019) . This number accounts for 28 percent of the total global refugee population, and Uganda is the third largest refugee hosting country in the world after Turkey and Pakistan. The country has one of the most favorable and progressive refugee assistance programs in the world, with freedom of movement, work rights, and land officially set aside for refugees to settle and farm (Heng, 2016).

The majority of refugees in Uganda come from South Sudan, followed by DRC, Burundi, and Somalia, and the distribution pattern per country of origin has remained the same for the three-year period since 2016. Figure 9.2 shows that by January 2019, 66% of the refugees were from South Sudan followed by 26% from DRC while the remaining were from Burundi and other countries including Somalia. Most of the refugees from South Sudan settle in West Nile and northern Uganda due to spatial, cultural and logistical considerations. By February 2019, there were close to 800,000 refugees from South Sudan living in the country.

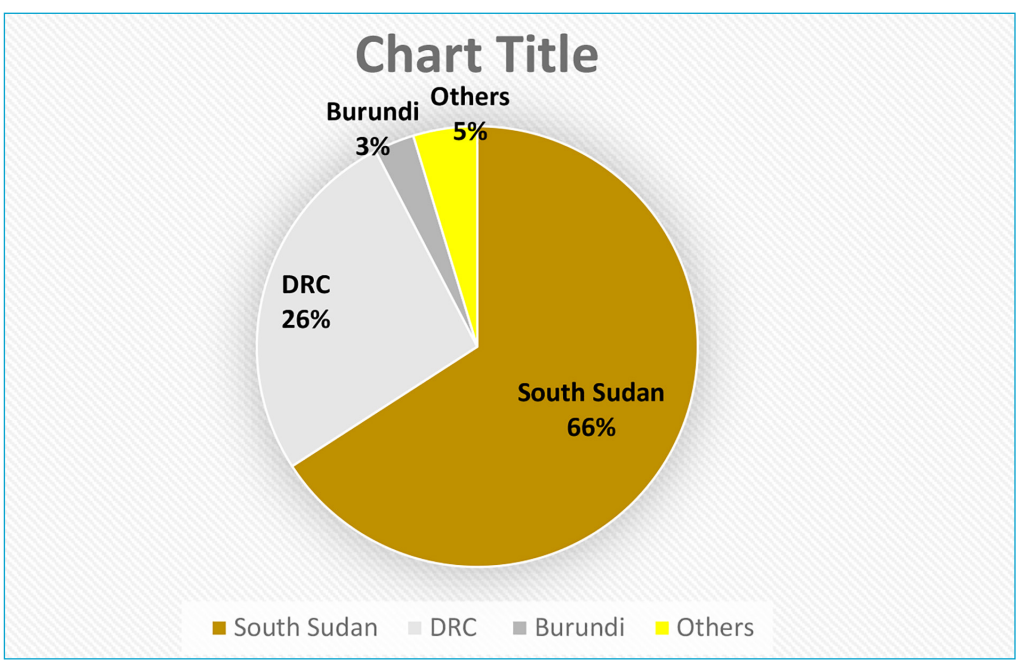


Figure 9.2: Country of Origin of Refugees in Uganda

9.2.1.1 Refugee population growth

The refugee population in the country keeps growing mainly in two ways: continued influx and reproduction (natural increase). Since 2012, the refugee population more than quadrupled from 225,949 to 1,470,981 by June 2018, largely fueled by huge influx as a result of forced migration and displacement. The numbers continue fluctuating with no sign of reversal. For example, by February 2019 the number had reduced to 1,205,913 only to increase to 1,256,725 by April 2019 and it is projected to increase to 1.7 million by the end of 2020 (UNHCR, 2019). Figure 9.3 shows that since 2012, the refugee population more than quadrupled from 225,949 to 1,470,981 by June 2018. The major environmental concerns as a result of hosting refugees are associated with utilization of natural resources and this is largely impacted on by increasing numbers.

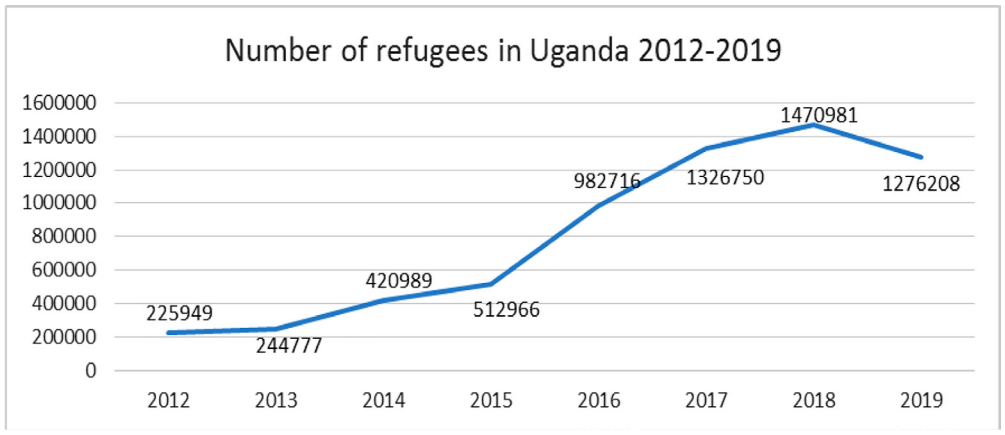
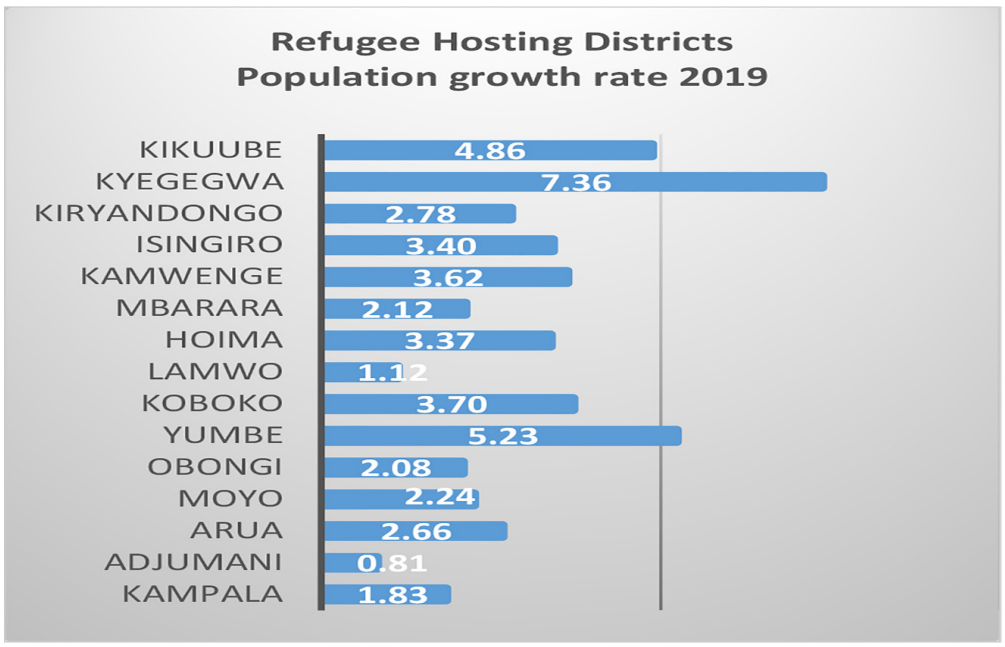


Figure 9.3: Refugee numbers in Uganda 2012 -2019 Source. NEMA, 2019

Refugee hosting districts also post higher population growth, total fertility and births rates. According to UBOS, Uganda`s population growth rate has remained at around 3% for the past several decades. Figure 9.5 shows that the average population growth rate in refugee hosting districts is consistently higher than 3% and more than half of the districts have a rate that is above 3.3%. Kyegegwa district has the highest rate of 7.36, followed by Yumbe 5.23 and Kikuube 4.86 while the lowest is Adjumani 0.81. A 2019 refugee health report further shows that out of the 4,142 registered deliveries in the month of May, 62% were refugees while 38% were nationals.



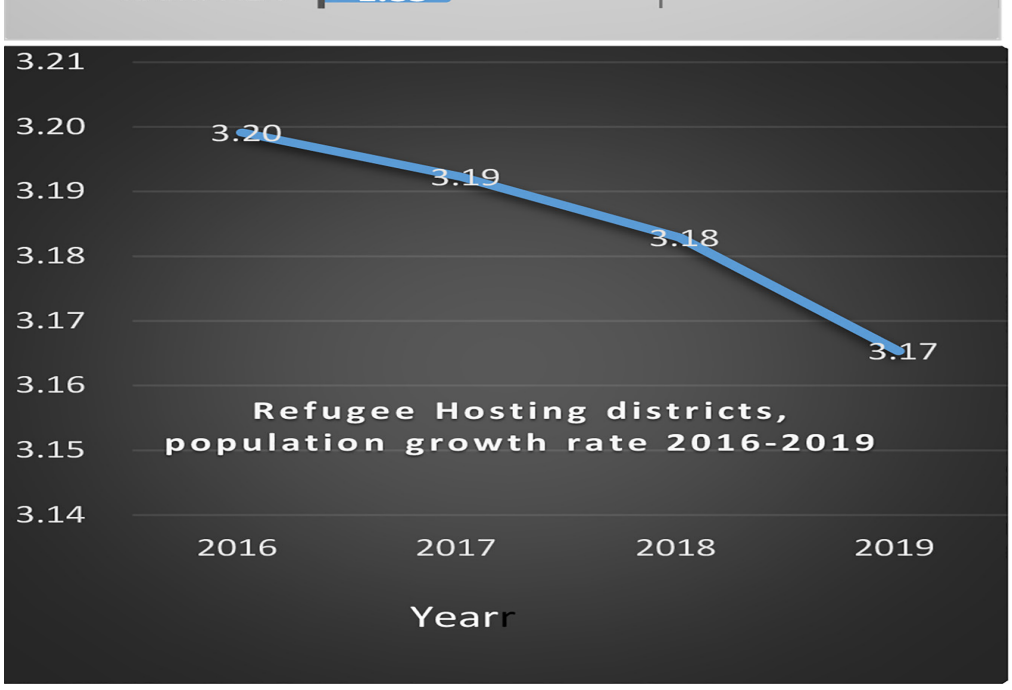


Figure 9.4: Refugee hosting district population growth rates 2016 -2019. NEMA 2019

9.2.1.2 Refugee Population and Host Communities

In Uganda, refugees are mainly hosted in the districts of Arua, Adjumani, Moyo, Koboko, Yumbe, Lamwo, Isingiro, Kyegegwa, Kiryandongo, Kamwenge, Kikuube and Kampala. By 2019 the total population of both refugees and host communities in the host districts was estimated at 7.4 million people, representing 18% of the Ugandan population. Out of this number, the refugee population was estimated at 1.3 million people representing 17.6% of the population in the host districts. In some host districts, the population share of refugees was almost equal to that of the host communities. For example, in Adjumani district refugees represent about 47% of the population compared to 53% of the host population, and in Moyo the situation was 44% to 56% respectively.

The refugee influx in the host districts has resulted in overall increase in numbers while environment and natural resources remain the same. This trend causes major environment concerns associated with utilization of natural resources that result into deforestation, general land use changes, land cover loss, waste management issues, pressing energy needs, pressure on water resources and physical infrastructure needs among others.

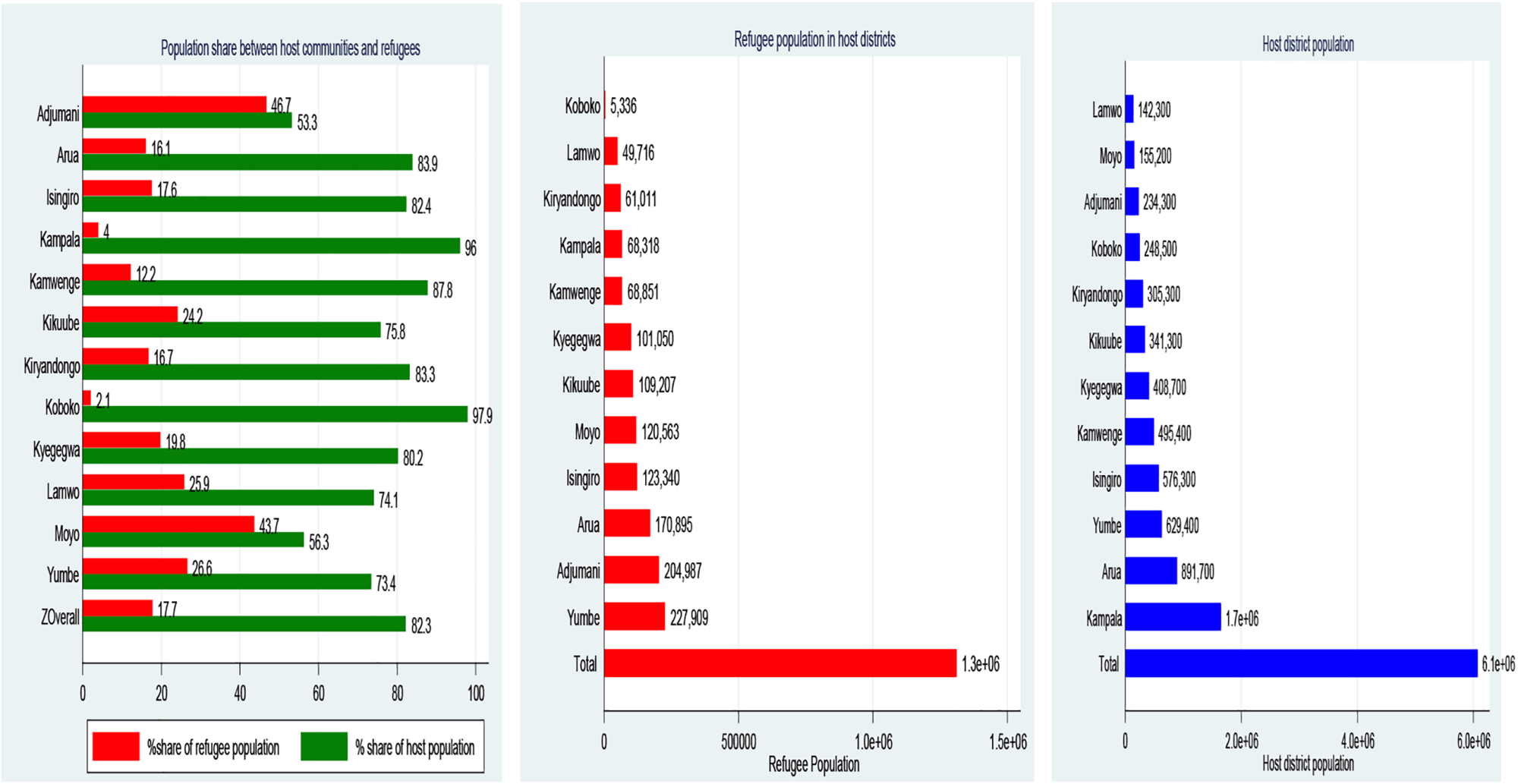


Figure 9.5: Population share between host communities and refugees. NEMA 2019

9.2.1.3 Size of settlement and population density

Bidibidi refugee settlement located in Adjumani district has the highest refugee population of 286,859 while Oliji settlement located in the same district has the lowest refugee population of 1,518 people. On average, the refugee settlements occupy a surface area of about 102.2(±73.44) square kilometers. Bidibidi settlement is the largest with a surface area of 250 square kilometers while Oruchinga is the smallest with surface area of only 8 square kilometers. Analysis of the distribution of the population within the settlements reveals that on average 1503.8(±1348.5) refugees occupy one square kilometer higher than an estimated national average of 221.6 (United Nations 2019). The most densely populated settlement is Palorinya with 4,418 refugees per square kilometer while most sparsely populated is Palabek with 294 refugees per square kilometer as indicated in the Figure 9.6.

