



Masaka District

Hazard, Risk And Vulnerability Profile



2016

ACKNOWLEDGEMENT

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Hon. Hilary O. Onek

Minister for Relief, Disaster Preparedness and Refugees

EXECUTIVE SUMMARY

Vulnerability assessment, hazard and risk mapping is an important exercise carried out by OPM in accordance with The National Policy for Disaster Preparedness and Management (Section 4.1.1) and also targeting to minimize vulnerability at community and local government levels by reducing the impact of the hazards where possible through mitigation, prediction, warning and preparedness.

This report has been prepared in close collaboration and coordination with UNDP and other stakeholders. The report is presented in 3 chapters with chapter one detailing the background of the report which comprises of the Government of Uganda shifting the disaster management paradigm from the traditional emergency response focus toward one of prevention and preparedness. Here the report highlights the objectives of the exercise as to Collect and analyze the field data using GIS and Develop specific multi-hazard, risk and vulnerability profiles using a standard methodology.

Chapter two highlights the overview of the district and its location where the District is situated about 37 kms away from the equator towards the south. Its soils are generally Ferrallitic, characterized by red colored sandy clay loams within the municipality and yellowish sandy loams in the surrounding areas. The rainfall pattern is bimodal having two seasons with dry spells between July and August, and January to March. The landscape and topography in general is rolling and undulating with vertical gully heads and valley bottom swamps including streams flowing to lakes and rivers.

Chapter three clearly explains the materials and methods applied in conducting the assessment and here a multidisciplinary approach was adopted for the assessment of multi-hazard, risk and vulnerability profiles production. The approach included; an investigation of socio-economic parameters, biophysical characteristics and spatial analysis of hazards in the district.

Chapter four has findings that encompass multi hazard, risk and vulnerability status of the district. It has been noted that Masaka district has continuously experienced multi-hazards for over 30 years. The multi-hazards that are experienced in the district can be classified as:

- i. Geomorphological and geological hazards including soil erosion
- ii. Climatological or hydro-meteorological including flash floods, hailstorms, lightning, drought and strong winds
- iii. Ecological or biological hazards including pests, parasites and diseases, human and wildlife conflicts and invasive species
- iv. Technological hazards including road and water accidents
- v. Environmental hazards including wetland degradation, deforestation and land conflicts

In conclusion, reducing vulnerability at community, local government and national levels should be a threefold effort hinged on:

- a) Reducing the impact of the hazard where possible through mitigation, prediction, early warning and preparedness;
- b) Building capacities to withstand and cope with the hazards and risks;
- c) Tackling the root causes of the vulnerability such as poverty, poor governance, discrimination, inequality and inadequate access to resources and livelihood opportunities.

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LIST OF ACRONYMS

DLG	:	District Local Government
DPP	:	District Development Plan
DWRM	:	District Water Resources Management
GIS	:	Geographical Information Systems
HRV	:	Multi hazard, Risk and Vulnerability
MWE	:	Ministry of Water and Environment
NARO	:	National Agricultural Research Organisation
NEMA	:	National Environmental Management Authority
NFA	:	National Forestry Authority
OPM	:	Office of the Prime Minister
SRTM	:	Shuttle Radar Topography Mission
ToR	:	Terms of Reference
UBOS	:	Uganda Bureau of Statistics
UNDP	:	United Nations Development Programme
UNRA	:	Uganda National Roads Authority

DEFINITION OF KEY TERMS

Hazard is a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation

Risk is a probability of a hazard occurring or threatening to occur

Vulnerability refers to the propensity of exposed elements such as human beings, their livelihoods, and assets to suffer adverse effects when impacted by hazard events

Climate variability refers to the climatic parameter of a region varying from its long-term mean. Every year in a specific time period, the climate of a location is different. Some years have below average rainfall, some have average or above average rainfall

Disaster is a progressive or sudden widespread or localized, natural or human caused occurrence which causes or threatens to cause death or injury, damage to property, infrastructure or environment, disruption of life of a community and its magnitude exceeds the ability of those affected to cope using only their own resources

Disaster management is a continuous and integrated multi-sectoral and multidisciplinary process of planning and implementation of measures aimed at disaster prevention, mitigation, preparedness, response, recovery and rehabilitation

Mitigation means structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards

Preparedness means activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations

Response means measures taken during or immediately after an incident or a disaster in order to bring relief to affected communities or individuals

Adaptation means the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities

INTRODUCTION

1.1 Background

Uganda has over the past years experienced frequent disasters that ranges from drought, to floods, landslides, human and animal diseases, pests, animal attacks, earthquakes, fires, conflicts and other hazards which in many instances resulted in death, property damage and loss of livelihood. With the increasing negative effects of hazards that accompany population growth, development and climate change, public awareness and proactive engagement of the whole spectrum of stakeholders in disaster risk reduction, are becoming critical. The Government of Uganda is shifting the disaster management paradigm from the traditional emergency response focus toward one of prevention and preparedness. Contributing to the evidence base for the Disaster and Climate risk Reduction action, the Government of Uganda is compiling a national risk atlas of hazard, risk and vulnerability conditions in the Country to engage mainstreaming of disaster risk management in development planning and contingency planning at National and Local levels.

Since 2013, Office of the Prime Minister with support from UNDP has developed district hazard risk and vulnerability profiles in sub-regions of Rwenzori, Karamoja, Teso, Lango, Acholi, West Nile, Central and South western sub regions. During the exercise, local government officials and community members actively participated in the data collection and analysis through focus groups discussions and the key informant interviews. The data collected was used to generate hazard, risk and vulnerability maps and profiles for each district. Validation workshops were held in close collaboration with the district local government (DLG) technocrats, Development Partners, Agencies and Academic/research institutions. The developed maps show the local geographical distribution of hazards and vulnerabilities up to sub county level of the district.

1.2 Justification

The National Policy for Disaster Preparedness and Management (Section 4.1.1) mandate the Office of the Prime Minister to “Carryout vulnerability assessment, hazard and risk mapping of the whole Country and update the data annually”. UNDP’s DRM project 2016 Annual Work Plan; Activity 4.1 is “conduct national hazard, risk and vulnerability (HRV) assessment including sex and age disaggregated data preparation of district profiles.”

1.3 Objectives

The objectives of the assignment were to:

- 1) Collect and analyze field data using GIS in close collaboration and coordination with OPM in Masaka district
- 2) Develop district specific multi-hazard, risk and vulnerability profiles using a standard methodology.
- 3) Preserve the spatial data to enable use of the maps for future information.
- 4) Produce age and sex disaggregated data in HRV maps

1.4 Scope

This assignment was carried out by a team of consultants under the overall technical supervision by the Office of the Prime Minister and UNDP, Uganda. The assignment was conducted in the month of May, 2016.

2.1 OVERVIEW OF MASAKA DISTRICT

Masaka district is situated about 37 kms away from the equator towards the South and lies between 0°-25 South and 34° East having an average altitude of 1150 m above sea level. Bukomansimbi borders the district in the South East, Kalungu in the North, Rakai and Lwengo in the West and South respectively, and Kalangala district in the East (figure 1).

Soils are generally Ferrallitic, characterized by red colored sandy clay loams within the municipality and yellowish sandy loams in the surrounding areas. Along the shores of Lake Victoria, soils are hydromorphic. The total geographical area of the district Masaka is about 1603.3sq km out of which 801.5sq km are open water, wetlands and marshlands, and 308.3 hectares are under cultivation. The total gazette forest estate is about 8905.6 hectares, consisting about 6.38% of the total land area of the district. Scattered natural forests are also found along lakeshores.

The rainfall pattern is bimodal having two seasons with dry spells between July and August, and January to March. The months of March, April and May receive very heavy and well distributed rains of up to 1,200mm. The second season occurs in the months of September to December. With the exception of a few years of declining trend in precipitation, the annual average rainfall received is between 1100mm- 1200mm with 100-110 rainy days. Masaka district has a total area of about 1603.3sq kilometers of which land area is 803.5sq.kilometres. The landscape and topography in general is rolling and undulating with vertical gully heads and valley bottom swamps including streams flowing to lakes and rivers. Most parts are dotted with hills. Masaka District is endowed with a high potential of water resources. It has five lakes which include Lake Victoria, Nabugabo, Birinzi, Kayugi, and Manywa. The main river is Nabajjuzi however, with so many tributaries. These form sources of water for both domestic use and for production. In areas where there are no rivers and lakes, the potential is still high because of the ground water and rain water harvesting.

The total population of Masaka District is 321,809 according to 2014 (Planning unit/MDLG, 2014). The population is disaggregated as follows; 159856 are males, 161,953 females and 72,917 Households. The population density is 248 persons per sq km as compared to 224 in 1991. Masaka district has an average household size of 4.3. Agriculture is the major economic activities in Masaka district. The majority of farmers are small holders who grow both perennial and annual crops. The perennial crops include; banana, Coffee, and Tea while the annual crops include; Maize, Sweet potatoes, Cassava and Ground nuts.

3.1 MATERIALS AND METHODS

3.3.1 Multi-hazard, risk and vulnerability profile assessment

3.3.1.1 Approach

A multidisciplinary approach was adopted for the assessment of multi-hazard, risk and vulnerability profiles production. The approach included; the investigation of socio-economic parameters, biophysical characteristics and spatial analysis of hazards in the district.

3.3.1.2 Data collection

3.3.1.2.1 Socio economic investigation

The socio economic assessment of multi-hazards, risks and vulnerability was threefold: the consultations, key informant interviews and Focus Group Discussion. The consultations were conducted at the district level and this included government officials who were selected on the advice of the Chief Administrative Officer and assessment team. The issues and concerns discussed were the causes, effects, adaptive responses, risks and vulnerability of multi-hazards experienced in the district. The question and answer session was selected purely because the officials were knowledgeable and had vast experience in the occurrence, severity and frequency of hazards in the district.

