



THE REPUBLIC OF UGANDA

Rakai District

Hazard, Risk and Vulnerability profile



2016

Acknowledgment

On behalf of office of the Prime Minister, I wish to express my sincere appreciation to all of the key stakeholders who provided their valuable inputs and support to this Multi-Hazard, Risk and Vulnerability mapping exercise that led to the production of comprehensive District Hazard, Risk and Vulnerability (HRV) profiles.

I extend my sincere thanks to the Department of Relief, Disaster Preparedness and Management, under the leadership of the Commissioner, Mr. Martin Owor, for the oversight and management of the entire exercise.

The HRV assessment team was led by Ms. Ahimbisibwe Catherine, Senior Disaster Preparedness Officer supported by Kirungi Raymond - Disaster Preparedness Officer and the team of consultants (GIS/DRR specialists); Dr. Bernard Barasa, and Mr. Nsiimire Peter, who provided technical support.

Our gratitude goes to UNDP for providing funds to support the Hazard, Risk and Vulnerability Mapping. The team comprised of Mr. Steven Goldfinch – Disaster Risk Management Advisor, Mr. Gilbert Anguyo - Disaster Risk Reduction Analyst, and Mr. Ongom Alfred-Early Warning system Programmer.

My appreciation also goes to the District Team:

1. Mr Ssonko Solomon - Chief Administrative Officer
2. Mr Bwanika Joseph - Principal Fisheries Officer
3. Mr Kanyike Mohammad - Agricultural Officer
4. Mr Kiyinji Jamil - District Natural Resources Officer
5. Mr Kalungi Richard - Environment Officer
6. Mr Kategaya Magid - Agriculturalist
7. Mr Lubowa Samuel - Senior Accounts Assistant
8. Mr Ssessanga Musisi - District Information Officer

The entire body of stakeholders who in one way or another yielded valuable ideas and time to support the completion of this exercise.

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 response to The National Policy for Disaster Preparedness and Management (Section 4.1.1) and also targeting to counteract 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 OPM as well as 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 located in the South Western region of Uganda, west of Lake Victoria, lying between longitude 31°E, 32°E and latitude 0°S. The Southern and Eastern parts of Rakai, which include Kyebe, Kabira and Kasali Sub counties display fair distributions of rainfall throughout the year. Rakai is divided into three topographic zones – Lake Victoria shores the North-Eastern and Western hills and the North-Western Plains. A total of 77 per cent of the people living in rural areas depend on subsistence farming.

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 Rakai 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, 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, bush fires, 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 Authority
NFA	:	National Forestry Authority
UNDP	:	United Nations Development Programme
OPM	:	Office of the Prime Minister
SRTM	:	Shuttle Radar Topography Mission
ToR	:	Terms of Reference
UBOS	:	Uganda Bureau of Statistics
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

CHAPTER ONE

1.1 Background

Uganda has over the past years experienced frequent disasters that ranges from drought, 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 towards 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 and risk management in development planning and contingency planning at National and Local Levels.

Since 2013, UNDP has been supporting the Office of the Prime Minister to develop 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) requires 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 of the consultancy

The objectives of the assignment were to:

- 1) Collect and analyze field data using GIS in close collaboration and coordination with OPM in Rakai 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 of the assignment

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.



CHAPTER TWO

2.1 Overview of Rakai District

2.1.1 Location

Rakai District is located in the South Western region of Uganda, west of Lake Victoria, lying between longitude 31°E, 32°E and Latitude 0°S. Its Southern boundaries are part of the international boundary between Uganda and Tanzania. It is bordered by Masaka District in the East, Kalangala District in the South-East and Isingiro District in the West and Lyantonde in the North. The District Headquarters are at Rakai Town which is a tarmac road distance of about 190km from Kampala the national capital. It has a total area of (sq km) 4908.7.

The Southern and Eastern parts of Rakai, which include Kyebe, Kabira and Kasali Sub counties display fair distributions of rainfall throughout the year. There is a relatively dry season around January and February, and another in June, July and August. The peak rainfall is received in March-April and May, whereas the minor peak is around October and November. The Mean annual vary from 1,350mm to 2,125mm. The District is endowed with a rich natural environment ranging from high forest, savannah grassland, and forest and tree plantation. It ranges from the medium altitude forests on the shores of Lake Victoria, through swamps to savannas.