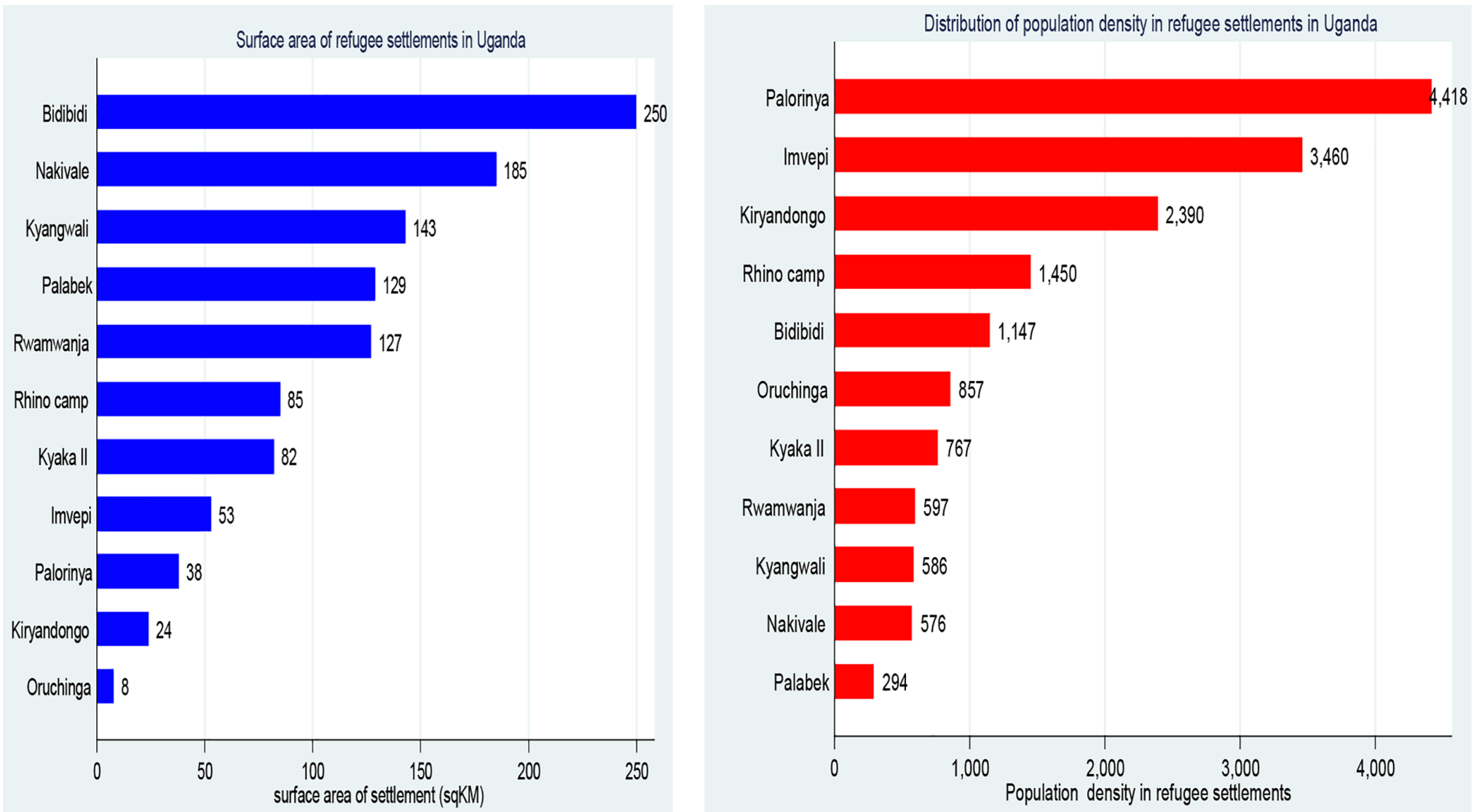


Figure 9.6 Surface area and distribution of population density in refugee settlements in Uganda

9.2.2 Land allocation and utilization in refugee settlements

Land allocation in refugee settlements is heavily influenced by the refugee influx. Initially, a refugee household was allocated 100 x 100 meters plot size for settlement and farming. As the numbers increased, the land continued to reduce and is poised to reduce further. Currently, each household in a refugee settlement has an average of 6 people while the plot size is mostly 30 by 30 meters. This plot of land is neither sufficient to support environmental services and activities nor satisfy livelihood and agricultural needs considering that a majority of refugees and host communities practice traditional-subsistence agriculture. In 2016, Government of Uganda and refugee settlement partners reduced food rations for all refugees that settled in the country before 2015. This meant that such refugees would have to rely more on household produced food that is already limited by plot size. The situation is aggravated by low agricultural productivity due to unreliable rainfall, floods and droughts, and inadequate use of innovative modern technologies to make farming more productive. The resultant effect is that refugees have resorted to hitherto conserved areas and encroached on fragile ecosystems (Forests, wetlands/river banks/ lake shores) for both food production and other livelihood and economic activities including sand mining, stone quarrying, charcoal production, gardening among others.

Plate 9.1 shows a large portion of Bugoma forest that has been cleared for timber and charcoal with the remaining space utilized for subsistence agriculture. Similar occurrences characterize all fragile ecosystems and conserved areas around refugee settlements. (Photo credit, NEMA 2019)

9.2.3 Energy needs

Refugees and host communities require energy for lighting, cooking and other amenities. Access to energy however remains a dire challenge. This is because more than 95% of these communities depend on wood fuel for cooking. Estimates indicate that about 21kgs of air dried wood per day is required by a refugee household for cooking and heating. There are approximately 244,870 refugee households translating into an estimated 5,142 tonnes of dry wood use per day. This implies that close to 2 million tonnes of wood fuel is used by refugees annually. This presents an extra demand on Uganda`s annual wood fuel needs estimated at 25 million tonnes. The resultant effect is that more trees are cut than planted. A 2015 Danish Refugee Council (DRC) baseline report revealed that in West Nile alone, a total of 1,110,792 trees had been cut between July 2014 and July 2015 , whereas only 4,987 were replaced. Plates 9.2 shows the wood fuel burden in Bugoma and Yayari villages.

Plate 9.2: A refugee carrying wood cut from Bugoma forest and deforestation in Yayari Village, Bidi Bidi settlement Kochi Sub County, Yumbe District. (Photo credit, NEMA 2019)

The heavy reliance of refugees on biomass for cooking and lighting just like host communities continues to exert enormous stress on the forest, tree and vegetation cover and is responsible for the encroachment and degradation of the environment in both settlements and host communities. Refugees walk longer distances in search of wood with some reporting more than 7 kilometers. A 2018 CREEC report showed that 62% of the refugees reported an increase in the distance walked to collect firewood mainly because of its unavailability as a result of clearance of the old vegetation. It is therefore clear that firewood is more scarce than ever before forcing communities to resort to reserved forest, tree and other vegetation cover.

There however, have been a number of interventions to avert the scarcity of wood fuel mainly through plantation forests. Most of the settlements have established wood lots that are protected from encroachment by refugee authorities. There exists a partnership between the National Forestry Authority and UNHCR to restore 422 hectares in 3 central forest reserves adjacent to settlements. The partnership will also support tree growing through setting up of nursery beds and supply of 5 million assorted species of seedlings.

Plate 9.3: Tree nurseries in Palabek refugee settlement (Photo credit, NEMA 2019)

In addition, most of the settlements have set up nursery beds to supply seedlings to both refugees and host communities. Other interventions include mapping of woodlots and tree marking of indigenous and threatened tree species to conserve and protect them from encroachment.

There are a number of attempts to improve on energy efficiency as a means of economizing wood fuel. This has involved use of solar lanterns, production and use of briquettes and clean cook stoves among others. Use of briquettes however remains low while supply of clean cook stoves is increasing but disproportionately allocated. Figure 9.7 shows that only five refugee settlements received clean cooking stoves. Bidi bidi settlement received 20,170 stoves while Pagirinya received the lowest (800). Other settlements appear to have not benefited from such large scale clean stove supply interventions

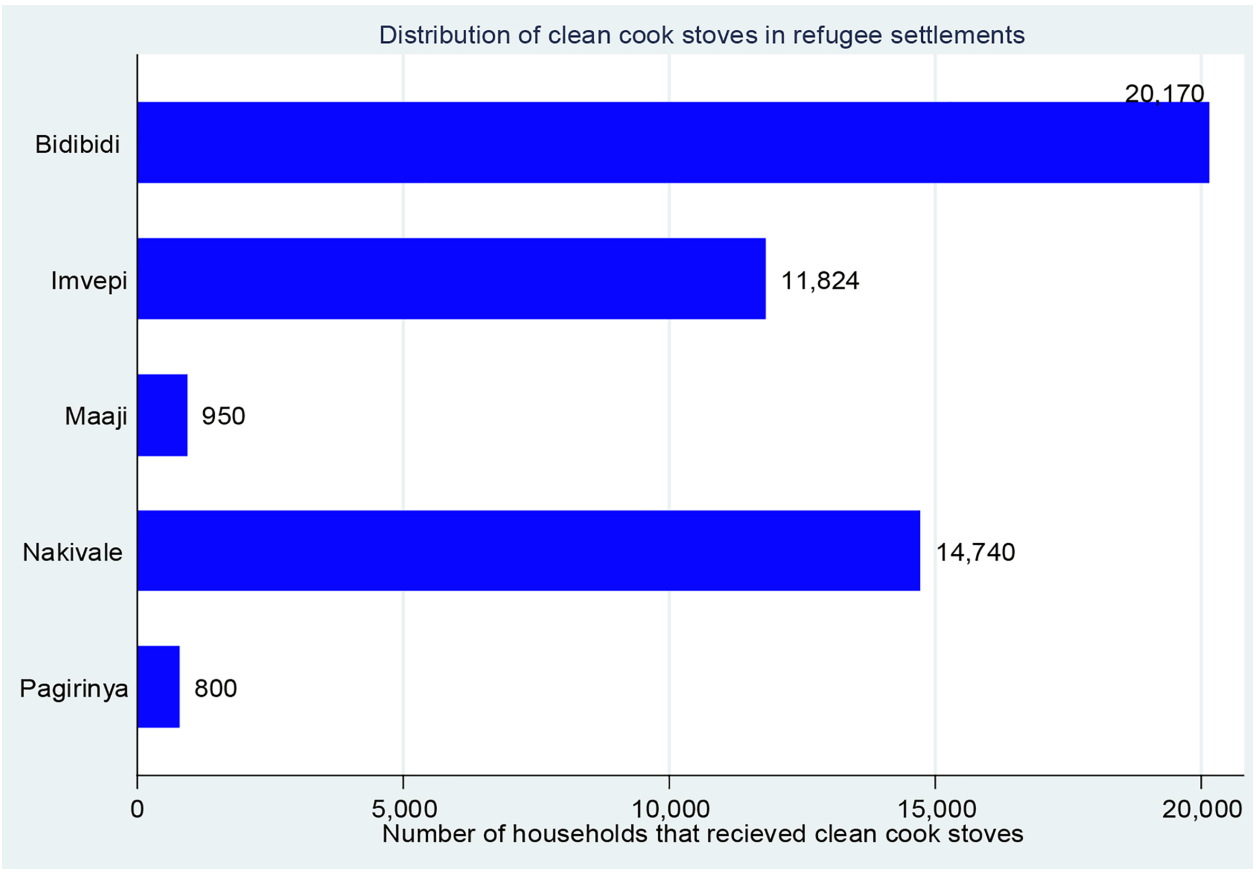
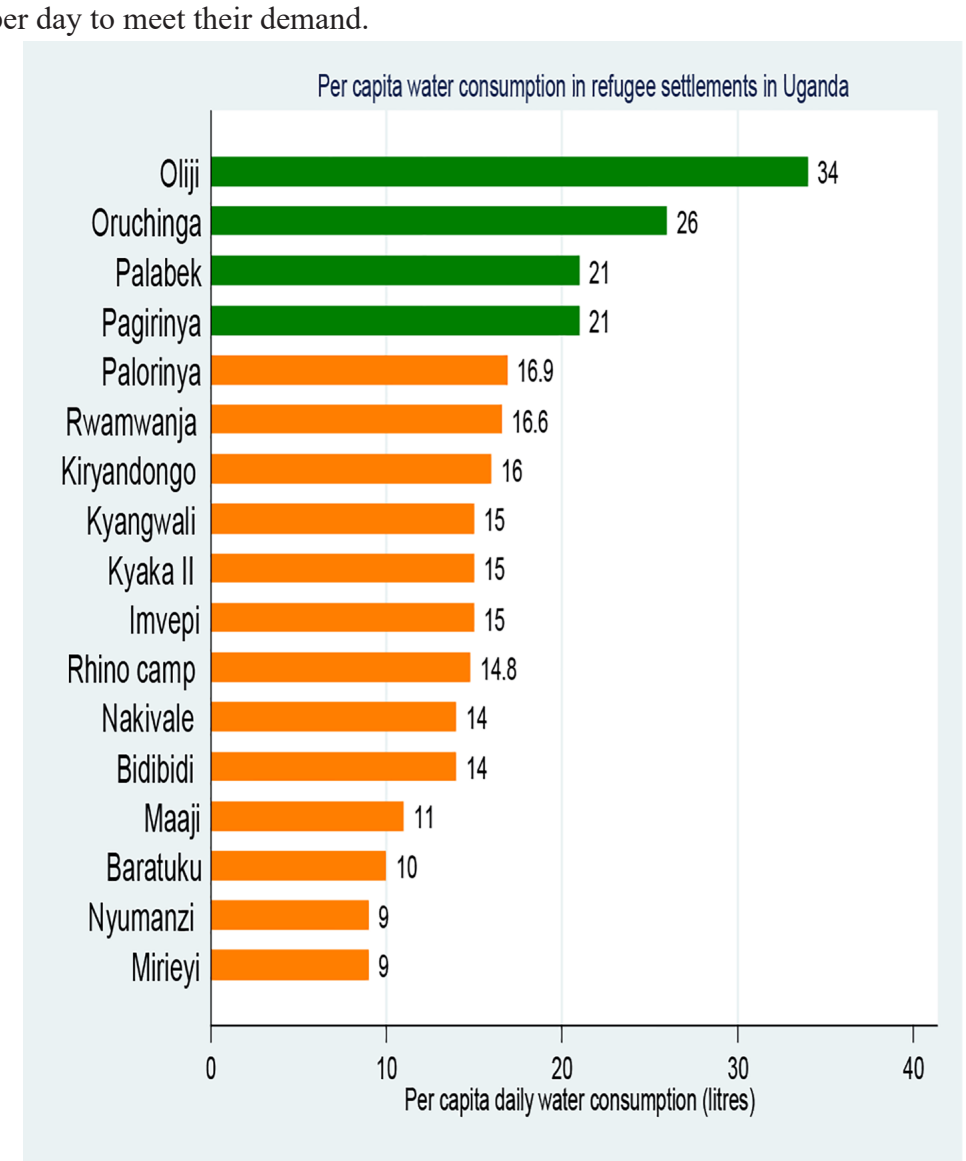