In addition to consultations, the key informant interviews were also carried out on the sub county officials for evidence based discovery. A total of two focus group discussions were also conducted in the sub counties: Buwunga and Bukakata. The groups on average comprised 10-15 members who were randomly selected by the sub county focal persons from the different parishes. The risk and vulnerability factors were determined through ranking and weighting procedures. The discussions helped to identify the most prone areas that were later visited for more site risk and vulnerability study. Four broad vulnerability areas were participatory identified in the district, these being social, economic, environmental and physical components. In each of these vulnerability components, participants characterised the exposure agents, including multi-hazards, elements at risk and their spatial dimension.

3.3.1.2.2 Spatial analysis

A series of spatial datasets were collected, pre-processed and processed to extract information on the magnitude and distribution of hazards, risks and vulnerability. The primary and secondary datasets were collected and collated prior to information extraction. The primary data include GPS coordinates while the secondary dataset included satellite images, land use/cover maps, digital elevation model, population and hydrological maps.

The utilised datasets used to create multi-hazards, risks and vulnerability maps are here indicated below:

Table 1: Sources of spatial datasets obtained and utilised in the study

No	Datasets	Sources	Period
1	Population	UBOS	2014
2	Roads	UNRA	2009
3	Land use/cover	NFA	2010
4	Hydrography	MWE	2010
5	Wetlands	MWE	2009
6	Protected areas	NFA	1990
7	Soil	NARO	2013
8	Trading centres	NFA	2014
9	Digital Elevation Model (30m)	SRTM	2014

The identified multi-hazards were mapped following standards procedures and methods for acceptability and reasonable output. Some of the analytical procedures are stated here below:

Table 2: Multi-hazard analytical detailed description of procedures

No	Multi hazards	Procedures
1	Flood inundation	Yang et al. (2006)
2	Soil erosion	Fistikoglu & Harmancioglu (2002)
3	Land conflicts	Homer-Dixon (1994)
4	Strong winds	Bunting & Smith (1993)
5	Invasive species	Venette et al. (2010)
6	Road accidents	Kamijo et al. (2000)
7	Lightning	Yokoyama (2002)
8	Pests, parasites and diseases	Based on major crop and livestock enterprise

The frequency and severity of multi-hazards, risks and vulnerability levels were categorized based on key informant interviews and expertise as follows:

Table 3: Multi-hazard severity classes/levels

Classes	Ranges (%)
Extremely/very high	90-100
High	60-89
Moderate	30-59
Low	10-29
Very low	0-9

3.3.1.2.3 Validation

The multi-hazard, risk and vulnerability prone areas were identified and studied in the field. The Spectra Precision handheld Global Positioning System (model: Mobile Mapper 20) units

were used to map the hotspot and vulnerable areas. The compiled profile was validated by the representative District Government officials in a validation workshop held in Jinja District from 27th June – 1st July, 2016.

3.2 Multi-hazard assessment

3.2.1 Introduction

The multi-hazards that are experienced in Masaka District can be classified as:

- i. Geomorphological and geological hazards including soil erosion
- ii. Climatological or hydro-meteorological including; flash floods, hailstorms, lightning, drought and strong winds
- iii. Ecological or biological hazards including; pests, parasites and diseases, human and wildlife conflicts and invasive species
- iv. Technological hazards including; road and water accidents
- v. Environmental hazards including; wetland degradation, deforestation and land conflicts

The comprehensive information on the frequency, severity and distribution of multi-hazards is presented here below in a chronological episodes order.

3.2.2 Drought

Masaka is one of the districts that is near the cattle corridor and henceforth experiences prolonged dry spells. The experienced drought events are manifested as prolonged dry spells that cause shifts in the onset of rainy seasons.

The frequency and severity of drought episodes are perceived to be caused by changes in the climate pattern, wetland degradation, location in the rain shadow, changes in land use, poor farming methods and deforestation. Drought occurrences are associated with deficit soil moisture, reduction of surface water sources, withering of crops, inadequate pasture to animals, reduce productivity and reliance on imported foods. It is aggravated by low adaptive capacity of farmers and reduced soil fertility. Predictably, the most affected months are those from December – March and July – September of each seasonal calendar.

Notably, the most adverse effects of drought include reduced income levels for farmers and district revenue, reduced farm yields, reduced inputs and investment in the agricultural sector. In addition, drought increases prices of staple food, food insecurity, migration, theft of crops in gardens, wetland degradation, famine, transactional sex for food, illness and loss of livestock. The severity and distribution of drought affects all the sub counties in particular Buwunga, Kabonera and Mukungwe.

3.2.3 Soil erosion

The soil erosion has affected the integrity of farmlands, wetlands and water sources in the district. The main soil erosion types common in the district include rill, gully and sheet erosion. Soil erosion is principally triggered by poor farming methods, over grazing, deforestation, poor land use planning, poor maintenance of roads and intensive rainfall events.

The occurrence of soil erosion is associated with the washing away of top soil, siltation of water sources and destruction of infrastructure including roads and bridges. The events are common and widespread during the rainy season. The farmers are vulnerable to the severity of soil erosion due to poor farming methods, and land shortage which lead to cultivation of steep slopes and low lying flood prone areas.

The adverse effects of soil erosion experienced in the district include: low crop yields, low income levels, land abandonment, reduction in the quality and quantity of surface water sources, high costs of transport, increased incidences of pests, parasites and diseases, loss of landscape beauty, land conflicts, introduction of new invasive species and famine. The occurrences and severity of soil erosion equally affects all the sub counties in the district (figure 2).



Plate 1: Soil erosion gulleys in Katwe-Butengo Division, Masaka District

3.2.4 Pests, parasites and diseases

The occurrence, severity, frequency and distribution of pests, parasites and diseases are high as compared to the last 10 years in the district. In crop production, the farmers are engaged in the growing of cassava, beans, groundnuts, rice, potatoes, millet maize and Bananas as food and cash crops, however, their production has drastically reduced over time due to increasing and emergence of new pests, parasites and diseases.



Plate 2: Banana Bacterial Wilt in Katwe-butengo Division

The high pre-and post-harvest pest and disease incidences in crops is mainly attributed to changes in weather patterns, deforestation, inadequate extension services, inadequate regulation and surveillance, trans-boundary movement, soil exhaustion, poor farming methods, high costs and substandard pesticides and poor storage facilities. The changes in weather patterns favours the life cycle of pests that continuously destroy crops resulting into famine and on the other hand poor farming methods are attributed to ignorance and poor mind-sets. The crop pests and diseases are associated with crop destruction, stunted growth and farmer ignorance on better farming methods.

The factors that have contributed to the vulnerability of farmers include: poor planting materials high cost and substandard pesticides/herbicides and limited extension services. The adverse effects include build-up of pests and soil degradation leading to low crop yields and subsequently low income levels, some of the notable pests and diseases are indicated here below (table 4). The effects of pests, parasites and diseases were evident in all the sub counties (figure 2).

Table 4: Major pests and diseases

No	Crops	Pests and diseases
1	Cassava	Cassava brown streak disease, cassava mosaic
2	Groundnuts	Groundnut rosette, Leaf miner
3	Maize	Stem borers, maize smurt, maize streak
4	Sorghum	Sorghum midge, stem borers, sorghum shoot fly
5	Cowpeas	Aphids
6	Soybean	Web worm, rust
9	Bananas	Banana Bacterial Wilt, banana weevils, sigatoka
10	Tomatoes	Tomato Blight
11	Rice	Stem borers, rice yellow mortal virus
12	Beans	Aphids, root rot disease
13	Citrus	Rot, fruit-fly, hard scab
14	Coffee	Coffee wilt disease, coffee twig borer

In livestock production, Masaka District lies in an endemic Tsetse and trypanosomiasis zone. The occurrences of parasites and diseases was basically caused by communal grazing, ignorance, poor on-farm management, deforestation, mixing of livestock due to limited pasture fields, wetland degradation, animal movement, grazing along road reserves and reduced surface water quality.

The parasites and diseases are associated with low milk yield, low meat products, slow growth in livestock and encroachment of marginal lands such as wetlands among others. The predictability of the parasites and diseases is on the increase of each year. The livestock keepers are apparently vulnerable due to sub-standard pesticides, unreliable weather patterns, limited extension services, water and pasture.

The adverse effects of livestock parasites and diseases include: loss of livestock, reduced household income levels, loss of revenue to the district, illness and human death. Some of the notable parasites and diseases included ticks, tsetse flies, worms, mites in poultry, New castle, Swine fever, Nagana, East Coast fever, foot and mouth disease among others. The livestock parasite and disease incidences are reported in all the sub counties (figure 3).

3.2.5 Wetland degradation

The wetland types found in Masaka District are characterized as papyrus, palms and thickets, bushlands, grasslands (MWE, 2009). The wetland systems are under continual threats from the increasing rate of encroachment for wetland products and services. The wetlands are utilised as livestock grazing fields, extraction of building materials, crop growing, fishing and firewood among others. The major drivers of wetland degradation include land shortage, drought, reduced soil fertility, political pronouncements, soil erosion, drought, poor farming methods, assumed ownership, change in land use, ignorance, resource conflicts, brick making, sand mining, seasonal fires, over harvesting and invasion by invasive species (Plate 3).

The degradation is associated with silting of water bodies, reducing soil nutrients, lowering the water table, resource conflicts and over cultivation. The rates of wetland encroachments are high during the prolonged dry months characterised with low water availability and limited pastures. The factors that have increased the vulnerability of wetlands include limited enforcement mechanism and funds to demarcate the wetland boundaries.

The adverse effects of wetland degradation include subsequent occurrences of flash floods, erratic rains and drought, reduced water quality and quantity in water sources, loss of wetland biodiversity, drought, increased incidences of pests, parasites and diseases, loss of property, livestock and human life. The effects have been reported in all the sub counties found in the district (figure 4).