Rakai is divided into three topographic zones – Lake Victoria shores the North-Eastern and Western hills and the North-Western Plains. The North eastern and western parts of the Rakai District are hilly (Rakai highlands) only interrupted by two major lake depressions (Kijanebalola and Kacheera) and occasional wide flat valleys (pseudo plains). The southern-eastern and North Western parts of the District comprise almost flat to undulating plains topography, the North-Eastern and Western hills and the North-Western plains. Over 75 per cent of Rakai soils are ferralitic representing an almost final stage of weathering with little or no mineral reserve left. Other types include lithosols, alluvial and lacustrine sands and alluvial clays. The Population of Rakai totals to 518,002 (UBOS, 2014). When compared to the 2002 population census results, the population in the District grew by 2.1% over a period of 12 years.

A total of 77 per cent of the people living in rural areas depend on subsistence farming. The District is basically reliant on crop and livestock production. The major sources of livelihood include: subsistence farming, formal employment, small scale business, remittances and fishing among others. The main food crops include , Bananas, Irish potatoes, maize, beans, cassava etc. Coffee is the major traditional cash crop in the District.

CHAPTER THREE

3.1 Materials and methods

3.1.1 Hazard, risk and vulnerability profile assessment

3.1.1.1 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.

3.1.1.2 Data collection

3.1.1.2.1 Socio economic investigation

The socio economic assessment of 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: Byakabanda and Rakai Town Council. 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.

3.1.1.2.2 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 dataset included GPS coordinates while the secondary datasets were 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	Lightening	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

3.1.1.2.3 Validation

The 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. This profile was certified by the District representative 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 Rakai District can be classified as:

- i. Geomorphological and geological hazards including soil erosion
- ii. Climatological or hydro-meteorological including flash floods, hailstorms, 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, bush fires, 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 Pests, parasites and diseases

The occurrence, severity, frequency and distribution of Pests, parasites and diseases are high as compared to the last 35 years in the District. In crop production, the farmers are engaged in the growing of beans, groundnuts, cassava, rice, potatoes, millet, maize, bananas and coffee as food and cash crops, however, their production has drastically reduced over time due to increasing and emergence of new crop pests and diseases.



Plate 1: Left: Orange dog pest on a citrus plant – Kakuuto Sub-county,
Right: A heavily BBW infested banana plantation, Kagamba Sub county

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, recycling of planting materials, type of crop grown (cereals), poor farming methods, high costs of pesticides, 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 poverty, attitude, ignorance and poor mind-sets. The crop pests and diseases are associated with crop destruction, stunted growth, early rotting and farmer ignorance on better farming methods.

The factors that have contributed to the vulnerability of farmers include: poor seedlings, substandard pesticides and limited extension services. The adverse effects include low crop yields, low income levels, build-up of pests and soil degradation among others. Some of the notable pests and diseases are indicated here below (Table 4). The effects of pests 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 miners
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
7	Bananas	Banana Bacterial Wilt (see Plate 1), banana weevils, sigatoka
8	Tomatoes	Tomato Blight, wilt, flies, thrips
9	Rice	Stem borers, rice yellow mortal virus
10	Beans	Aphids, anthracnose, bean mosaic virus
11	Citrus	Rot, fruit-fly, hard scab, orange dog, anthracnose
12	Coffee	Coffee wilt disease, coffee twig borer Irish potatoes Blight, wilt, millipedes

In livestock production, Rakai District lies in an endemic Tsetse fly 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 and scarcity of water and pastures.

The adverse effects of livestock parasites and diseases include: loss of livestock, reduced household income levels and food, loss of revenue to the District, human ill health . Some of the notable parasites and diseases included; ticks, tsetse flies, worms, mites New Castle Disease, Swine fever, Nagana, East Coast Fever, foot and mouth disease, mange among others. The livestock parasite and disease incidences are reported in all the Sub counties (Figure 2).

3.2.3 Drought

Rakai is one of the Districts found in the cattle corridor. 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, rotting of crops 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, illness and loss of livestock. The severity and distribution of drought affects all the Sub counties in particular Byakabanda, Rakai Town Council, Kiziba, Kyalulangira, Lwanda, Kibanda, Kifamba, Kagamba, Kacheera and Ddwaniro.

3.2.4 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.



Plate 2: Soil erosion galleys in Lwakaloolo Parish, Dwaniro Sub county

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 crop pests, parasites and diseases, loss of landscape beauty, land conflicts, spread of invasive species and famine. The occurrences and severity of soil erosion equally affects all the Sub counties in the District (figure 3).

3.2.5 Wetland degradation

The wetland types found in Rakai District are characterized as papyrus, 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 causes of wetland degradation include land shortage, drought, reduced soil fertility, political interference, soil erosion, drought, poor farming methods, assumed ownership, changes in land use, ignorance about the value of wetlands, resource conflicts, brick making, sand mining, seasonal fires, over harvesting and invasion by invasive species (Plate 3).



Plate 3: Burning of wetlands, Rakai Town Council

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 lack of resources 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).