Figure 9.7: Distribution of clean cook stoves in refugee settlement. NEMA 2019

An estimated 48,484 refugee households accounting for 19.8% have received energy saving cook stoves. This implies that close to 80% of the refugees use the traditional three stone-cook stoves. There is also low adoption and usage rates of the few supplied clean stoves coupled with limited use of alternative sources of energy such as solar, biogas among others.

9.2.4 Water resource needs

Provision of water to refugees and host communities remains a key priority area for government of Uganda. There however, remains a shortfall in water supply amidst efforts to produce and supply water to all in need. Figure 9.8 indicates water per-capita consumption and per-capita water use deficit in refugee settlements. The average per-capita water consumption is 16.4 liters (±6.3) which is lower than the expected daily use of 20 liters per day per person. Only four refugee settlements (Oliji, Oruchinga, Palabeck and Pagirinya) meet the minimum required per-capita water consumption while the rest are below. Average daily water use deficit is 5.1litres (±3.7). Four settlements (Maaji, Baratuku, Mirieyi and Nyumanzi) on average, receive almost half of the required per-capita water for consumption. The overall water deficit in refugee settlements is estimated at approximately 7 million liters per day. Figure 9.8 indicates that Bidibidi refugee settlement requires extra 1.721 million liters of water per day to meet their daily water demand. Baratuku refugee settlement requires extra 0.096 million liters of water per day to meet their demand.



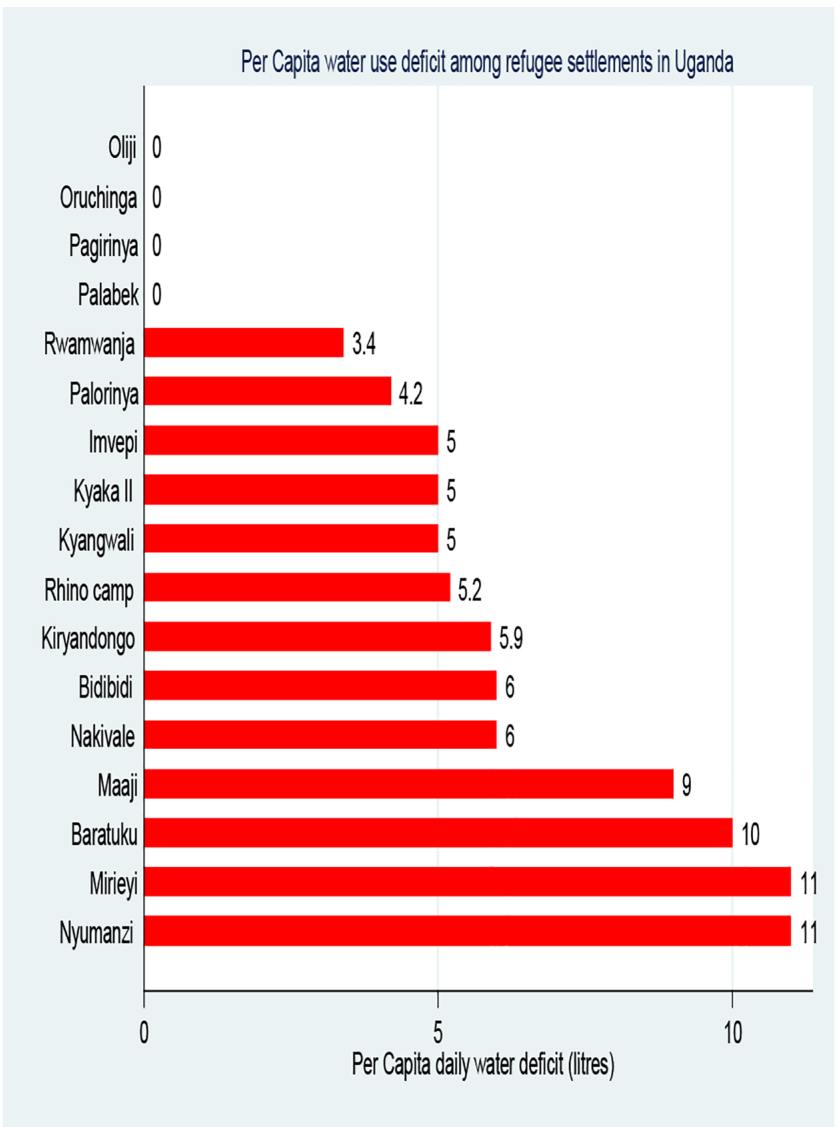


Figure 9.8: Water consumption and water deficit among refugee settlements. NEMA 2019

Most refugee settlements are water stressed. The most common way of supplying safe water to the settlements is by water trucking from natural springs, boreholes and from surface water treatment plants. Despite being flexible, this system of water supply is expensive and is usually challenged by muddy conditions of the roads during the wet season. In addition, a number of these water sources are usually non-functional due to low yields, occasional technical breakdown of water systems, and accessing low water quality. This has resulted into long queues and use of unsafe water sources.

Plate 9.4: Water collection from a borehole in Nakivale Refugee Settlement, woman collecting water from Kakoni wetland and a water source point in Bugogoli stream within Bugoma Forest Reserve (Photo credit, NEMA 2019)

A number of efforts have been made to address the water scarcity in refugee settlements. By 2017, there were close to 67 motorized water systems and 927 hand pumps in the refugee settlements (UNHCR, 2017). Both UNHCR and OPM have declared environment management as a priority area of focus for refugee operations. Catchment management and planning has been adopted as the approach and framework for managing water resource related issues. Notwithstanding the efforts, water deficit remains a major challenge while most existing water supply systems have not been granted abstraction permits and related environmental clearance.

9.2.5 Waste Management

Waste generated in refugee settlements comes in two forms; organic and inorganic or non-bio degradable and is mainly generated through domestic and institutional waste sources. Non bio degradable waste includes plastics, medical waste and other forms. Organic waste includes household food waste, ash, paper packaging, crop residuals and fecal matter among others.

9.2.5.1 Solid waste management

Generally, management of waste in refugee settlements is still a problem. At household level, waste pits and burning are common while dumping in open fields is used by institutions and settlements. The 2017 UNHCR WASH strategic operational framework sets the target of one refuse pit per household. This implies that there are more than 240,000 waste pits in settlements assuming each household has a refuse pit. Most of these pits are uncovered and could be potential breeding grounds for mosquitoes and sources of methane gas emission. Figure 9.9 shows that 88% of refugee households in West Nile possess a refuse pit while the remaining 12% practice other methods including burning and burying.

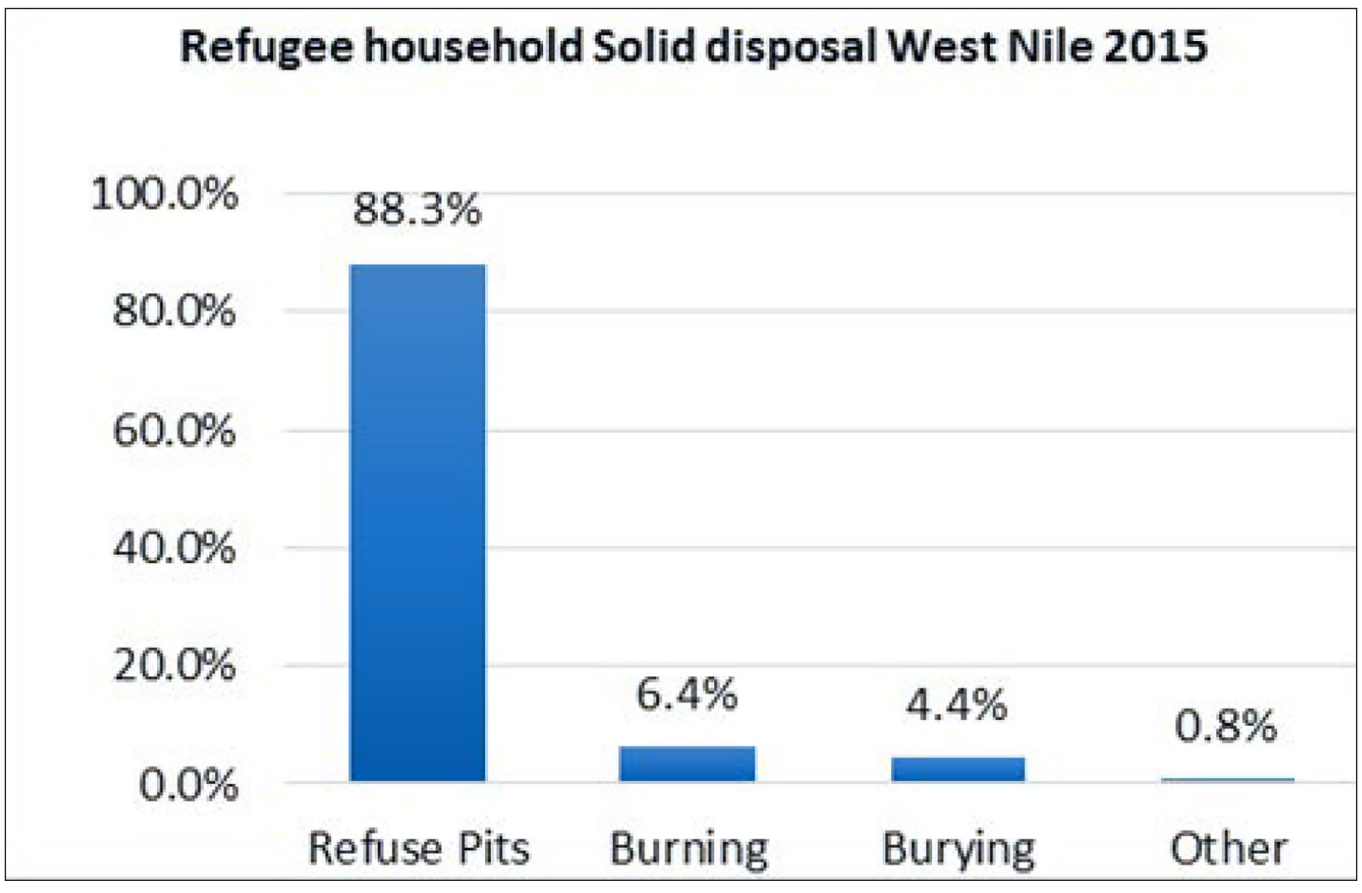


Figure 9.9: Refugee household Solid disposal in West Nile 2015. Adapted: DRC 2015

With increasing refugee population and influx of refugees from the neighboring countries, the waste types and volumes have been increasing posing both environmental and health challenges. While there is scanty data on type of and volume, solid waste forms a bigger share. As of April 2019, there was a total population of 1,256,729 refugees. It is estimated that 149.65kg of waste is generated per person per year. This translates into 188,069,494 tonnes of waste generated by refugees per year. This is substantive given that waste disposal and management systems are inadequate.

Waste heaps and banks are used at communal and institutional level supplemented by open dumping. The few waste banks that exist especially in markets are also poorly managed with no signs of separation and limited collection or emptying, heaping or complete neglected use. Furthermore, there is limited separation of waste both at source and final dumping while the few settlements that have managed to designate a land fill neither have environmental clearance nor management plan. As noted most of the settlements either do not have or have poorly located and managed disposal areas while none has properly engineered landfills (WERRP 2019).

Plate 9.5: Solid waste land fill in Kyaka and Nakivale refugee settlements (Photo credit, NEMA 2019)

Plate 9.5 shows typical solid waste landfills in refugee settlements. In Nakivale, for instance the identified land fill is near residential homes with no demarcation and clear management plan. In Bukere, Kyaka the disposal site is located near a major water body in a valley while Rhino and Omugo have no final disposal area. Land fill and open dumping result into a number of challenges mainly because waste is blown away by wind, causing more littering.

9.2.5.2 Fecal Sludge Management

Fecal sludge is a mixture of human waste, water and other solid wastes. Proper management of sludge involves collection, treatment and disposal or reuse. In refugee settlements, fecal sludge is mainly collected in latrines. This implies that latrine coverage and use greatly impact fecal sludge management. Latrines are mainly institutional, communal or household. By 2017, an estimated 2,000 institutional and 10,000 communal toilets had been constructed. An additional 1,802 communal and 123 institutional latrines were planned for construction (UNHCR WASH framework 2017). Despite the modest efforts, coverage remains low with a higher user ratio for both communal and household latrines. Figure 9.10 indicates household latrine coverage in refugee settlements. The number of households with latrines is 6,980 while those without latrines stands at 7,424. This translates into a latrine coverage rate of 51.5%. This is below the target of one latrine per household. This implies that almost half of refugee households have no access to a household latrine and could be using either public latrines or other inconvenient areas.