Plate 3: Wetland degradation in Buwunga Sub County



Figure 4: Levels of wetland degradation

3.2.6 Deforestation

Deforestation is perceived as the cutting of trees for wood and timber purposes. This has mainly affected Masaka district because most of the trees have been wiped away in search for land for settlement caused by the high birthrates and migration and charcoal and timber products. Because soils have lost their fertility -commercialization of agriculture is hindered. Because of corruption, weak laws, enforcement is not effectively made to protect forest reserves and forests.

The factors that contribute to the vulnerability include weak enforcement of forestry laws, high population growth rates, drought and reduced soil fertility among others in the district.

The resultant effects have led to increases in pests, parasites and diseases incidences, destruction of habitats and drought. In addition to the loss of biodiversity, water resource conflicts and loss of water quality have been recorded in the district. The activities are prevalent in all the sub counties; however there are more severe in Buwunga, Kyanamukaka and Bukakata (figure 5).



Plate 4: Forest degradation in Kyanamukaaka



Figure 5: Deforested areas

3.2.7 Flash floods

Masaka district experiences flash floods that destroy several acres of crops and properties. The district lies in the Lake Victoria floodplain. In addition to erratic/heavy rainfall, wetland degradation, poor drainage and farming methods, siltation, unplanned settlement, deforestation and political pronouncements are the major causes of flash floods in the district. The district experiences a bi-model type of rainfall pattern. The floods occur in the months of April-May and September-November of each year. The rainfall patterns are largely influenced by neutral conditions of sea surface temperatures in the eastern and central equatorial Pacific Ocean, and the warming of sea surface temperatures in the western sector of equatorial Indian Ocean.

The wetlands are degraded to create cultivable fields for crop growing and establish settlements. In their happening, the wetland vegetation is cut down resulting into less absorption of excess water. The cultivation is responsible for the blockage of stream channels that cause excess water to inundate. In addition, the nature of clay soil type which exhibits hard soil structure does not easily allow runoff water to percolate resulting into stagnation of water.

The characteristics of flash floods is associated with water logging of crop fields, increment in water borne diseases (malaria, typhoid, cholera etc), submergence of roads and houses etc. However, seasonal predictions show that the district has a high chance of receiving near normal rains. The factors that contribute to the vulnerability of households include: ignorance, lack of or and sub-standard agro inputs, and weak enforcement of wetland policies among others.

The adverse effects of flash floods include; a reduction in household income low levels, crop yields, increased prices of staple foods, illness, destruction of water sources, displacement of families, destruction of roads, loss of human life, property and livestock. The phenomenon severely affects all the sub counties in Masaka District (figure 6).

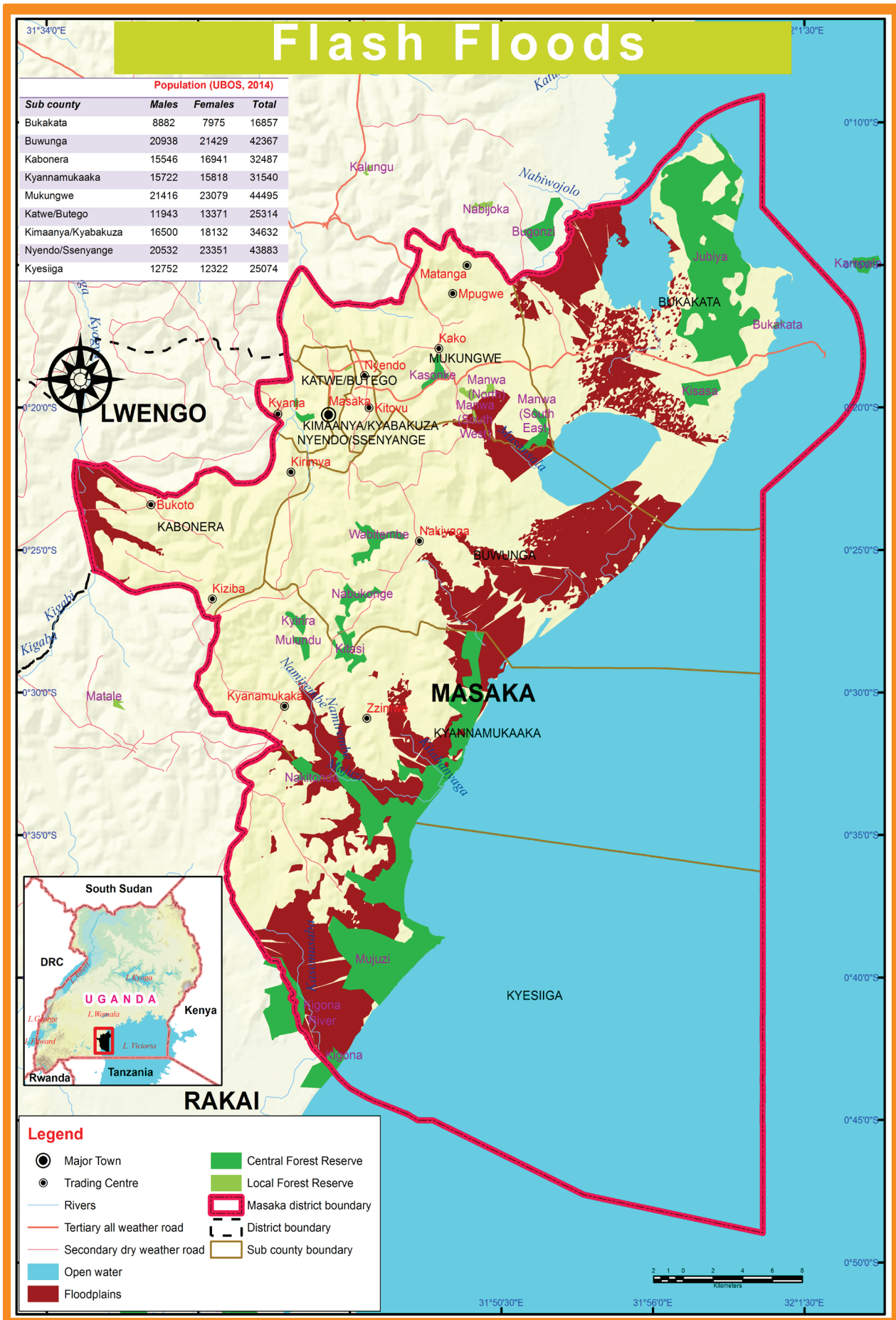


Figure 6: Flood prone/inundation areas

3.2.8 Strong winds

The strong winds are normally experienced during the rainy season as compared to the dry season. The devastating winds occur during torrential rains and cause significant havoc in the social and economic wellbeing of the communities. The winds have become more rampant and severe simply because of high deforestation rates, presence of water bodies, wetland degradation, changes in the onset of rainy seasons and poor farming methods among others.

The occurrences and severity of strong winds are characterised with heavy showers, falling of crops, high rates of surface runoff, breakage of trees and destruction of houses. The winds are more common during the rainy season especially in the months of July, September, October, November and December of each seasonal year. The communities have become vulnerable due to lack of tree seedlings, unreliable seasonal weather forecasts and clearance of vegetation among others.

The strong winds have led to low crop yields, loss of life and property, increase in the occurrences of diseases, multiplication of invasive weeds and low income levels etc. The most severe impacts have been reported in the sub counties of Bukakata, Buwunga and Kabonera (figure 7).

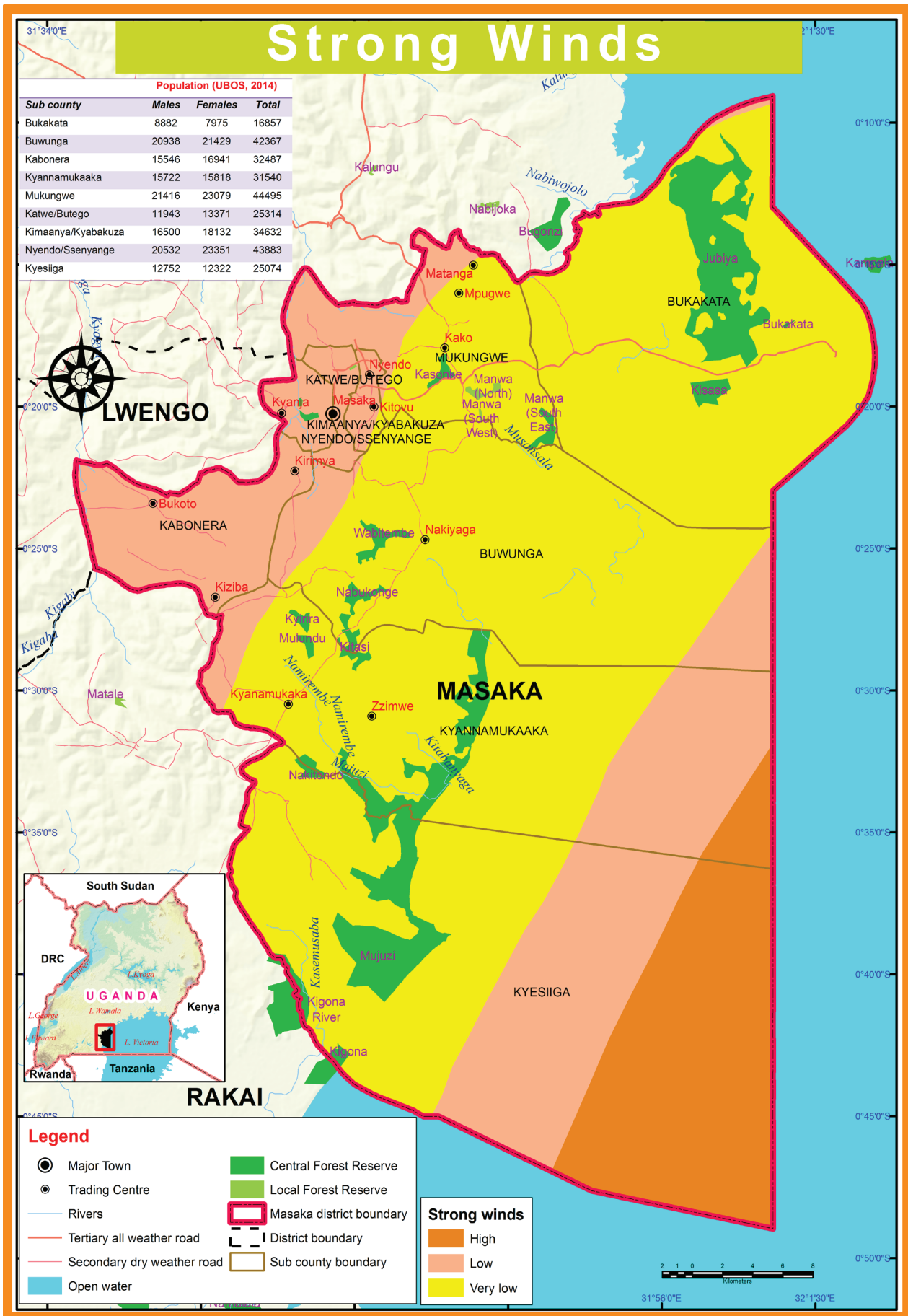


Figure 7: Strong winds levels

3.2.9 Hailstorms

The occurrence and severity of hailstorms are a frequent phenomenon in Masaka District. The hailstones fall during heavy downpour and these take a period of about 10-30minutes. The frequency and distribution of hailstorms is primarily caused by changes in the onset of rainy seasons especially after prolonged dry spells, erratic rains and deforestation. Hailstorms are associated with vegetation, crop and property destructions. In addition to increasing surface rainfall runoff, they also clog water channels. The hailstorms are severely predicted to occur during the second rainy season. The deforestation activities have increased the magnitude of severity especially in farmlands and homesteads. The trees are cut down to acquire timber for brick making and construction.

The farmers are vulnerable to the effects of hailstorms due to the massive clearance of trees, limited availability of tree seedlings and unreliable or no seasonal weather forecasts.

The adverse effects of hailstorms include destruction of property, food shortages, loss of human life and livestock. The episodes affect every sub county in the district (figure 8).



Figure 8: Distribution of hailstorms

3.2.10 Road and water accidents

Road and water accidents claim a number of lives in the district of recent than before. The prevalence of road accidents are attributed to the driving of cars in dangerous mechanical conditions, reckless driving, indiscipline, negligence, lack of road sign posts, bad weather, overloading, , livestock grazing in the road reserves, narrow roads, incompetent drivers and over speeding. The road accidents mainly involve pedestrians, cars, bicycles, motorcycles and boats. The water accidents are largely caused by strong winds and Hippos in the water bodies.

The road and water accidents are associated with injuries, disabilities and arrests among others. The incidences are more frequent during the festive seasons such as Christmas and Easter, election days and at the start and closure of schools. The factors that contributed to the vulnerability of households to road accidents are; weak enforcement of traffic laws, poor roads and establishment of road markets among others.

The notable effects of road and water accidents include: loss of human life and livestock, illness, disabilities, loss of property and documentation, reduction in crop and livestock production and loss of income in compensations. The accident incidents are reported in all the sub counties throughout the year (figure 9).



Figure 9: Road and water accidents distribution

3.2.11 Invasive species

The occurrence of invasive species in the district is twofold: those that are land and other water based. The invasions on land are mainly in farmlands while the water based can be seen on the lakes, ponds and wetlands. The frequency and severity of invasive species are sometimes determined by both natural and anthropogenic factors. In particular, the invasive species on land have evaded the district purely because of changes in weather patterns, reduced soil fertility, poor farming methods, soil erosion, animal movements, wetland degradation, high seed multiplication and dispersion by wind. Some of the notable species include striga “Kayongo”, Lantana Camara, Congress weed (*Parthenium hysterophorus*) among others. On water, the species are spread by strong winds, boat movements, wetland degradation, fishing activities, high seed multiplication and siltation among others.

The occurrence of land based species is associated with stunted crop growth, crop failure, frequent weeding, poor yields and land abandonment. The water species are characterised with slow boat movement, migration of fish stocks, high transport costs and water pollution among others. The invasions are high during the rainy season due to the increase in the plant water content that facilitates their high growth.

The adverse effects of land based species include loss of biodiversity, loss of livestock, low income levels, poor crop yields and encroachment of public land among others. On the other hand in water, the species cause illness, loss of biodiversity, depletion of fish stocks, high transport costs and malnutrition among others. The invasion of both alien species is common in all the sub counties (figure 9).



Plate 5: Water hyacinth in swamps

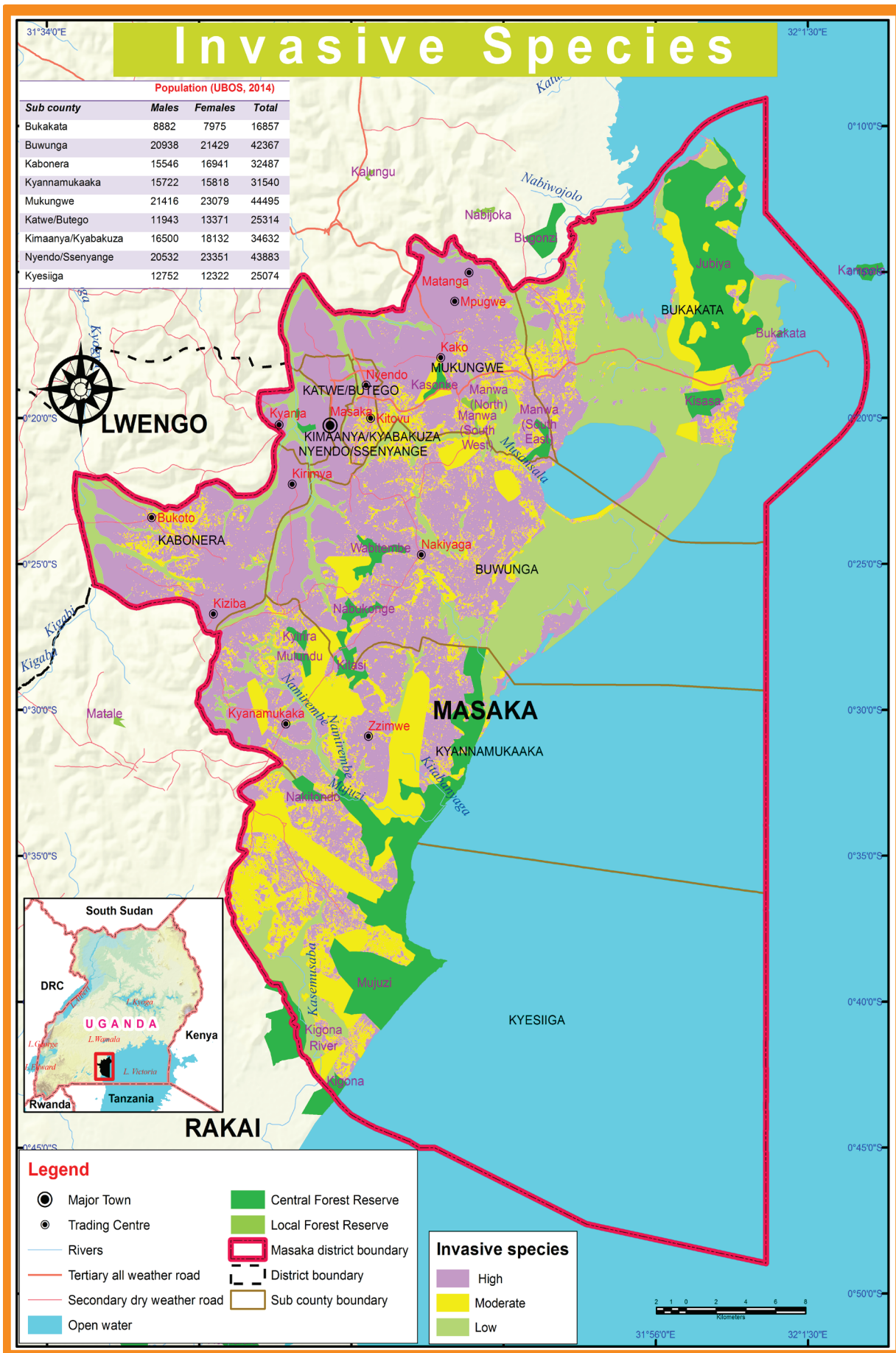


Figure 10: Distribution of invasive species

3.2.12 Land conflicts

Land conflicts have now become rampant in the district for the past 10 years. Most of the land in the district is under mailo land ownership with many tenants and increasing number of leaseholds freeholds. The conflicts are between the people, government, communities and cultural institutions and vice versa.

The land conflicts in the district are fuelled by unclear ownership of wetlands, population pressure, mailo land ownership with tenants (“Bibanja” owners), overlapping land policies, ignorance, unclear administrative and protected area boundaries, land grabbing, unequal distribution of land in families and untitled land for tenants. The conflicts are associated with prolonged court cases, displacement of people, low crop and livestock production among others. The land conflicts are more frequent in the populated sub counties in the district. The households are vulnerable to the frequent occurrence of land conflicts due to land ownership rights, land grabbers, unplanned settlements and lack of clear boundaries with the neighbours.

The conflicts have resulted into the migration of people to the neighbouring sub counties and other districts, under development, loss of human life and livestock; and loss of property and income due to court cases. Furthermore, the tenure arrangements are associated with over exploitation by several implemented land use options such as overgrazing, bush burning and land fragmentation on the allocated piece of land. The eventualities are more severe in Kyanamukaka, Kyesiga and Bukakata sub counties (figure 11).