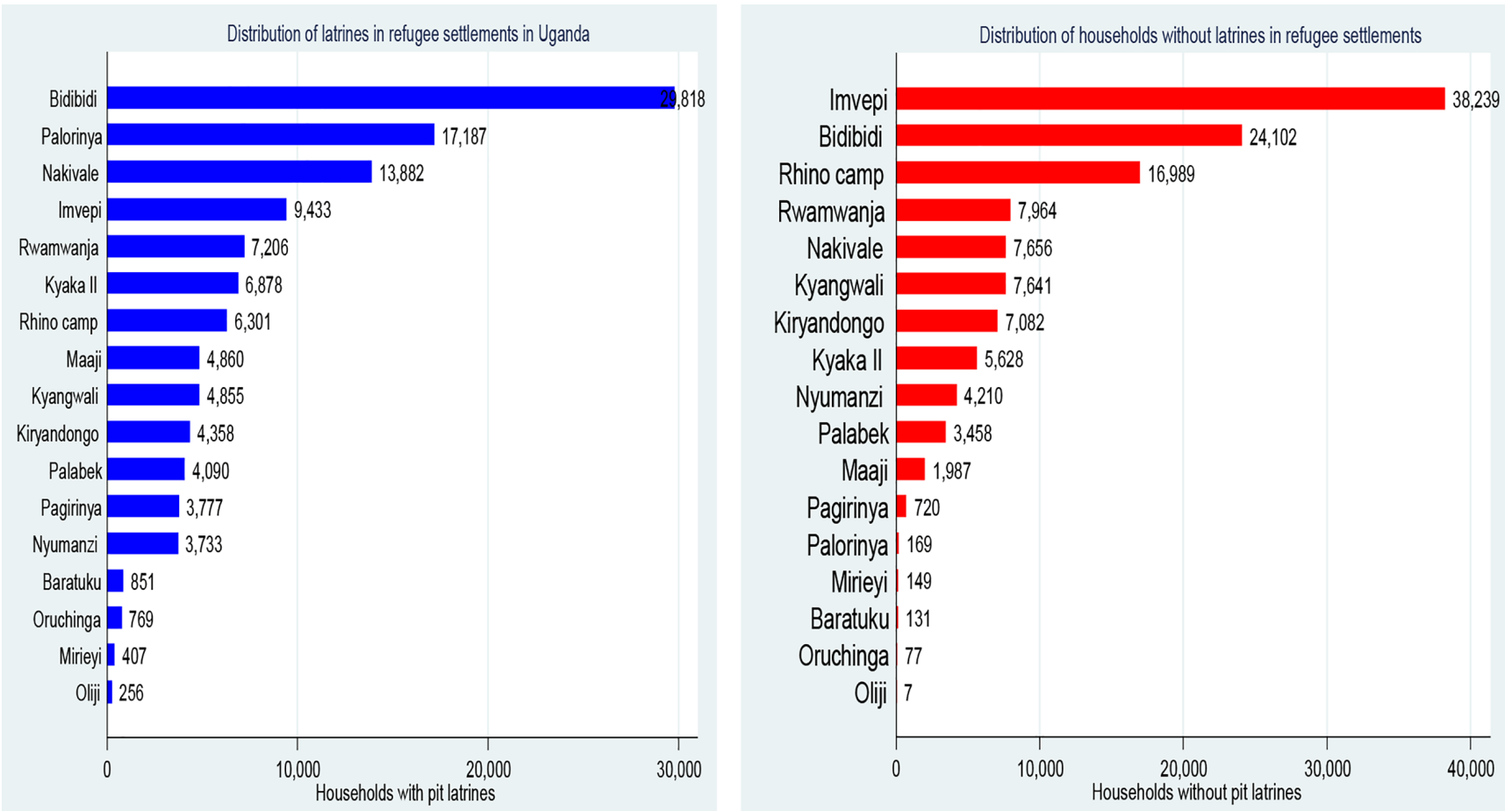


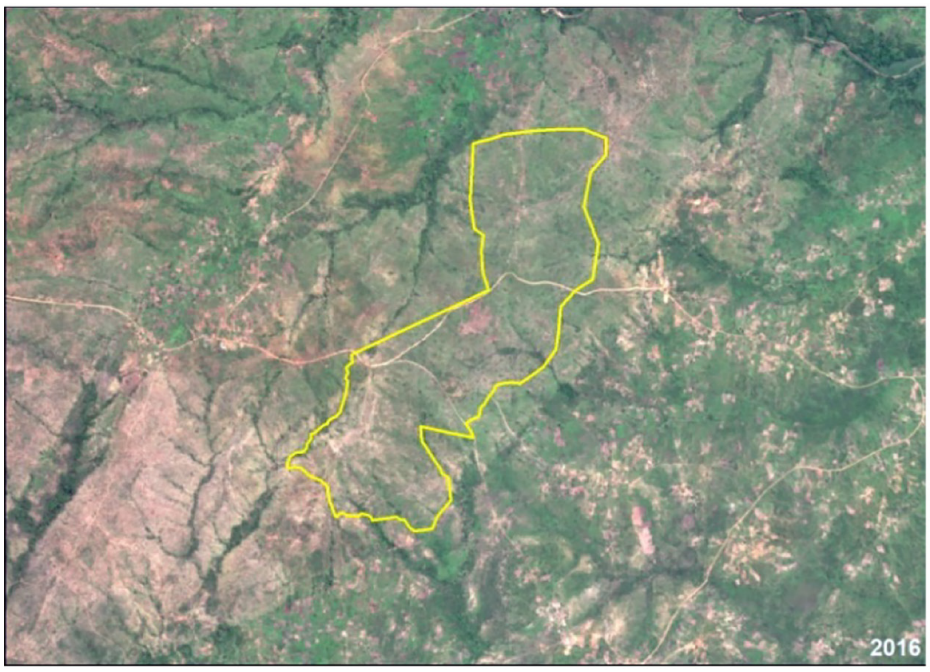
Figure 9.10: Distribution of latrines and households without latrines in refugee settlements. NEMA 2019

Amidst the low latrine coverage, is the challenge of collection and treatment of fecal sludge. Household latrines are usually shallow mainly due to either the rocky or fragile nature of some of the settlements. Most of the household latrines are not drainable posing an additional burden of collection and transportation of sludge. While there is commendable effort to have lined up and drainable communal and institutional latrines, the limited fecal sludge treatment systems imply that most of the sludge remains in the pits or is poorly disposed.

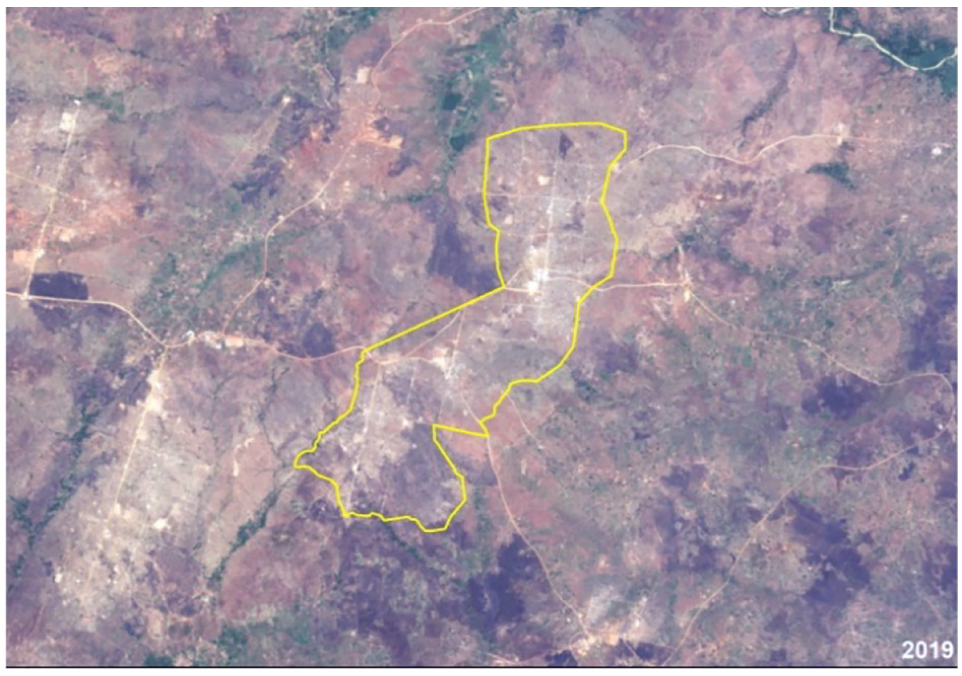
9.3 Pressures and Impacts

9.3.1 Refugee influx

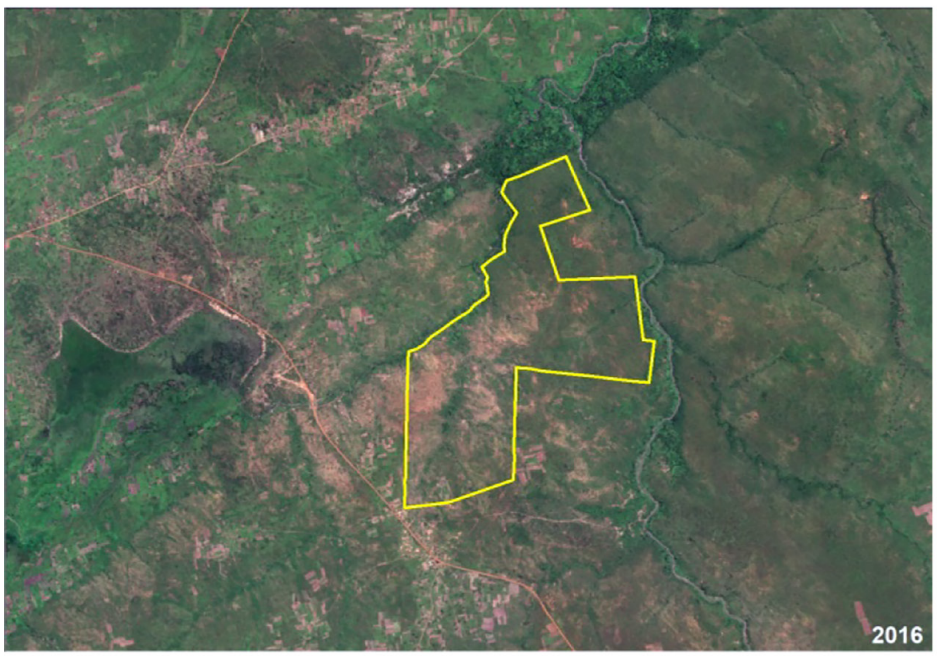
Refugees just like host communities utilize land and related resources for a variety of reasons. The use of such resources results into land cover changes and environmental losses. While such losses may not be attributed to refugees only, it is clear that the refugee influx has contributed to environmental degradation in Uganda. This is due to the fact that in most cases, the influx is unexpected and thus unplanned. It is reported that in the financial year 2016/2017 alone, Uganda's natural resources amounting to nearly US$ 280 Million were lost in resettling refugees (UNDP, 2017). Just over half (55%) of the losses are attributed to the consumption of biomass (wood fuel) and water resources, 12% to land conversion, and 34% to other ecosystem losses. This cost however does not take into account the full environmental implications associated with sustaining a refugee in Uganda (NEMA 2018).