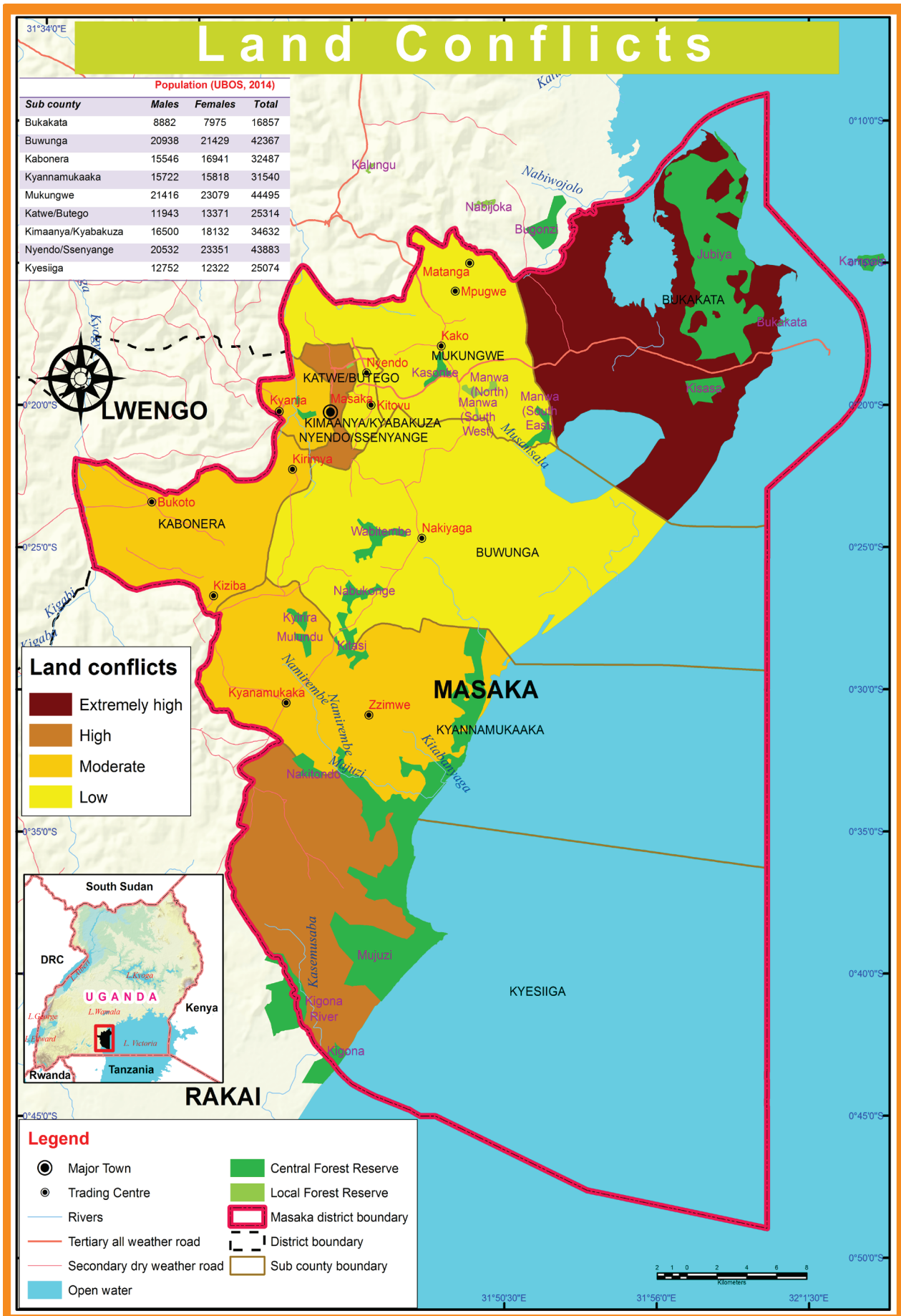


Figure 11: Severity of land conflicts

3.2.13 Lightning

Uganda has one of the highest rates of lightning strike deaths in the world. The incidences are attributed to changes in climate and weather patterns, construction of houses on high grounds, and loss of natural tree cover due to deforestation activities. In particular, the lightning incidences are influenced by the unusual surge of the moist air from the Atlantic Ocean and Congo air-mass that occur during the rainy seasons.

The thunderbolt incidences are associated with the destruction of crops and vegetation, loss of life in human and livestock, heavy downpour and hailstorms. The incidences normally occur at the onset of the rainy season. These are frequent in the months of April-May and September-December of every year. The increase in vulnerability to lightning cases is attributed to deforestation, degradation of hills and shift in seasons.

The strikes have resulted into the loss of household income, loss of property and drought. The deficiencies in soil moisture and water stress are highly reported in Kyanamukaka Sub County in the District.



Plate 6: Lightning strike

3.2.14 Human and wildlife conflicts

The human and wildlife conflicts are apparently on the increase primarily because of changes in weather patterns and increase in demand for land and vegetation related products. For example the high demand for timber has deprived wild animals of their habitats therefore making them to invade farmlands and people's homes in search for food and shelter.

The attacks are characterized by crop destruction, increase in disease incidences, death of wild animals (sitatungas, monkeys etc.) and loss of human life. The conflicts are more common during the crop harvesting period of each year. The factors that contribute to the vulnerability in these conflicts include the types of crops grown, wetland degradation, deforestation, unclear boundaries of protected areas and population pressure.

The encounters have resulted into the loss of household income, reduction in tourism revenue, migration, illness, low crop yields and modification of local climate. The fatalities have been highly reported in Buwunga, Bukakata and Kyesiiga sub counties (figure 12).



Figure 12: Levels of human wildlife conflicts

3.2.15 Bush burning

The occurrence and frequency of fires is seasonal in the district. The fires are started by majorly the cattle keepers to break the cycle of parasites and facilitate pasture regeneration as perceived and farmers during opening of gardens. Some of the fires are attributed to poverty, ignorance, charcoal burning, poor farming methods, hunting and land conflicts.

Bush burning is associated with the clearance of vegetation, conversion of wood into charcoal, destruction of crops and property. The bush fire incidences are rampant during the dry season (December-March and July-September). Vulnerability to the fires is due to the rampant land conflicts, drought, livestock production and inadequate enforcement of conservation policies.

The secondary effects of unmonitored fires include loss of property, loss of human life and livestock, low crop yields, migration of animals, displacement of people, soil degradation and loss of biodiversity. Severe fire incidents have been recorded in Bukakata, Kyesiga Sub counties.

3.3 Multi-hazard adaptation responses

According to the key informant interviews and FGDs, indicated here below are responses undertaken by the communities to adapt to the multi-hazards.

Table 5: Multi-Hazard adaptation responses

No	Multi-Hazards	Adaptation Responses	Recommendations
1	Drought	<ul style="list-style-type: none"> • Crop irrigation • Tree planting • Planting drought resistant crops • Establishment of alternative income generating activities like business • Agro forestry • Food preservation and storage • Planting quick maturing seeds • Practicing conservation agriculture • Rain water harvesting 	<ul style="list-style-type: none"> • Provision of tree seedlings and quick maturing seeds • Food relief • Extraction of underground water • Fund irrigation technologies • Diversify sources of livelihood • Construction of food storage facilities • Law enforcement on wetland degradation • Encourage hay and silage making • Promote the use of renewable energy • Subsidization of hydro electric power
2	Soil erosion	<ul style="list-style-type: none"> • Digging trenches and ridges • Mixed cropping • Tree planting • Crop spacing • Growing of cover crops • Sensitization (farmer visits) • Minimum tillage 	<ul style="list-style-type: none"> • Sensitization of the farmers on proper farming methods • Agro-forestry • Provision of tree seedlings • Subsidize the costs of pesticides and fertilizers • Funding the community outreach department • Encourage water harvesting • Adopting underground water tanks

No	Multi-Hazards	Adaptation Responses	Recommendations
3	Pests/ parasites and Diseases	<ul style="list-style-type: none"> • Crop rotation • Spraying • Vaccination of livestock • Treatment of animals • Use of disease resistant varieties • Destruction of infected crops or animals • Diversification of livelihood • Environmental sanitation 	<ul style="list-style-type: none"> • Subsidizing pesticides and vaccines • Provide improved/resistant breeds • Fund the community outreach department • Strengthen pests, parasites and diseases surveillance • Integrated pest management • Strengthen and improve agricultural extension services • Review of the laws on agro-chemicals • Information systems on diseases on diseases outbreaks and control
4	Wetland degradation	<ul style="list-style-type: none"> • Sensitization on the dangers of encroaching wetlands • Tree planting • Practicing conservation agriculture • Prosecuting culprits to court • Evictions • Formation of community wetland management committees • Alternative livelihood 	<ul style="list-style-type: none"> • Strengthen the wetland management committees • Strict enforcement of wetland laws • Demarcation of wetlands • Water harvesting for agriculture • Promote tourism • Increase funding for wetland conservation
5	Deforestation	<ul style="list-style-type: none"> • Use of improvised fuel like cow dung • Use of energy saving stoves • Tree planting • Biogas • Sensitization 	<ul style="list-style-type: none"> • Massive tree planting • Encourage the use of energy saving stores • Adopt technologies that use less wood • Sensitize communities • Introduction of environmental issues in school curriculum
6	Floods	<ul style="list-style-type: none"> • Digging of drainage channels • Intensify on communicable diseases • Improvised canoes • Provision of underground water sources 	<ul style="list-style-type: none"> • Sensitization on wetland degradation • Wetland demarcation • Enforce buffer zone • Flood control plans • Proper road construction
7	Strong winds	<ul style="list-style-type: none"> • Tree planting • Planned constructions • Food relief • Fishing holidays 	<ul style="list-style-type: none"> • Provision of tree seedlings • Use of wind turbines • Sensitization of the community on a village level about tree planting • Construction of planned houses • Conservation agriculture, wood lot technology
8	Hailstorms	<ul style="list-style-type: none"> • Tree planting • Food relief • Temporal structures • Planting fast growing crops 	<ul style="list-style-type: none"> • Food and seedlings provision on occurrence • Provision of tree seedlings • Provision of weekly weather forecasts