Bidibidi 2016

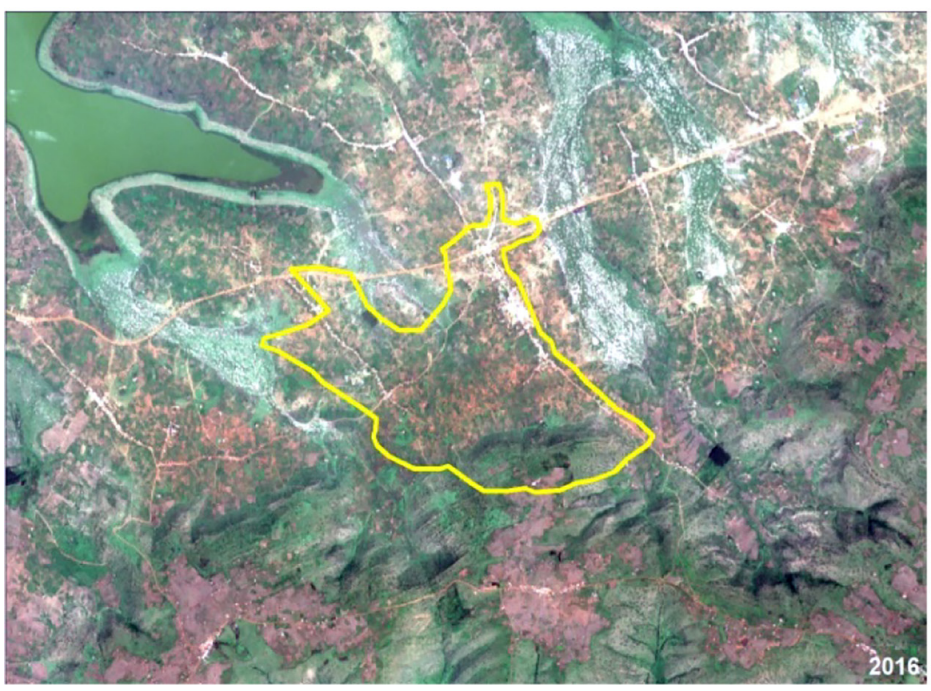


Bidibidi 2019

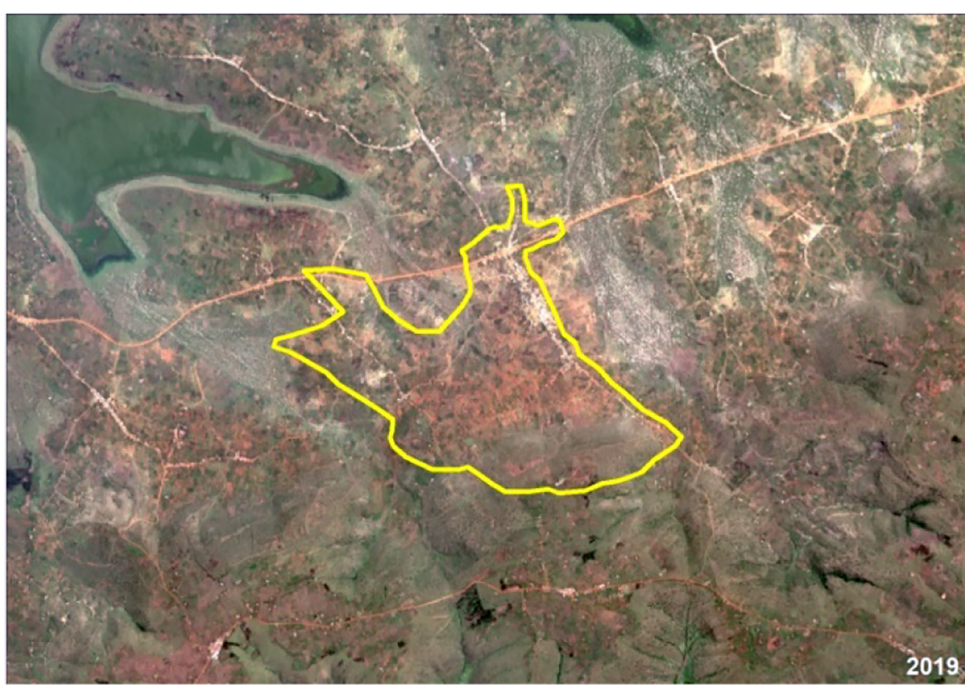


Pagirinya 2016

Pagirinya 2019



Nakivale 2016



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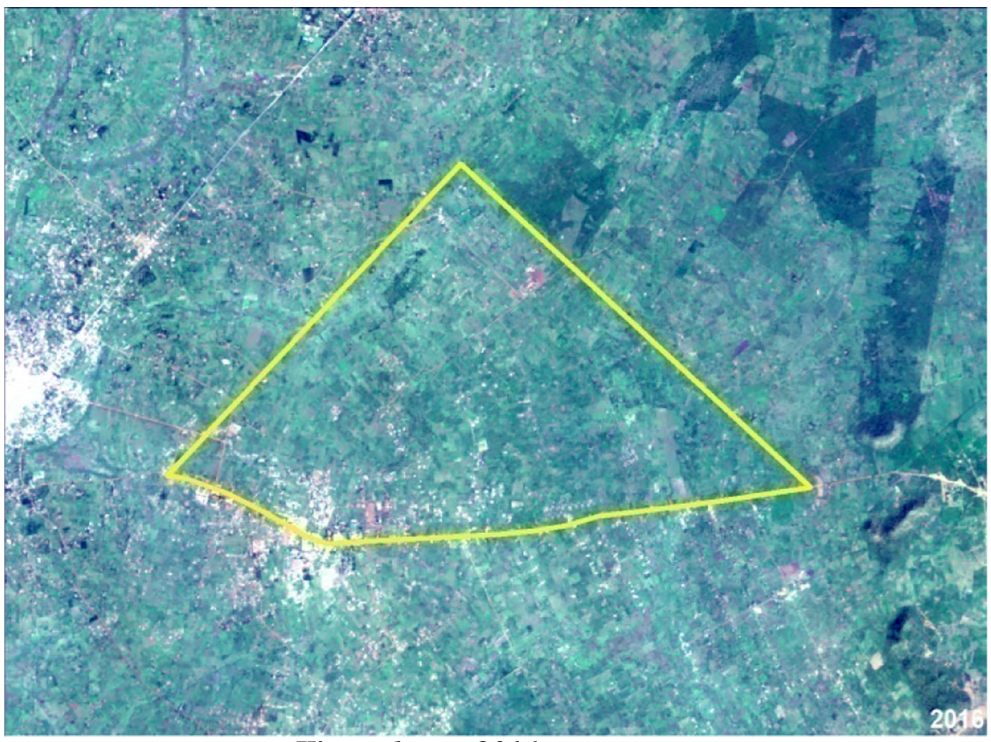
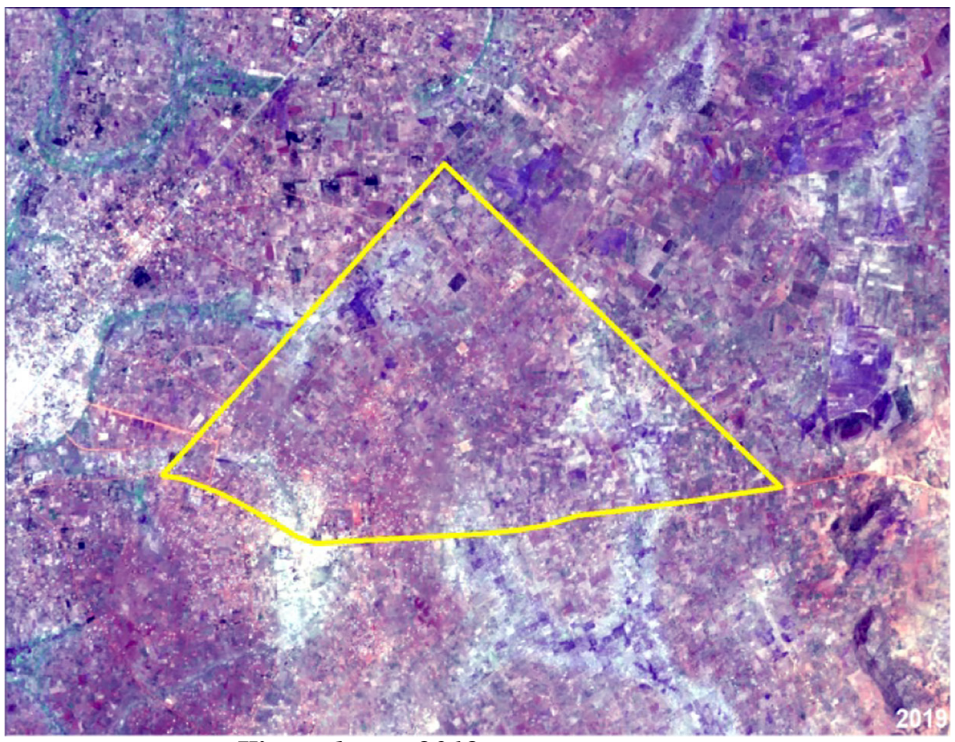


Kiryandongo 2016



Kiryandongo 2019

Plate 9.6: Change pairs of selected settlements on land use and land cover

As shown in Plate 9.5, Uganda has also experienced major land use and land cover changes over the years it has hosted refugees. The major land cover changes that have occurred due to refugee settlement establishment are related to agricultural production for food needs, construction and energy needs, and physical infrastructure developments. It is evident that hosting refugees has exerted extra strain on the natural resources. A summary report in 2019 by CREEC noted that generally there were major increases in land extents since 2014 as a result of hosting refugees. Coverage of tree plantations was on a downward trend, wetland cover had reduced in size, and the woodlands faced enormous decline in land area within and outside the refugee settlements. Open waters had declined and land mass and grasslands reduced. Further, land cover maps show environmental degradation in all the settlements characterized by reducing bush and wood land, grass, forest and wetland cover and increasing farmland both subsistence and large scale, built up areas but also plantation forests.

9.3.2 Impacts from agricultural production and livelihood activities

The main pressures behind environmental degradation are human needs and demand for food and thus farming, energy mainly for cooking and heating and livelihood. Agriculture is the main source of livelihood for both refugees and host communities. While subsistence agriculture is the common practice, there are also large scale agriculture projects mainly developed by institutions. The environmental impact from both subsistence and large scale farming appears similar, resulting in encroachment on fragile ecosystems. The reducing size of refugee household plots as a result of influx, coupled with poor methods of farming and over cultivation implies loss of vegetation cover and soil fertility with dire consequences of soil erosion and siltation. The end result has been encroachment on fragile ecosystems including forests, wetlands, river banks among others.

Deforestation and forest degradation are pronounced in all forest reserves that neighbor refugee settlements including Bugoma, Budongo, Era, Zoka, Kagombe among others. Forest degradation is mainly as a result of demand for agricultural land, materials to construct dwelling units and fuel wood. This has resulted in not only forest degradation but also scarcity of fuel wood and trees. With fewer trees available, refugees have resorted to walking longer distances, skipping meals and opting for different diets which pose safety and health challenges.

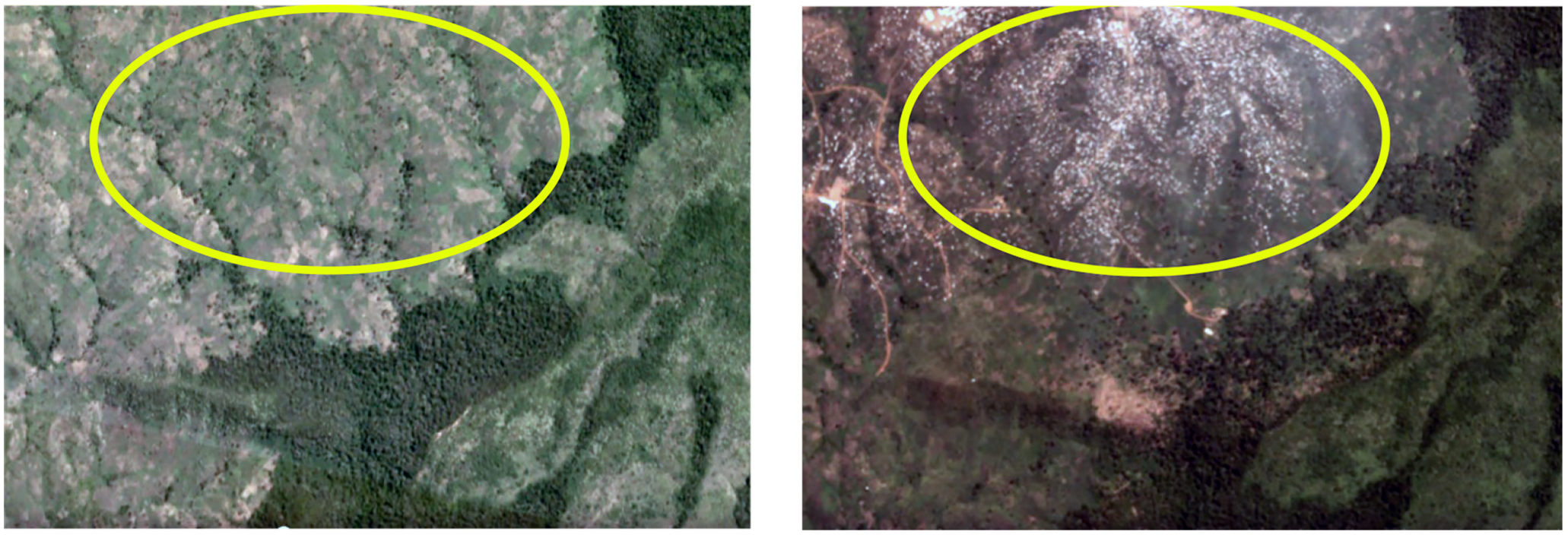


Plate 9.7: Kyangwali Refugee Settlement Camp in May 2017 and May 2019

Plate 9.8: Encroachment on Bugoma Forest Reserve for agriculture, charcoal burning and logging (Photo credit, NEMA 2019)

9.3.3 Social consequences of natural resources degradation

Socially, the environmental impacts of settling refugees have mostly centered on the use of natural resources particularly land cover resources. While positive impacts including intermarriages, socialization and economic opportunities are reported, conflicts related to land ownership, control of grazing areas, threats and harassment remain a concern but not captured in the formal reporting system. Competition over diminishing natural resources continues to cause tension and disruption of peaceful co-existence between refugee and host communities thereby compromising the asylum space. Wood fuel scarcity is a common source of tension and affects mostly women and girl children. A study by CREEC reported that of the 579 respondents who faced threats in the refugee community, 56% reported adult women while 30% reported adolescent girls as the ones most likely to be affected. Most of these threats are sexual perpetrated by adult men. The 2018 refugee health report found the highest incidence of reported rape in Rhino camp, Oruchinga and Bidibidi settlements. It is important to note that there is

limited data on sexual violence due to its scarcity. However, refugees particularly women continuously report threats that in nature happen during the search for firewood. Scarce wood fuel also affects health and nutrition. The 2017 Food Security and Nutrition Survey Report reveals that refugee settlements in Arua, Adjumani, Bidibidi, Palorinya and Palabek have a Global Acute Malnutrition (GAM) of more than 10% and this is classified as serious (HSRRP 2019-2024). This could be related to feeding and diet mix that is partly connected to food preparation which relies on availability of cooking energy. The impacts of deforestation and loss of tree cover are thus beyond the environment realm.

9.3.4 Wetland and Lakeshore encroachment in selected settlements

Most of the wetlands in refugee settlements are not demarcated increasing chances of encroachment. By 2009 for instance, the wetland coverage in the four settlements of Bidibidi, Imvepi, Palabek and Pilorinya in West Nile was 35,785 Ha and had reduced to 22,561Ha. Representing a 63% reduction. All settlements with wetlands have experienced this degradation and reduction in size. In virtually all settlements encroachment is observed on the lake, river and wetland systems. Plate 9.9 shows encroachment on Lake Nakivale by subsistence maize farming years after the lake had been demarcated and encroachers evicted. Similar images pertain to other water bodies; Rwamurunga in Isingiro, Enyau in Arua, Muzizi in Kibale, among others.

Plate 9.9: Maize cultivation within the protection zone of Lake Nakivale (Photo credit, NEMA 2019)

There is already a water deficit of an estimated 7 million liters per day in refugee settlements. This is partly due to huge refugee influx but also environmental stress. In West Nile for instance much as the ground water potential of the water sources is unknown, estimates indicate a 50% - 60% borehole drilling success rate. This implies that close to a half of drilling activities result in no yield, an indication of limited ground water potential in concerned areas. Limited ground water potential is mainly due to compromised water recharge. Water recharge is compromised by degradation and encroachment on the wetlands, natural forests, lakes and rivers, among others. This also affects water quantity and quality. A 2010 NAFFIRI study on Lake Nakivale for instance found that the lake was eutrophicated and exhibited an even depth of 1.2metres deep compared to its original maximum depth of 3.5 metres. While such cannot be attributed to encroachment by refugees only, the impact is costly to the environment and society. Reduced water quality and quantity has resulted into long queues for water in most settlements and dry boreholes while some of the settlements continue to practice water trucking.

9.3.5 Waste, pollution and health impacts

Human waste can substantially affect the environment if it is improperly managed. In refugee settlements, fecal sludge and sanitation is a big challenge largely because of inadequate treatment and disposal systems. Some of the sites and systems lie in areas with a high water table resulting into sinking of pit latrines and sludge which poses a pollution threat to the water resources. In some settlements sludge was reported disposed into the lakes and other surface water sources (NEMA 2019). This compromises water quality and poses dire health consequences.

Environmental impacts arising from poor management of fecal sludge in refugee settlements, relate to contamination of drinking water sources evidenced through the necessity to treat all drinking water supplies including groundwater and the high number of diarrheal cases reported at health facilities (NEMA, 2018). Potential impacts include eutrophication of surface waters and contamination of crop produce since fecal sludge is retained and/or disposed-off on the same pieces of land used for crop production. Also environmental and sanitation related illness remain a concern in refugee settlements. The leading causes of illness and death among refugees are malaria, respiratory and diarrhea diseases. The 2019 Health Sector Refugee Response Plan reports that malaria accounts for (37%) of the disease burden, watery diarrhea (5%), respiratory tract infections (24%), among others (HSRRP 2019). Watery diarrhea is a huge burden in settlements like Kyangwali and Palabek (UNHCR health report, 2018). There have also been reported cholera outbreaks, most of which are strongly related to both changing environments and waste management.

9.4 Policy Responses

The legal and regulatory framework for managing refugee issues is mainly contained in the Refugee Act of 2006 and refugee regulations of 2010. While the National Refugee policy is still under development, Uganda promotes an open door policy to refugees. This implies that the country receives all refugees on arrival. As a result, the country continues to receive more arrivals than departures/repatriation. The open door policy coupled with humanitarian and emergency approach however appear to contribute to a number of environmental challenges largely due to planning shortfalls. The country has not undertaken a Strategic Environment Assessment (SEA) of the refugee settlement programme. As such settlement of refugees is conducted on an adhoc basis at times and in areas that may compromise the environment. Establishment of such settlements is done without requisite approvals and clearance including Environment and Social Impact Assessment (ESIA) certification, land use and physical development plans and consideration of the carrying capacity, among others. Of the 48 settlements for instance, only 3 have undergone the ESIA certification with two undertaken after establishing the settlements. This partly contributes to environmental degradation, restricting monitoring, inspections and related enforcement to post settlement scenarios. There is need to carry out assessments and inspections for all refugee settlements. The requirement for ESIA certification thus needs to be adhered as required by law.

Uganda has embarked on a development oriented model to managing refugees. The country is implementing the Comprehensive Refugee Response Framework (CRRF). The Comprehensive Refugee Response Framework is a multi-stakeholder model for a whole of society approach to refugee protection and management in line with the New York declaration on Refugees and Migrants. The framework aims at ensuring a more coordinated and harmonized approach that focuses on both the humanitarian and development concerns of refugees and host communities.

Three CRRF plans including the education, health and water and environment sector response frameworks have been developed. The completion and operationalization of the Water and Environment Refugees Response Framework is expected to contribute significantly to environmental protection and restoration. The plan is estimated to cost US$ 916 million of which 60% will be used to reverse the impacts and effects on the environmental degradation and provision of fuel for the refugees. This is a positive development that will however require movement beyond development of the plan to mobilization of resources, engagement of agencies and related operationalization.

The Refugee and Host Population Empowerment (ReHoPE) strategy is a self-reliance and resilience strategic framework targeting refugees and host communities. ReHoPE was designed in 2017 and aimed at ensuring that the humanitarian mandate is protected through a development lense. While ReHoPE contributed substantially to infrastructure development needs of transport, health and education, little progress was registered in the area of environment management. The strategy has since been replaced by the World Bank funded Development Response to Displacement Impact Project (DRDIP) which is aligned within the Uganda`s Comprehensive Refugee Response Framework.

The Development Response to Displacement Impact Project (DRDIP) and Northern Uganda Social Action Fund (NUSAF) were all developed by the government of Uganda under the Office of the Prime minister. The two interventions are related to conflict and displacement and in both approach, context and location. NUSAF targets 55 districts in Northern Uganda that include refugee hosting districts while DRDIP targets only refugee hosting districts. Both projects uses a community driven approach model. The two projects are funded by World Bank and DRDIP initially received a USD 50 million credit from World Bank focusing on four major components of Infrastructure, Environment, Livelihoods and Project Management including monitoring and Evaluation, and Regional and National Institutional Support.
DRDIP has attracted an additional USD 150 million to finance the second phase. The initial phase of the project focused on mainly infrastructure development while environment and livelihoods component is emerging. Modest and notable achievements by both DRDIP and NUSAF include ear marking 5% of resources to a project for environment and safeguards. NUSAF has supported the development and funding of Environment and Social Safeguards management

plans for more than 8,110 sub projects while DRDIP has funded more than 700 sub projects. While all the refugee hosting districts have been able to benefit from the DRDIP interventions, engagement and support to national environment agencies as initially conceived has not yet been realized. A deliberate strategy to engage national environment management agencies is thus needed for realization of the projects` environmental targets.

9.5 Recommendations

1) Uganda`s open door refugee policy is a model across the globe. There is however need reinforce the policy to prioritize the legal and regulatory frameworks relating to sustainable environment management. The open door policy needs to integrate environment management as a key strategic, mandatory and priority area of focus.
2) There is a dire need for conducting a Strategic Environmental Assessment (SEA) of the refugee settlement programme. This would look at available options for best planning and managing refugee related environmental concerns.
3) Environment and Social Impact Assessments (ESIA) are a requirement by law. For a long time, this requirement has been ignored. ESIAs should be mandatory requirements before establishing settlements. This is important given that the country will continue to host refugees. Such would pave way for establishing environmental conditions, carrying capacity potential and best options to managing environmental impacts related to refugees
4) Environment and natural resources mainstreaming should be undertaken across all settlements and refugee programmes. All interventions implemented in refugee settlements need to comply with such a requirement. Equally important is the need for reporting of environmental interventions within settlements. This will require the Office of the Prime Minister and UNHCR to integrate their reporting systems with the National Environment Management Reporting system.
5) National environment management agencies should be engaged and fully involved in refugee environment management programmes including planning, implementation and ownership. There is limited interaction between refugee settlement and management partners and environment management agencies which calls for more engagement. This is important not only for reinforcement of existing interventions but also sustainability of programmes particularly where the short term project approach is used.
6) Operationalise the Water and Environment Sector Refugee response plan through commitment of funds towards restoration and environment support services. These include: Enhancing environmental enforcement by increasing the number of Environmental Protection Force at district level and extension workers at sub-county level, revitalizing District and local environment and natural resources committees and developing environmental management regulations, guidelines and conditions for refugee settlements.

Bibliography

Andreasi Bassi Susanna, Iskandar Tange, Benjamin Holm, Alessio Boldrin and Martin Rygaard, (2018). A Multi-Criteria Assessment of Water Supply in Ugandan Refugee Settlement. Water 2018, 10, 1493; doi:10.3390/w10101493 www.mdpi.com/journal/water

FAO and OPM. Food Security, Resilience and Well-being Analysis of Refugees and Host Communities in Northern Uganda. (2018) Rome.

Heng Zhu, Mateusz Filipski , Jaakko Valli , Ernesto Gonzalez, Anubhab Gupta and J. Edward Taylor ; 2016. Economic Impact of Refugee Settlements in Uganda, 28th October, 2016Maonga Jane, WASH in Uganda refugee settlements: next phase. PowerPoint presentation,UNHCR, Available online:

National Fisheries Resources Research Institute (NaFIRRI) (2010), Report of a Rapid Assessment of the Lake Nakivali Fishery, Prepared for the Office of the Prime Minister on Lake Nakivali Refugee Settlement.

UNICEF Uganda Situation Report, January-June 2019. Available online https://reliefweb.int/sites/reliefweb.int/files/resources/UNICEF

UNHCR (2019). WASH strategic operational framework, Uganda Refugee operations.

United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019, Online Edition. Rev.

Republic of Uganda (2019). Water and Environment Sector Refugee Response plan. Ministry of Water and Environment and UNCHR Kampala

Republic of Uganda (2019). Health sector integrated refugee response plan, Ministry of Health, UNCHR

Republic of Uganda (2018). Education Response plan for refugees and host communities in Uganda, Ministry of Education and Sports, UNCHR

World Bank (2017). REHOPE — Refugee and Host Population Empowerment strategic framework – Uganda. Available online: https://data2.unhcr.org/en/documents/download/64166

TOR humanitarian working group for Environment & Energy https://data2.unhcr.org/en/documents/details/64207

2019/2020 RRP – https://data2.unhcr.org/en/documents/details/67314

2018 Reports - https://data2.unhcr.org/en/documents/details/69350

https://data2.unhcr.org/en/documents/details/69348

https://data2.unhcr.org/en/documents/details/69349

2018 – Joint Multi-Sector Needs Assessment https://data2.unhcr.org/en/documents/details/65982

2018 – WB/FAO Rapid Diagnostic West Nile https://data2.unhcr.org/en/documents/details/64186

2018 - Malteser/ECO Feasibility Study https://data2.unhcr.org/en/documents/download/68167

2018 - Key findings from a GIZ study in Arua https://data2.unhcr.org/en/documents/details/64188

2017 – UNHCR/FAO Rapid Wood Fuel Assessment Bidi Bidi https://data2.unhcr.org/en/documents/download/64175

2015 – DRC-DDC Environment Baseline West Nile https://data2.unhcr.org/en/documents/download/64177

2014 - WRC SAFE in Nakivale https://data2.unhcr.org/en/documents/download/64175

2013 – UNHCR Nakivale https://data2.unhcr.org/en/documents/download/64173

2009 – WFP/WRC/GTZ SAFE in Nakivale https://data2.unhcr.org/en/documents/download/64174

Example timelapse Land Use and Land Cover Map (NFA data) for a refugee settlement area https://data2.unhcr.org/en/documents/details/66112

ESIAs (and attached):

https://data2.unhcr.org/en/documents/details/64157

https://data2.unhcr.org/en/documents/details/64158

FAO/UNHCR TOR Forest Resource Management Plan Bidi Bidi https://data2.unhcr.org/en/documents/details/64537

Draft NEMA Programme https://data2.unhcr.org/en/documents/details/64211

https://data2.unhcr.org/en/documents/details/69350

https://data2.unhcr.org/en/documents/details/69348

https://data2.unhcr.org/en/documents/details/69349

PART 3:
POLICY & ACTION RESPONSES

Introduction

The policy responses and actions are aligned to the application of the national, regional and international legally binding and agreed environmental goals and objectives. Several instruments, therefore inform the policy responses such as international treaties, conventions and protocols and the non-legally binding international instruments including outcomes of the United Nations summits and World Conferences in the field of environment, resolutions of the United Nations General Assembly, code of conduct adopted by the governing bodies of the relevant United Nations Bodies and Specialized agencies in the field of environment, and decisions and recommendations of commissions and governing bodies. At national level the laws and regulations, policy strategic interventions, plans and development projects become goals and commitments that guide policy action responses.

Most policy responses discussed below were incorporated in the recent policy and framework governing environment management informed by the review of the National Environment Act Cap 153 which was in turn informed by the National Environment Management Policy (NEMP) review and strategic interventions proposed under the NEMP draft 2014. The review concluded with proposals to repeal Cap 153 to incorporate the emerging issues and facilitate reforms in the sector. In November 2017, the National Environment Bill was published with proposals to repeal and replace the 1995 National Environment Act cap 153 to conform to policy reforms in the sector and provide legal measures to address environmental issues that had emerged since 1995. On 7th March 2019, the NEA No.5 of 2019 was assented to and come into force on 27th June 2019. It introduces several measures and mechanisms to enhance management of the different segments of the environment. Some of the measures include; the Right of Nature, Special Conservation Areas, Payment for Ecosystem services, Biodiversity and other Offsets, sound management of chemicals, pollution control and liability, management of impacts arising from Oil and Gas developments, climate change, e-waste management, strategic environmental assessments, management of plastics and plastic products, enhanced role and functions of lead agencies, and establishment of the Environment Protection Force, and the mandate to develop guidelines and tools for management of the different aspects of the environment, among others.
Therefore, the different factors that inform the state of environment described herein are supported by environmental policy, legal and institutional arrangements broadly designed to respond and align with international, regional and national developments and commitments as well as address new and emerging challenges associated with impacts of climate change for sustainable livelihoods and economic development.

Environment is broad and covers the physical factors surrounding human beings; the biological factors of animals and plants; and the social factors of people, including human interactions with both the natural and built environment . The demands on the environment sector are inevitably enormous because environment is critical to health, social and economic wellbeing. Environment is indeed key to the means of supporting one's existence through the access and mobilization of resources for various activities that enable people pursue goals necessary for their survival and longer-term well-being among other needs. Therefore, the linkage between livelihood and natural resource stock, access and use; physical infrastructure development, tools and equipment; social cohesion, income and investment, - and culture among other aspects is demonstrated by the theme for this State of Environment Report, "Managing the environment for climate resilient livelihoods and sustainable economic development".

In that regard, the policy, legal and institutional responses to environmental issues continue to revolve among sector players depending on the pressure for development and needs from the environment. Different types of responses and actions have been made including; policy reviews, development of guidelines and tools, design and implementation of strategies and plans, institutional strengthening, Projects and legislation, among others.

This part of the report is designed to discuss the different types of policy responses that have been used to address the environmental issues and assess their success and inadequacies. This part also makes recommendations that will inform reviews and amendments where needed.

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Biodiversity

Biodiversity loss is a human concern, and efforts to reduce the unacceptable loss of biodiversity and address ecosystem degradation have been made under the different types of responses. Uganda like other developing countries is engaged in development projects that contribute to the increasing loss of biodiversity and continue to pose a threat to the rich biodiversity in the country. Biodiversity is also a critical resource for food, medicine and tourism industry. It is therefore, recognized that valuing, conservation, wise use and restoration of biodiversity is critical to reversing the trends.

Several policy measures incorporated in the NBSAP II are under implementation, including; development of national capital accounting systems, development of standards for Genetically Modified organisms, Mainstreaming biodiversity across sectors, Restoration of degraded ecosystems including rangelands, Community awareness programs, environmental compliance and enforcement, training on value addition of local communities and groups on the shea butter products, Promotion and access to markets to enhance conservation, Development of byelaws and ordinances in local governments, Protection of shea butter tree from charcoal production, Resource mobilization through project proposals for shea butter tree conservation, among others.

Several actions are also designed to fulfill Uganda's obligations under the Convention on Biological Diversity (CBD) and its attendant protocols, the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), Convention on International trade of Endangered Species (CITES) through participation and adoption of tools designed to support biodiversity management and conservation. Some of these are implemented as funded projects supported by UNEP, UNDP and GEF (CONNECT Project-Mainstreaming Biodiversity Information into the heart of Government decision making, Rio project on the "Strengthening Institutional Capacity for Effective Implementation of UNCBD, UNCCD and UNFCCC in Uganda). In line with the above described developments and commitments, Uganda is beneficiary to some projects designed to experiment initiatives to guide ecosystem accounting coordinated by UNEP- WCMC and IPBES.