9	Road and water accidents	<ul style="list-style-type: none"> • Law enforcement • Installation of road signs • Installation of humps • Wearing Life jackets • Community policing • Using wide boats • Provision of life jackets • Spot checks 	<ul style="list-style-type: none"> • Enforcement of traffic laws • Frequent maintenance of roads • Sensitization • Subsidization of life jackets • More funds in water transport • Road signs installation • Increase surveillance through installation of cameras • Routine inspection for road and water worthies
10	Invasive Species	<ul style="list-style-type: none"> • Mixed planting • Crop rotation • Uprooting • Planting resistant crops • Sensitization 	<ul style="list-style-type: none"> • More research on invasive species • Planting resistant improved seeds • Legislation on the movement of seeds • Provision of improved seedlings • Need a specific department • Special attention to eliminate the invasive species
11	Land Conflicts	<ul style="list-style-type: none"> • Law courts like Clan, LC's, magistrate courts • Demarcation of land • Acquisition of land titles • Sensitization 	<ul style="list-style-type: none"> • Subsidization of land registration • Sensitization of the community on land ownership • Popularize the land policy • Quick judgments of land cases • Gazetting and buffering the lake
12	Man made fires	<ul style="list-style-type: none"> • Court appeals • Use of alternative sources of light like Lanterns • Sensitization • Extinguishing fire 	<ul style="list-style-type: none"> • Increase sensitization • Revision and enforcement of wildfire act??? • Use approved structures supervised by qualified personnel
13	Lightning	<ul style="list-style-type: none"> • Planting of trees • Installation of lightning arrestors • Proper electrical installation 	<ul style="list-style-type: none"> • Subsidization of lightning arrestors • Encourage tree planting • Law enforcement on the installations of arrestors • Early warning systems • Wetland demarcations
14	Human wildlife conflicts	<ul style="list-style-type: none"> • Community sensitization • Use of scare crows • Gazetting of animal habitats • Involving Wildlife authority • Trapping and hunting 	<ul style="list-style-type: none"> • Uganda Wildlife Authority should be vigilant • Establish communal zone and parks • Equip vermin control staff • Conduct massive awareness campaigns • Sensitization of the community on the peak hours • Re-gazetting encroached wild life habitants • Gazetting water collection points • Promote eco-tourism
15	Bush fires	<ul style="list-style-type: none"> • Sensitization 	<ul style="list-style-type: none"> • More funds to the natural resource department • Strengthen the extension services • More sensitization • Revision and enforcement of wildfire act???

4.1 RISK ASSESSMENT

This table presents relative risk for hazards to which the communities attached probability and severity scores.

Table 6: Risk assessment of multi-hazards for Masaka District

	PROBABILITY	SEVERITY OF IMPACTS	RELATIVE RISK	VULNERABLE SUB COUNTIES
	<i>Relative likelihood this will occur</i>	<i>Overall Impact (Average)</i>	<i>Probability x Impact Severity</i>	
Multi-hazard	1 = Not occur 2 = Doubtful 3 = Possible 4 = Probable 5 = Inevitable	1 = Very Low 2 = Low 3 = Moderate 4 = High 5 = Very High	1-10 = Low 11-20 = Moderate 21-25 = High	
Floods/ Runoffs	4	4	16	Bukakata, Mukungwe, Kyesiiga, Kyannamukaaka
Droughts	5	5	25	Buwunga, Kabonera, Mukungwe, Kyannamukaaka, Kyesiiga
Hail storms	3 (LOW)	4	12	Bukakata, Buwunga, Kabonera, Kyannamukaaka, Mukungwe, Katwe/ Butego, Kimaanya / Kyabakuza, Nyendo/Ssenyange, Kyesiiga
Man-made fires	2	5	10	Masaka municipality
Lightning	2	4	8	Kyannamukaaka
pests, parasites and diseases	5	5	25	Bukakata, Buwunga, Kabonera, Kyannamukaaka, Mukungwe, Katwe/ Butego, Kimaanya/Kyabakuza, Nyendo / Ssenyange, Kyesiiga
Land conflicts	4	3	12	Bukakata, Kyannamukaaka, Kyesiiga
Strong winds	3	5	15	Bukakata, Buwunga, Kabonera
Invasive species	3(LOW)	4	12	Bukakata, Buwunga, Kabonera, Kyannamukaaka, Mukungwe, Katwe/ Butego, Kimaanya/Kyabakuza, Nyendo/ Ssenyange, Kyesiiga
Road, water accidents	3(LOW)	5	15	Bukakata, Buwunga, Kabonera, Kyannamukaaka, Mukungwe, Katwe/ Butego, Kimaanya/Kyabakuza, Nyendo/ Ssenyange, Kyesiiga Council,
Soil erosion	5	5	25	Bukakata, Buwunga, Kabonera, Kyannamukaaka, Mukungwe, Katwe/ Butego, Kimaanya/Kyabakuza, Nyendo/ Ssenyange, Kyesiiga
Human wild life conflicts	2	4	8	Bukakata, Buwunga, Kyesiiga

	PROBABILITY	SEVERITY OF IMPACTS	RELATIVE RISK	VULNERABLE SUB COUNTIES
Bush fire	2	3	6	Bukakata, Buwunga, Kabonera, Kyannamukaaka, Mukungwe, Katwe/ Butego, Kimaanya/Kyabakuza, Nyendo/ Ssenyange, Kyesiiga
Earth quakes	1	5	5	Municipality, Buwunga
Wetland degradation	4	5	20	Bukakata, Buwunga, Kabonera, Kyannamukaaka, Mukungwe, Katwe/ Butego, Kimaanya / Kyabakuza, Nyendo / Ssenyange, Kyesiiga
Deforestation	4(HIGH)	5	20	Buwunga, Kyannamukaaka, Bukakata

Key for Relative Risk

	High
	Moderate
	Low

4.2 Occurrence and frequency of multi-hazards

The table below shows the years in record and recurrence intervals of multi-hazards reported by the respondents in the district (table 7).

Table 7: Frequency of multi-hazards

No	Multi-hazard	Number of Events (last 30 years)	No. years in record	Recurrence Interval per year (months/seasons)	Hazard Frequency (%) Chance/year
1	Earth quakes	1	2012	2	200
2	pests, parasites and diseases	30	1986-2016	12	40
3	Land slides				
4	Drought	30	1986-2016	2	6
5	Hailstorms	30	1986-2016	2	6
6	Bush fires	30	1986-2016	12	40
7	Invasive species	16	2010-2016	12	75
8	Human wildlife conflicts	4	2013-2016	12	300
9	Wetland degradation	9	2007-2016	12	133
10	Soil erosion	30	1986-2016	2	6
11	Strong winds	2	2008,2016	3	150
12	Land conflicts	16	2010-2016	12	75
13	Floods	3	2009,2012,2016	2	66
14	Man-made fires	3	2010,2014,2016	1	33
15	Lightning	3	2010,2013,2014	2	66
16	Water, Road accidents	30		12	40
	Deforestation	7	2009-2016	12	171

4.3 Elements at Risk and Vulnerability assessment

Vulnerability depends on low capacity to anticipate, cope with and/or recover from a disaster and is unequally distributed in a society. The vulnerability profile for Masaka district was assessed based on exposure, susceptibility and adaptive capacity at sub county and district levels highlighting their sensitivity to multi-hazards. Indeed, vulnerability was divided into biophysical (or natural including environmental and physical components) and social (including social and economic components) vulnerability. Whereas the biophysical vulnerability is dependent upon the characteristics of the natural system itself, the socio-economic vulnerability is affected by economic resources, power relationships, institutions or cultural aspects of a social system.

The assessment reveals that geomorphological and geological hazards in form of soil erosion; climatological or hydro-meteorological in the form of flash floods, hailstorms, drought and strong winds; ecological or biological hazards in the form of pests, parasites and diseases, and invasive species; technological hazards in the form of road accidents and environmental hazards in the form of wetland degradation and land conflicts predispose the community to high vulnerability state in Masaka district (table 8).

Table 8: Components of vulnerability in Masaka District

Vulnerability Components	Exposure	Elements at risk	Geographical Scale	Susceptibility	-	Resilience	Geographical Scale
Social components	Hazards Land conflicts	Human population Crops	Sub county	Potential impacts Loss of property Displacement of people Retards developments	Sub county	Coping strategies Sensitise people on land developments and land use Clearly demarcating and defining land owner ship Court Acquiring land titles	District
	Invasive species	Crops Livestock	District	Interfere with water transport. Loss of animals Loss crop yields	District	Destruction of weeds through uprooting, burning and slashing	District
	Soil erosion	Human population Crops	District	Stunted crop growth Reduced yields Poor crop production Situation of water bodies Decreased biodiversity Decrease in soil fertility Reduced water quality Destruction of property	District	Tree planting Sensitization Soil and water conservation i.e. bridges, trenches, mulching	District
	pests, parasites and diseases	Human and livestock populations Crops	District	Loss of livestock and humans Reduced livestock productivity Complete crop failure Stunted growth of crops	District	Vaccination Spraying Sensitization Crop rotation Planting disease resistant crops Quarantine Mosquito nets Destruction of effected crops& animals Alternative income sources	District

Vulnerability Components	Exposure	-	Susceptibility	-	Resilience	District	
	Hail storms	<ul style="list-style-type: none"> Human and livestock populations Crops 	District	District	<ul style="list-style-type: none"> Complete crop failure Stunted growth of crops Destruction of houses Flooding Drying of water sources climatic change Increased pest and disease incidences Loss of water quality and quantity Loss of grazing grounds Conflicts on water waters 	<ul style="list-style-type: none"> Sensitisation through radios Enforcement of wetland laws Demarcation of wetlands Prosecuting culprits to Court Wetland management committee Eviction 	District
	Wetland degradation	<ul style="list-style-type: none"> Lakes Crops Human population 	District	District	<ul style="list-style-type: none"> Human deaths Disabilities after injuries 	<ul style="list-style-type: none"> Regular guidance by traffic officers Construction of humps and road signs Reflector jackets, seat belts and helmets Spot checks for alcoholism 	District
	Water, Road accidents	<ul style="list-style-type: none"> Human and livestock populations 	District	District	<ul style="list-style-type: none"> Stunted growth of crops Diseases Poor quality water for domestic use Retards development 	<ul style="list-style-type: none"> Raising of roads by use of culverts Water treatment Awareness and trainings use of Improved water sources like boreholes 	District
	Floods/Water logging	<ul style="list-style-type: none"> Human and livestock populations Crops Infrastructure including roads 	Sub county	Sub county	<ul style="list-style-type: none"> Reduced crop and animal production Theft of food Promiscuity 	<ul style="list-style-type: none"> Drought resistant crops Storage of food Sensitization Adoption of irrigation technologies Water harvesting Migration 	District
	Drought	<ul style="list-style-type: none"> Human and livestock populations Crops 	Sub county	Sub county			