The NBSAP II 2015 - 2025 was aligned to the Aichi targets and implementation is ongoing. This contributed to the discussions at the CoP MoP in Egypt, during which it was agreed that regional assessments of biodiversity and ecosystem services for Africa; the thematic Assessment of Land Degradation; Restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services could inform the national actions on biodiversity and accelerate progress towards the achievement of the Aichi Biodiversity Targets. The development of the Post-2020 biodiversity framework for negotiation is ongoing for an Action Agenda for Nature and People.

Key outcomes of response actions to biodiversity challenges include tools to enhance implementation of the policy and legal framework and development of tools to guide biodiversity conservation and management. The tools include; the National Environment Act No.5 2019, the Wildlife Act 2019, and the National Biodiversity and Social Offset strategy 2019 to guide national measures on mitigation of impacts from development projects on biodiversity, and the National Biodiversity Finance Plan 2019-2027/28, among others.

As indicated above, conservation institutions led by UWA have embarked on developing the National strategy to combat Poaching, Illegal Wildlife Trade and Trafficking of wildlife. This is intended to strengthen the fight against illegal wildlife trade and poaching and strengthen the basis for prosecution of offenders.

In 2019, a National Wildlife Crime Coordination Taskforce was constituted by the Minister of Tourism Wildlife and Antiquities comprising of representatives from Ministry of Tourism, Wildlife and Antiquities, Uganda Wildlife Authority, Uganda Revenue Authority (Customs Department), Ministry of internal Affairs (Immigration Department), Uganda Peoples Defense Forces, Uganda Police Force, Civil Aviation Authority, National Forestry Authority, Finance Intelligence Authority, Directorate of Public Prosecution, Internal Security Organization and External Security Organization. The task force has been trained in CITES nomination criteria.

Further, as part of implementation of NBSAP II, five new funds have emerged. One of these is the Uganda Biodiversity Trust Fund (UBTF) an independent conservation fund. The Uganda Green Growth Development Strategy has drawn financing for the five focus areas of agriculture, green cities, sustainable transport, sustainable energy and natural capital management. The European Union office in Uganda has supported the mobilization of at least EUR 207.35 million for implementation of biodiversity conservation and management related activities.

One of the challenging issues is the lack of scientific knowledge on open environmental transformation technologies. These include the use and spray of biocides for pest management in Agriculture which can elicit transient gene silencing responses and create non-targeted toxicities. Also, the global strategy for plant conservation has designed initiatives to provide guidance on ecosystem accounting but mechanisms are still in experimental stage. Uganda should adopt and implement measures that will strengthen ecosystem accounting within the System of Environmental Economic Accounting (SEEA) and measures for controlling IAS within the framework of NISSAP including identifying and control pathways of introduction as well as ecological and socio-economic

8 Section 2 National Environment Act No. 5 of 2019
9 National State Policy Objective XIII of the 1995 Constitution

impacts of IAS. It is also necessary to build capacity and to design measures that enable the identification, monitoring and assessment of impacts of the technologies. NEMA should further use the special conservation area principle to enhance protection of biodiversity outside protected areas.

Oil and Gas, Energy and Extractives

The critical challenges under the Oil and Gas industry is infrastructure development, processing and pollution control. Following the proposed reforms in the environment framework law, several tools were developed and others under consideration to ensure that they are harmonized and correspond to environmental concerns on Oil and gas developments. These include: the National Environment (Environmental and Social Assessment) Regulations; the National Environment (Audit) Regulations; the National Environment (Management of Ozone Depleting Substances and Products) Regulations; the National Environment (Waste Management) Regulations; the National Environment (Strategic Environmental Assessment) Regulations; the National Environment (Oil Spill Prevention, Preparedness and Response) Regulations; among others.

Further, the Ministry of Energy and Mineral Development undertook a number of measures to address the impacts from the developments in the sector including hydro power projects ranging from controlled waste disposal, pollution control, establishment of offset areas for example the Kalagala and Itanda Special Conservation Area (2019), development of alternatives to use of wood poles and metallic transmission line to use of concrete poles for the distribution lines. Robust Resettlement Action Plans for the projects where displacement took place as well waste disposal plans for the plants to prevent any leakages and toxic waste release into the environment, measures to reduce the impacts of biomass consumption for energy generation, development and promotion of energy efficiency technology with low carbon emission, for example the green charcoal project which supported the reforestation of over 10,000 acres of woodlands in the cattle corridor districts of Mubende, Nakaseke, Kiryandongo and Kiboga.

Measures to integrate climate change in line with the obligations under United Nations Framework Convention on Climate Change (UNFCCC), its Kyoto Protocol (KP) and the Paris Agreement, included investments in solar PV to increase access to clean energy that were implemented for institutions and DLGs under the MEMD ERT program and implementation of the Clean Cooking Supply Chain Expansion Project and a number of other strategies such as the Uganda Green Growth Development Strategy 2017/18-2030/31 that provides interventions for achieving low emissions economic growth pathways for both the present and future generations.

Air Quality

Given the numerous sources of pollution, several policy interventions have been made including enhancing mechanisms for environmental levy on second hand vehicles and electricals, licensing systems to monitor and control pollution and regulation of the pollution drivers. Measures are broadly provided for under the National Environment Act and integrated in the Waste Management Regulations for control and monitoring. These include extended producer responsibility, waste generator's liability from source to disposal. There are other measures like landfills, e- waste collection centres and ban of hazardous substances. Measures to establish air quality standards in accordance with the National Environment Act are under discussion. Currently, all existing initiatives have been using mainly World Health Organization guidelines that provide guidelines on the acceptable air quality limits, but national specific regulations need to be enacted and operationalized as they speak to the needs of the country.

While the draft Air Quality Standards Regulations are under discussion, several actions and measures in effect to monitor air quality. For instance, KCCA passed an Ordinance and installed equipment to monitor air quality in Kampala, a mass transit system e.g. the passenger train from Kampala to Namanve was introduced and it reduced the number of people using 14-seater taxis equivalent to 142 trips by 14-seater taxis, the planned Bus Rapid Transit system for Kampala, the pilot Non-motorized Transport corridor under construction along Namirembe road intended to reduce exposure to air pollution through prioritizing walking and cycling. KCCA further identified potential monitoring sites and 25 air quality monitors have been procured to measure PM2.5 and PM10 and NO2. Government introduced the average fleet age by putting a ban on the importation of vehicles of age above 15 years to reduce old vehicles which are the main sources of air pollution

Initiatives to promote research and innovation have also been promoted. Makerere University in partnership with AirQo research initiative within College of Computing and Information Science and the Lung Institute and East African GeoHealth Hub is championing research on air quality and low-cost air quality monitors have been installed in different urban areas in Uganda aimed at contributing to the improvement of urban ambient air quality and provision of scientific evidence that could inform mitigation strategies including policy interventions. The research programme also focuses on air pollution impacts on child health, occupational health and climate change

Other initiatives have been managed by the US- Mission where the US-Department of State in

Partnership with the EPA conducts air quality monitoring in selected US-Embassies and Consulates globally. These datasets are publicly made available in real-time to the public through an online platform (www.airnow.gov/). Historical datasets (2018 and 2019) from the Kampala monitoring station were collated and summarized to demonstrate that measures to monitor air quality are critical.

Recommendations

Ambient and indoor air pollution levels are on the rise in the country mainly due to different drivers from the various sectors of the economy. The most effective response to air pollution depends on establishing comprehensive policy and regulatory measures to support actions to achieve clean air, specifically NEMA should collaborate with relevant agencies to establish Air Quality Standards Regulations to provide national-level guidance and raise awareness of the increasing rate of air pollution in the Country; develop the National air quality strategy to provide a clear framework to support the implementation of air quality regulations and scale up on existing piloted initiatives to monitor air quality in Urban centre, industrial areas, commercial and residential areas.

The National Physical Development Plan should be developed taking into consideration the existing air quality regulatory measures and proposed reforms. Critical to this is the establishment of commercial and industrial zones to relieve development pressure in some regions of the Country and provide opportunities for better livelihoods across the country. Regulating land use activities that can be accepted in different areas taking into account the national air quality regulation and strategy. This can be achieved through zoning to designate acceptable land uses like commercial, residential, industrial, transport and transportation/utility routes. Bring services closer to people to reduce movements.

Further, NEMA should promote increased waste collection efforts and promote 3Rs (Reduce, Reuse and Recycle) at household level mainly in urban areas and cities to reduce waste burning. Utilizing the 3Rs to promote waste reduction measures, reusing of the different waste like organic wastes for composting and recycling.

Water Quality

TMeasures to ensure water quality and quantity is managed have been designed in accordance with the Water Act and the National Environment Act. Water demands include; industrial production, irrigation, energy development and abstractions for different processes like campsites, are challenges. Actions undertaken include, review of the effluent discharge regulations, restoration of water catchment areas, irrigation to boost agricultural production and hydro power development for clean energy, among others.

Large gravity flow schemes developed to meet community demands and enhance access to water are threatened due to the capacity gaps to sustain the catchment and other factors including deforestation, wetland degradation, destruction of water catchment zones and the unsustainable development of industries in critical ecosystems and associated impacts of pollution and poor health.

Recommendations

Demarcation, isolation and treatment of underground mine water, containment of tailings erosion and leachate before it is discharged into the natural water resources should be done.

Highly contaminated soils should be mapped and cultivation or grazing animals on such soils discouraged or prohibited. Bio-accumulator plants such as Thilaspitheluscens should be planted on highly contaminated soils as part of phytoremediation initiatives. These methods have been used before in other areas faced with mine contamination.

The Ministry of Water and Environment should strengthen institutional set up for water catchment management zones and trans boundary area at local levels, expand the Integrated Water Resources Management (IWRM) framework to include other aspects like poverty eradication and disaster preparedness in addition to provision of drinking water and sanitation and collect data to inform water quality and quantity.

NEMA in collaboration with MWE should enforce waste management regulations, secure field monitoring equipment, and refurbish the Laboratories to enhance management of water quality and quantity in the entire country

Soil condition

According to Nandwa 2001; Zhang et al. 2017 and Musinguzi et al. 2015, soil organic matter is low to medium in most places, and is declining due to increased erosion and poor land management practices that have negative impact on fertility and productivity. For our soils to remain productive, they must therefore be properly managed to maintain organic matter at reasonable levels, preferably above 3%. It is noted that the National Environment (Minimum Standards for Management of Soil Quality) Regulations S.I 59 of 2001 focus on soils in arable land paying no attention to the soil demand, management of its nutrients and extractives, including classical mining and artisanal for aggregates, sand, peat, clay, murram, gold or diamonds, among other activities that impact soils.

To manage the environment for climate resilient livelihoods and sustainable economic development the findings in this report underpin the gap in land use planning which is critical for the management of environment in Uganda. Land use cuts across all sectors that impact the environment. All investment takes place on land and the absence of a physical development plan to guide infrastructure development including roads, schools, industry, and agriculture development, among others continues to take its toll. This can easily relate with soil nutrient deficiency and low fertilizer use. More attention should be given to rural and urban areas which are the target for extractives, large scale agriculture and settlements. Therefore, institutional collaboration to strengthen land use management for effective environment management is recommended.

The National Agriculture Policy (NAP) provides a broad framework for soil management in the country. This guided the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) in the development of the Agriculture Sector Strategic Plan (ASSP) aimed at transforming the sector from subsistence to commercial agriculture. The ASSP prioritizes to increase access to critical farm inputs which will enhance access to and use of fertilizers for all categories of farmers as a strategic intervention. In line with this, Government prioritized increasing fertilizer use from the current low levels 0.23 -3.0 kg to 20.0 kg of nutrients per hectare by 2020, by putting in place the requisite policy and regulatory framework, including the National Fertilizer Policy, Strategy and Regulations. To realize this, Government issued the National Fertilizer Policy and the corresponding strategy in 2016, to address constraints to fertilizer use.

The Government also revived the Directorate of Agricultural Extension (DAES) and recruited extension staff to strengthen extension service delivery to farmers.

Recommendations

Soil mapping

c) Government should support efforts to develop a detailed soil map and associated maps of indicative soil properties, preferably at a scale of 1:50000, to guide land management.

d) Government should support efforts to develop a detailed soil erosion risk map to guide the review of existing regulations to control soil erosion.

Fertilizer production and usage

f) The National Agricultural Research Laboratory should be supported to produce nutrient deficiency maps required to guide the private sector in the production of balanced soil- and crop-specific fertilizers.

g) The National Agricultural Research Laboratory should be supported to intensify fertilizer research and guide fertilizer (both organic and inorganic) use, especially the promotion of fertilizer use along the 4Rs, use of balanced fertilizers and training of extension staff and other stakeholders in the areas of fertilizer use.

h) The National Agricultural Research Laboratory should partner with fertilizer blending companies in developing formulations of balanced fertilizers.

i) The National Agricultural Research Laboratory should be supported to develop fertilizer recommendations aimed at maximizing economic benefits.

j) The National Agricultural Research Laboratory should support the use of agricultural lime, because sometimes it is low pH and not nutrients that limit crop yield.

Legislation and review

c) NEMA should review the National Environment (Minimum Standards for Management of Soil Quality) Regulations, 2001, to update criteria for determining soil quality and consider other uses of soil beyond agriculture.

d) NEMA should review the National Environment (Hilly and Mountainous Area Management) Regulations, 2000, to consider emerging science in the areas of mapping and soil conservation.

Enforcement

c) Local Governments should enforce the adoption of appropriate soil and water conservation strategies as required by the relevant regulations and guidelines. It is important the Zonal Agricultural Research and Development Institutes support this effort.

d) MAAIF should enforce regulations to protect farmers from fake fertilizer products.

Environmental Hazards and Disasters

Disaster risk assessment and mapping in areas of Rwenzori, Elgon and Kigezi was done to identify and map landslide vulnerable communities. The identified vulnerable areas were assessed and community awareness about landslide occurrence done. Further, expansion of both community-based disaster preparedness (CBDP) programs and their evidence base have been prioritized, 912 Disaster Risk Assessments in 126 districts was conducted by the Office of the Prime Minister and 122 risk, hazard and vulnerability profiles and maps for the districts prepared. A Resettlement Plan of Landslide Prone Communities in the Elgon Sub Region was developed, 44 District Disaster Management Committees (DDMC) were operationalized in the 112 districts in the Teso, Rwenzori, Karamoja, Elgon and Buganda sub regions and catchment management committees and plans for Awoja, Mitano, Mpologoma, Mpanga, Semiliki) spearheaded by water management zones under Ministry of Water and Environment and NUSAF III were established. National Integrated Early Warning Systems bulletin, seasonal forecasts advisories, installation and management of automated weather stations, surface and underground water gauges/elementary stations and installation of geo-observer network in Rwenzori are used as mechanisms for dissemination and a National Disaster Risk Atlas for Uganda is under development.