Vulnerability Components	Exposure	-	Susceptibility	-	Resilience	District
	Human wild life conflicts	<ul style="list-style-type: none"> • Crops • Human and livestock population 	Sub county	Sub county	<ul style="list-style-type: none"> • Trapping • Hunting • Gazetting natural resources • Involving UWA 	District
	Man made fires	<ul style="list-style-type: none"> • Human and livestock populations 	Sub county	Sub county	<ul style="list-style-type: none"> • Install fire extinguishers • Awareness • Courts of law • Witch craft 	District
	Deforestation	<ul style="list-style-type: none"> • Human and livestock populations 	Sub county	Sub county	<ul style="list-style-type: none"> • Tree planting • Use alternative sources of fuel like bio gas • Use of energy saving stoves • Awareness 	Sub county
	Lightning	<ul style="list-style-type: none"> • Human and livestock populations • Crops • Infrastructure including homes, schools and hospitals • Natural vegetation including trees 	Sub county	Sub county	<ul style="list-style-type: none"> • Install lightning conductors • Witch craft • Planting specific tree species 	District
	Bush fires	<ul style="list-style-type: none"> • Crops 	Sub county	Sub county	<ul style="list-style-type: none"> • Fire lines • Awareness 	Sub county

Vulnerability Components	Exposure	-	Susceptibility	-	Resilience	District
	Strong winds	<ul style="list-style-type: none"> • Human and livestock populations • Crops • Infrastructure including homes, schools and hospitals • Natural vegetation including trees 	<ul style="list-style-type: none"> • Increased travel time especially on lakes • Accidents • Increased plants, human and animal diseases • Reduced production 	Sub county	<ul style="list-style-type: none"> • Use of support on crops like bananas • Tree planting • Observing fishing holidays(July & Aug) • Constructing planned houses 	District
Economic component	Invasive species	<ul style="list-style-type: none"> • Crops • Livestock 	<ul style="list-style-type: none"> • Low income in the long run as a result of poor yield and low productivity • High costs of removal • Increased costs of production 	District	<ul style="list-style-type: none"> • Destruction of weeds through uprooting, burning and slashing 	District
	Land conflicts	<ul style="list-style-type: none"> • Human population 	<ul style="list-style-type: none"> • Retards personal and community development • High court expenses 	Sub county	<ul style="list-style-type: none"> • Sensitise people on land developments and land use • Clearly demarcating and defining land owner ship • Court 	District
	Wetland degradation	<ul style="list-style-type: none"> • Lakes • Crops • Human population 	<ul style="list-style-type: none"> • Loss of income • Loss of government revenue 	District	<ul style="list-style-type: none"> • Sensitisation through radios • Enforcement of wetland laws • Demarcation of wetlands • Prosecuting culprits to Court • Wetland management committee • Eviction 	District

Vulnerability Components	Exposure	-	Susceptibility	-	Resilience	District
	pests, parasites and diseases	<ul style="list-style-type: none"> Human and livestock populations Crops 	<ul style="list-style-type: none"> Loss of income Loss of government revenue Increased expenditure on pesticides and drugs 	District	<ul style="list-style-type: none"> Vaccination Spraying Sensitization Crop rotation Planting disease resistant/tolerant varieties Quarantine Mosquito nets Abandoning farms e.g. coffee farms Destruction of effected crops & animals Alternative income sources 	District
	Soil erosion	<ul style="list-style-type: none"> Human population Crops 	<ul style="list-style-type: none"> Loss of income Loss of government revenue 	Sub county	<ul style="list-style-type: none"> Tree planting Sensitization Soil and water conservation i.e. bridges, trenches, mulching 	District
	Hailstorms	<ul style="list-style-type: none"> Human and livestock populations Crops 	<ul style="list-style-type: none"> Loss of income Loss of government revenue 	District		District
	Drought	<ul style="list-style-type: none"> Human and livestock populations Crops 	<ul style="list-style-type: none"> Loss of income due to low productivity Loss of government revenue 	Sub county	<ul style="list-style-type: none"> Drought resistant crops Storage of food Sensitization Farming in wetlands Water harvesting Reduced food ratios, one meal per day Theft Transactional sex Labour for food Migration 	District



Vulnerability Components	Exposure	-	Susceptibility	-	Resilience	District
	Water, Road accidents	• Human populations	• Loss of lives hence low incomes	District	<ul style="list-style-type: none"> • Regular guidance by traffic officers • Construction of humps and road signs • Reflector jackets, seat belts and helmets • Spot checks for alcoholism 	District
	Water logging	<ul style="list-style-type: none"> • Human and livestock populations • Crops • Natural vegetation • Infrastructure including roads 	<ul style="list-style-type: none"> • Loss of income • Loss of government revenue 	Sub county	<ul style="list-style-type: none"> • Raising of roads by use of culverts • Water treatment • Awareness and trainings • use of Improved water sources like boreholes 	District
	Wetland degradation	<ul style="list-style-type: none"> • Crops • Human and livestock population 	<ul style="list-style-type: none"> • Loss of biodiversity • Reduced water quality • Increased incidences of water borne diseases 	District	<ul style="list-style-type: none"> • Tree planting along the wetland area • Awareness 	District
	Human wild life conflicts	<ul style="list-style-type: none"> • Crops • Human and livestock population 	<ul style="list-style-type: none"> • Loss of income 	Sub county	<ul style="list-style-type: none"> • Trapping • Hunting • Gazetting natural resources • Involving UWA 	District
	Man made fires	<ul style="list-style-type: none"> • Human and livestock populations 	<ul style="list-style-type: none"> • Low income • Loss of government revenue • Increased costs for maintenance 	Sub county	<ul style="list-style-type: none"> • Install fire extinguishers • Awareness • Witch craft 	District
	Deforestation	<ul style="list-style-type: none"> • Human and livestock populations 	<ul style="list-style-type: none"> • High costs of water treatment 	Sub county	<ul style="list-style-type: none"> • Tree planting • Use alternative sources of fuel like bio gas • Use of energy saving stoves • Awareness 	Sub county

	Lightning	<ul style="list-style-type: none"> • Human and livestock populations • Crops • Infrastructure including homes, schools and hospitals • Natural vegetation including trees 	Sub county	<ul style="list-style-type: none"> • Low income • Loss of government revenue 	Sub county	<ul style="list-style-type: none"> • Install lightning conductors • Witch craft • Planting specific tree species 	District
	Bush fires	<ul style="list-style-type: none"> • Crops 	Sub county	<ul style="list-style-type: none"> • Low income 	Sub county	<ul style="list-style-type: none"> • Fire lines • Awareness 	Sub county
	Strong winds	<ul style="list-style-type: none"> • Human and livestock populations • Crops • Infrastructure including homes, schools and hospitals • Natural vegetation including trees 	Sub county	<ul style="list-style-type: none"> • Low income • Loss of government revenue 	Sub county	<ul style="list-style-type: none"> • Use of support on crops like bananas • Tree planting • Observing fishing holidays(July & Aug) • Constructing planned houses 	District
Environmental component	Invasive species	<ul style="list-style-type: none"> • Crops 	Sub county	<ul style="list-style-type: none"> • Loss and stunted growth of crops 	Sub county	<ul style="list-style-type: none"> • Destruction of weeds through uprooting, burning and slashing 	District
	Land conflicts	<ul style="list-style-type: none"> • Crops • Human population 	District	<ul style="list-style-type: none"> • Destruction of crops 	District	<ul style="list-style-type: none"> • Sensitise people on land developments and land use • Clearly demarcating and defining land owner ship • Court 	District

	Wetland degradation	<ul style="list-style-type: none"> Lakes Crops Human population 	District	<ul style="list-style-type: none"> Loss of bio diversity Drying of water resources climatic change 	District	<ul style="list-style-type: none"> Sensitisation through radios Enforcement of wetland laws Demarcation of wetlands Prosecuting culprits to Court Wetland management committee Eviction 	District
	Soil erosion	<ul style="list-style-type: none"> Human population Crops 	Sub county	<ul style="list-style-type: none"> Loss of vegetation cover including trees and crops Land degradation 	Sub county	<ul style="list-style-type: none"> Tree planting Sensitization Soil and water conservation i.e. contour bands, trenches 	District
	pests, parasites and diseases	<ul style="list-style-type: none"> Human and livestock populations Crops 	District	<ul style="list-style-type: none"> Loss of crops and animals 	District	<ul style="list-style-type: none"> Vaccination Spraying Sensitization Crop rotation Planting disease resistant crops Quarantine 	District
	Hailstorms	<ul style="list-style-type: none"> Human and livestock populations Crops 	District	<ul style="list-style-type: none"> Loss of vegetation cover including trees and crops 	District		District
	Drought	<ul style="list-style-type: none"> Human and livestock populations Crops 	Sub county	<ul style="list-style-type: none"> stunted growth of crops Loss of pasture 	Sub county	<ul style="list-style-type: none"> Drought resistant crops Storage of food Sensitization Farming in wetlands Water harvesting Migration 	District
	Human wild life conflicts	<ul style="list-style-type: none"> Crops Human and livestock population 	Sub county	<ul style="list-style-type: none"> Destruction of crops 	Sub county	<ul style="list-style-type: none"> Trapping Hunting Gazetting natural resources Involving UWA 	District

	Man made fires	<ul style="list-style-type: none"> • Human and livestock populations 	Sub county	<ul style="list-style-type: none"> • Pollution 	Sub county	<ul style="list-style-type: none"> • Install fire extinguishers • Awareness • Witch craft 	District
	Lightning	<ul style="list-style-type: none"> • Human and livestock populations • Crops • Infrastructure including homes, schools and hospitals • Natural vegetation including trees 	Sub county	<ul style="list-style-type: none"> • Destroy natural vegetation and crops 	Sub county	<ul style="list-style-type: none"> • Install lightning conductors • Witch craft • Planting specific tree species 	District
	Strong winds	<ul style="list-style-type: none"> • Human and livestock populations • Crops • Infrastructure including homes, schools and hospitals • Natural vegetation including trees 	Sub county	<ul style="list-style-type: none"> • Destruction of crops 	Sub county	<ul style="list-style-type: none"> • Use of support on crops like bananas • Tree planting • Observing fishing holidays (July & Aug) • Constructing planned houses 	District
	Deforestation	<ul style="list-style-type: none"> • Human and livestock populations 	Sub county	<ul style="list-style-type: none"> • Loss of biodiversity 	Sub county	<ul style="list-style-type: none"> • Tree planting • Use alternative sources of fuel like bio gas • Use of energy saving stoves • Awareness 	Sub county
	Bush fires	<ul style="list-style-type: none"> • Crops 	Sub county	<ul style="list-style-type: none"> • Loss of bio diversity • Destruction of crops • Migration of wildlife 	Sub county	<ul style="list-style-type: none"> • Fire lines • Awareness 	Sub county
	Water logging	<ul style="list-style-type: none"> • Human and livestock populations • Crops • Natural vegetation including roads 	District	<ul style="list-style-type: none"> • Loss of bio diversity • Destruction of crops 	Sub county	<ul style="list-style-type: none"> • Raising of roads by use of culverts • Water treatment • Awareness and trainings • use of Improved water sources like boreholes 	District

Physical components	Invasive species	<ul style="list-style-type: none"> •Crops •Livestock 	District	<ul style="list-style-type: none"> •Low fish production •Harbours snakes and crocodiles •Blocks transport 	District	<ul style="list-style-type: none"> •Destruction of weeds through uprooting, burning and slashing 	District
	pests, parasites and diseases	<ul style="list-style-type: none"> • Human and livestock populations •Crops 	District	<ul style="list-style-type: none"> • Loss of livestock and humans • Complete crop failure • Stunted growth of crops 	District	<ul style="list-style-type: none"> • Vaccination • Spraying • Sensitization • Crop rotation • Planting disease resistant crops • Quarantine • Mosquito nets • Abandoning farms e.g. coffee farms • Destruction of effected crops& animals • Alternative income sources 	District
	Wetland degradation	<ul style="list-style-type: none"> • Lakes • Crops • Human population 	District	<ul style="list-style-type: none"> • Drying of water sources • Bio diversity destruction 	District	<ul style="list-style-type: none"> • Sensitisation through radios • Enforcement of wetland laws • Demarcation of wetlands 	District
	Soil erosion	<ul style="list-style-type: none"> • Human population • Crops 	District	<ul style="list-style-type: none"> • Stunted crop growth • Siltation of water bodies • Decreased biodiversity • Destruction of property 	District	<ul style="list-style-type: none"> • Tree planting • Sensitization • Soil and water conservation i.e. bridges, trenches, mulching 	District
	Water, Road accidents	<ul style="list-style-type: none"> • Human and livestock populations 	District	<ul style="list-style-type: none"> • Human deaths 	District	<ul style="list-style-type: none"> • Regular guidance by traffic officers • Construction of humps and road signs • Reflector jackets, seat belts and helmets • Spot checks for alcoholism 	District
	Hailstorms	<ul style="list-style-type: none"> • Human and livestock populations • Crops 	District	<ul style="list-style-type: none"> • Loss of livestock • Complete crop failure • Stunted growth of crops 	District		District

	Land conflicts	<ul style="list-style-type: none"> • Human population • Crops 	Sub county	<ul style="list-style-type: none"> • Loss of property • Displacement of people 	Sub county	<ul style="list-style-type: none"> • Sensitise people on land developments and land use • Clearly demarcating and defining land owner ship • Court • Acquiring land titles 	District
	Drought	<ul style="list-style-type: none"> • Human and livestock populations • Crops 	Sub county	<ul style="list-style-type: none"> • Loss of vegetation cover • Lowering of water levels • Death of livestock • Scarcity of water • Proliferation of livestock diseases • Limited pasture 	Sub county	<ul style="list-style-type: none"> • Drought resistant crops • Storage of food • Sensitization • Farming in wetlands • Water harvesting • Reduced food ratios, one meal per day • Theft • Transactional sex • Labour for food • Migration 	District
	Floods/Water logging	<ul style="list-style-type: none"> • Human and livestock populations • Crops • Infrastructure including roads 	Sub county	<ul style="list-style-type: none"> • Loss of lives • Destruction of roads • Displacement of people • Destruction of property 	Sub county	<ul style="list-style-type: none"> • Raising of roads by use of culverts • Water treatment • Awareness and trainings • use of Improved water sources like boreholes 	District
	Human wild life conflicts	<ul style="list-style-type: none"> • Crops • Human and livestock population 	Sub county	<ul style="list-style-type: none"> • Death of people • Destruction of property • Spread of diseases • Tension 	Sub county	<ul style="list-style-type: none"> • Trapping • Hunting • Gazetting natural resources • Involving UWA 	District
	Man made fires	<ul style="list-style-type: none"> • Human and livestock populations 	Sub county	<ul style="list-style-type: none"> • Destruction of crops • Loss of property 	Sub county	<ul style="list-style-type: none"> • Install fire extinguishers • Awareness • Witchcrafts 	District



	Lightning	<ul style="list-style-type: none"> • Human and livestock populations • Crops • Infrastructure including homes, schools and hospitals • Natural vegetation including trees 	Sub county	<ul style="list-style-type: none"> • Death and injury of human and livestock • Destroy properties 	Sub county	<ul style="list-style-type: none"> • Install lightning conductors • Witch craft • Planting specific tree species 	District
	Strong winds	<ul style="list-style-type: none"> • Human and livestock populations • Crops • Infrastructure including homes, schools and hospitals • Natural vegetation including trees 	Sub county	<ul style="list-style-type: none"> • Destruction of crops and properties 	Sub county	<ul style="list-style-type: none"> • Use of support on crops like bananas • Tree planting • Observing fishing holidays (July & Aug) • Constructing planned houses 	District
	Deforestation	<ul style="list-style-type: none"> • Human and livestock populations 	Sub county	<ul style="list-style-type: none"> • Loss of biodiversity 	Sub county	<ul style="list-style-type: none"> • Tree planting • Use alternative sources of fuel like bio gas • Use of energy saving stoves • Awareness 	Sub county
	Bush fires	<ul style="list-style-type: none"> • Crops 	Sub county	<ul style="list-style-type: none"> • Loss of bio diversity • Destruction of crops • Migration of wildlife 	Sub county	<ul style="list-style-type: none"> • Fire lines • Awareness 	Sub county
	Wetland degradation	<ul style="list-style-type: none"> • Lakes • Crops • Human population 	District	<ul style="list-style-type: none"> • Bio diversity destruction • Low arts and crafts production • Conflicts on water waters 	District	<ul style="list-style-type: none"> • Sensitisation through radios • Enforcement of wetland laws • Demarcation of wetlands • Prosecuting culprits to Court • Establishment of functional wetland management committees • Eviction 	District

CONCLUSION AND RECOMMENDATION

It was established that Masaka district has over the past 20 years increasingly experienced multi-hazards including floods, drought, invasive species, strong winds, pests, parasites and diseases for crops and livestock, soil erosion, land conflicts, lightning, deforestation, burning, wetland degradation, road accidents and hailstorms putting livelihoods at increased risk. The limited adaptive capacity (and or/resilience) and high sensitivity of households and communities in Masaka district increase their vulnerability to multi-hazard exposure necessitating urgent external support.

The multi-hazards that are experienced in Masaka District can be classified as:

- i. Geomorphological and geological hazards including; soil erosion
- ii. Climatological or hydro-meteorological including; flash floods, hailstorms, lightning, drought and strong winds
- iii. Ecological or biological hazards including; pests, parasites and diseases, human and wildlife conflicts and invasive species
- iv. Technological hazards including; road and water accidents
- v. Environmental hazards including; wetland degradation, deforestation and land conflicts

However, reducing vulnerability at community, local government and national levels should be a threefold effort hinged on:

- i. Reducing the impact of the hazard where possible through mitigation, prediction, early warning and preparedness
- ii. Building capacities to withstand and cope with the hazards and risks
- iii. Tackling the root causes of the vulnerability such as poverty, poor governance, discrimination, inequality and inadequate access to resources and livelihood opportunities

Recommended policy actions that should target vulnerability reduction include:

- i. Improved enforcement of policies aimed at enhancing sustainable environmental health;
- ii. Increased awareness campaigns aimed at sensitizing farmers/communities on disaster risk reduction initiatives and practices.
- iii. Revival of District Disaster Management Committees at the district levels
- iv. Support extensive research on the occurrence and frequency of disasters prior to disaster management
- v. Improve the communication channel between the disaster department and local communities

- vi. Office of the Prime Minister should decentralise their activities at the district level
- vii. OPM should strengthen the district disaster committees by developing guidelines and trainings
- viii. Establishment of disaster fund at the district levels
- ix. Fund and equip recruited extension works
- x. Support establishment of a disaster early warning systems
- xi. Provide support in form of free seedlings to promote afforestation and reforestation programmes

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Department of Relief, Disaster
Preparedness and Management
Office of the Prime Minister
P.O.Box 371, Kampala, Uganda

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Plot 11 Yusuf Lule, Road, Nakasero
P. O. Box 7184, Kampala, Uganda
Tel: (+256) 417 112 100
Fax: (+256) 414 344 801
www.undp.org