It is recommended that the National Disaster Risk Atlas development process should be completed and use in the implementation of plans at all levels. It is also recommended that environment management measures for the protection of hilly and mountainous areas as well as established guidelines to apply the measures should be provided.

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Refugees

The promotion of an open door policy coupled with humanitarian and emergence approach has contributed to a number of environmental challenges largely due to planning shortfalls and lack of a strategic environment assessment of the refugee settlement programme. Settlement of refugees is conducted on an adhoc basis as a response to associated security risks and in efforts to manage the numbers and anticipated influx, settlement areas are identified and secured through exclusive procedures that in most cases compromise the environmental standards required for settlements. Establishment of such settlements is done without requisite approvals and clearance including Environment and Social Impact Assessment certification, land use and physical development plans and consideration of the carrying capacity among others. Of the 48 settlements for instance, only 3 have undergone the ESIA certification with two undertaken after establishing the settlements. This partly contributes to environmental degradation as monitoring, inspections and related enforcement are restricted to post settlement scenarios. It calls for reviewing of the approach to planning and managing refugee settlements.

To address the emerging challenges associated with refugee settlements, Uganda has embarked on a development oriented model to managing refugees. The country is implementing the Comprehensive Refugee Response Framework (CRRF). The Comprehensive Refugee Response Framework is a multi-stakeholder model for a whole of society approach to refugee protection and management in line with the New York declaration on Refugees and Migrants. The framework aims at ensuring a more coordinated and harmonized approach that focuses on both the humanitarian and development concerns of refugees and host communities. Three CRRF plans including the education, health and water and environment sector response frameworks have been developed. The completion and operationalization of the Water and Environment Refugees Response Framework is expected to contribute significantly to environmental protection and restoration. The plan is estimated to cost US$ 916 million of which 60% will be used to reverse the impacts and effects on the environmental degradation and provision of fuel for the refugees.

The Refugees and Host Population Empowerment (ReHoPE) strategy is a self-

11 Nandwa 2001; Zhang et al. 2017 and Musinguzi et al. 2015

reliance and resilience strategic framework targeting refugees and host communities. ReHoPE was designed in 2017 and aimed at ensuring that the humanitarian mandate is protected through a development lense. While ReHoPE contributed substantially to infrastructure development needs of infrastructural needs of transport, health and education, little progress was registered in the area of environment management. The strategy considered part of the country`s Comprehensive Refugee Response Framework has since been replaced by Development Response to Displacement Impact Project (DRDIP).

The Development Response to Displacement Impact Project (DRDIP) and Northern Uganda Social Action Fund (NUSAF) were all developed by the government of Uganda under the Office of the Prime minister. The two interventions are related to conflict and displacement and in both approach, context and location. NUSAF targets 55 districts in Northern Uganda that include refugee hosting districts while DRDIP deep targets only refugee hosting districts. DRDIP supports refugee hosting communities in districts that have experienced a high burden of refugees. It uses the community driven approach model implemented by the Northern Uganda Social Action Fund project. The two projects are funded by World Bank and DRDIP initially received a USD 50 million credit from World Bank focusing on four major components of Infrastructure, Environment, Livelihoods and Project Management including monitoring and Evaluation, and Regional and National Institutional Support.

DRDIP has attracted an additional USD 150 million to finance the second phase. The initial phase of the project focused on mainly infrastructure development while environment and livelihoods component is emerging. Modest and notable achievements by both DRDIP and NUSAF include ear marking 5%of resources to a project for environment and safeguards. NUSAF has supported the development and funding of Environment and Social Safeguards management plans for more than 8110 sub projects while DRDIP has funded more than 700 sub projects. While all the refugee hosting districts have been able to benefit from the DRDIP interventions, engagement and support to national environment agencies as initially conceived has not yet been done.

Therefore, as Uganda continues to host refugees, there is need to reinforce the country`s open door refugee policy taking into consideration the legal and regulatory frameworks relating to sustainable environment management. The requirement for conducting of Strategic environmental assessments, ESIA, land use plans among others should be mandatory to pave way for establishing environmental conditions, carrying capacity potential and best options to managing environment challenges associated with hosting refugees.

Environment and natural resources mainstreaming should be undertaken across all settlements and refugee programmes. This will require the Office of Prime Minister and UNHCR to integrate their reporting systems with the National Environment Reporting system and promote implementation of the Water and Environment Sector Refugee response plan.

PART 4:
FUTURE OUTLOOK & RECOMMENDATIONS

Pollution Threat

Pollution threat on River Rwizi Catchment

Rwizi catchment currently covers an estimated area of 8200km2 spanning over twelve districts namely; Buhweju, Bushenyi, Sheema, Ntungamo, Mbarara, Isingiro, Kiruhura, Lyantonde, Lwengo, Rakai,Kyotera and Rwampara.

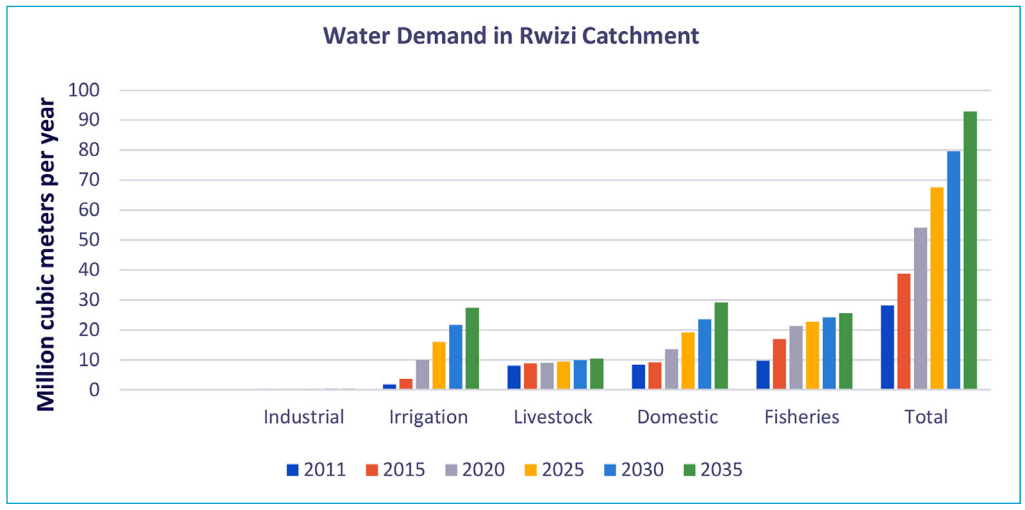

Figure 11.1: Total consumptive water demand by different sectors for Rwizi catchment (DWRM, 2016)

From the graph it is projected that the total water demand in the catchment will increase steadily throughout the years to 2035. The total consumptive water use projections for Rwizi catchment is about 39MCM. The total water supply is expected to rise from about 39MCM in 2016 to an estimated 92.90 MCM/ year in 2040. Figure 11.1 provides sectorial breakdown of this projection. Crop irrigation is projected to become even more dominant in future, when plans for new irrigation projects are implemented. While water for industrial consumption represents the lowest projected demand over the years.

The projected water demand for the Rwizi catchment as demonstrated above may not be met if river Rwizi which is the major source of water in the catchment is destroyed. Already there are signs of decreasing water quality and quantity in the river yet the river is threatened to extinction, due the increasing population pressure, poor agricultural practices and climate change.

Pollution Load in Rwizi Catchment

The abuse of the river has been widely manifested in middle catchment especially in Mbarara municipality, this is attributed to the population pressure, urbanisation, and industrialisation among others. The growth in population has led to the increased demand for agricultural land and infrastructure development, this has impacted on the river through reclamation of the river riparian wetlands for subsistence agriculture. Destroying wetlands undermines their role of water filtration and storage among others, other sources of pollution include improper waste disposal, sand mining along the river banks as well as brick laying around the buffer zone area thus, and runoff loaded with pollutants and sediments runs directly to the receiving river Rwizi.

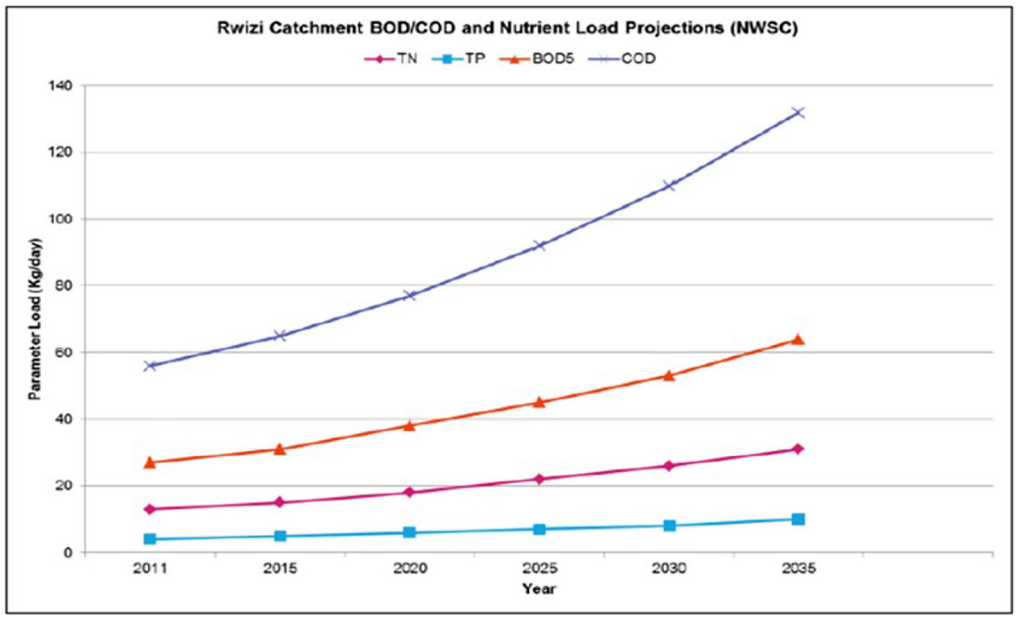

Figure 11.2: Nutrient load projections of River Rwizi. Source: (Data obtained from NWSC monitoring 2018)

The figure indicates that the Pollution loads in River Rwizi are expected to continue growing if no intervention is undertaken. The graph shows the projected gradual increase in the concentration of BOD and COD which represents concentration of organic matter in the water. Other parameters plotted on the graph include TP and TN which represent the projected gradual increase of nutrient concentration in the water.

The main source of pollution to the river is due to increasing industrial and domestic wastewater discharges as well as from surface water runoff from agricultural land and urban areas. The high levels of pollution in the river has led to increasing nutrient loads which in turn has led to the flourishing of invasive species such as the water hyacinth, *Eichhorniacrassips.*

Pollution threat from Oil and Gas development

There are a number of activities that have been carried out during the exploration phase of oil and gas and the coming production phase which have increased demand for water. The Surface water requirement predicted at a maximum water demand for surface water is approximately 12,762,000 m³/annum (equivalent to around 35,000 m³/d or 400 l/s) in Year 7 as shown in Figure 11.3 and this will be abstracted from Lake Albert. However, the oil development activities involves heavy abstraction of water resources for injection in wells to maintain underground pressure and avoid collapse of the ground. Then, the water generated in the production process needs to be treated before being discharged.

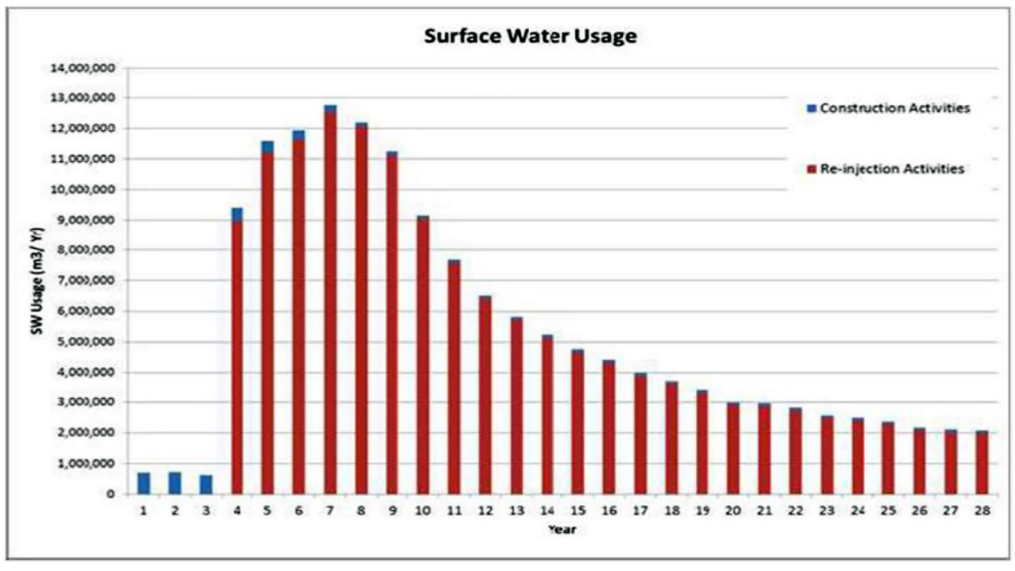

Figure 11.3: Projected surface water demand during exploration and appraisal in the Albertine graben. Source: Tilenga ESIA

The Directorate of Water Resources Management has strategically positioned continuous monitoring telemetric equipment systems on Lake Albert at Kingfisher and on Albert Nile at Pakwach. Water samples from groundwater sources and Lake Albert in the Albertine Graben were analyzed for heavy/trace metals that included; Major contaminants in oil waste include toxic metals such as cadmium (Cd), chromium (Cr), lead (Pb), arsenic (As), copper (Cu), manganese (Mn), zinc (Zn), cobalt (Co), aluminium (Al), mercury (Hg) & iron (Fe). The heavy metals are often common in crude oil and drilling fluid that is used in oil exploration and production. Some water samples from the graben indicated high concentrations of some of the heavy metals. Some of these metals are carcinogenic and high concentrations in drinking water will pose a health risk to the local communities in the Albertine Graben.

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