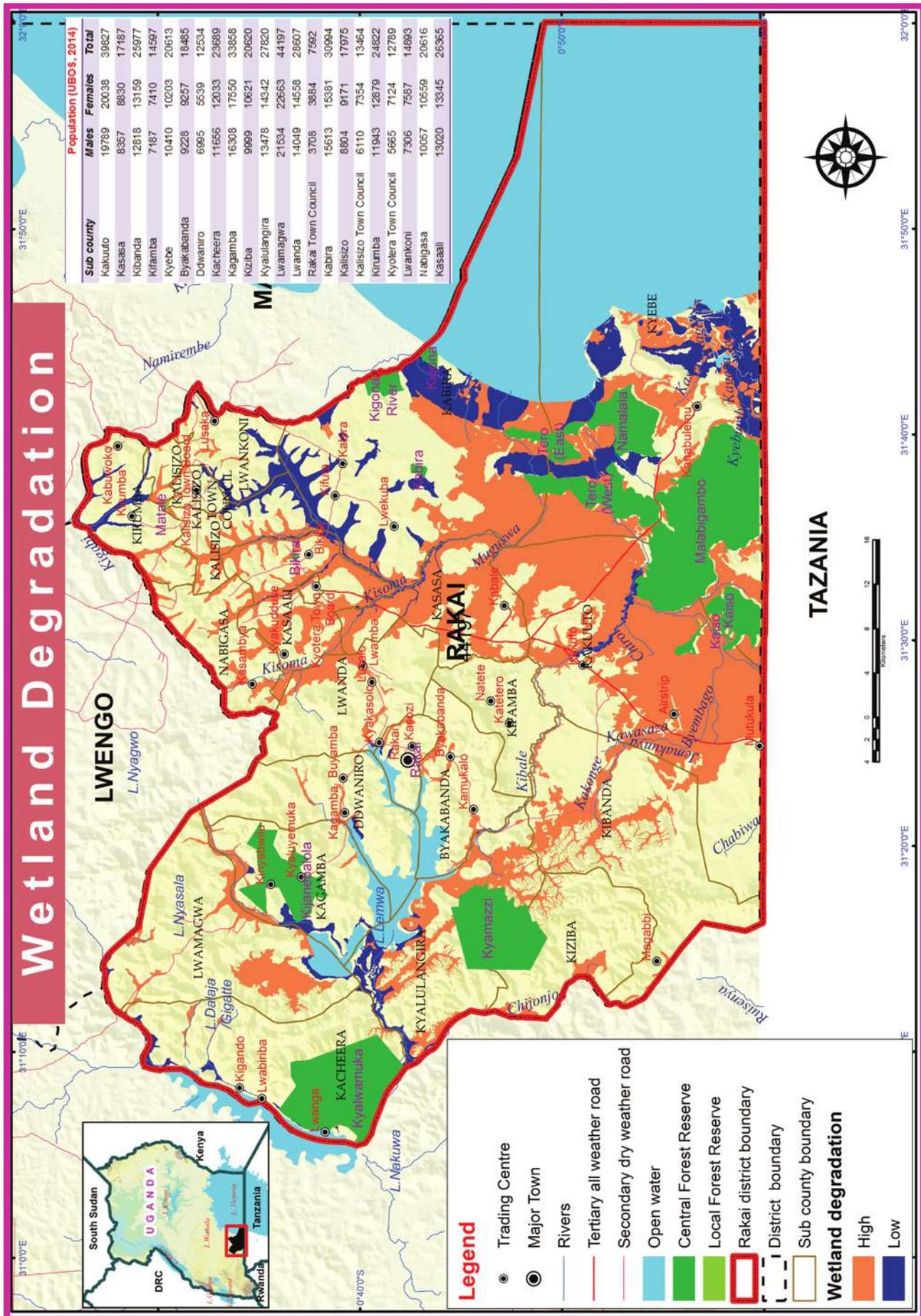


Figure 4: Levels of wetland degradation



3.2.6 Land conflicts

Land conflicts have worsened in the District over the last 10 years. Most of the land in the District is under unregistered customary ownership, though there is an increasing number of leaseholds and freeholds. Cases of Land conflicts often involve families, communities, institutions and Government.

The land conflicts in the District are fuelled by unclear ownership of wetlands, population pressure, customary land ownership, overlapping land policies, ignorance, unclear administrative and protected area boundaries, absentee land lords, land grabbing, inequitable distribution of land in families and untitled land. The conflicts are associated with prolonged court cases, displacement of people and 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 ultimate outcome of these is the loss of social security given that land is the most significant factor of production and domicility.

The conflicts have resulted into the migration of people to the neighbouring Sub counties and other Districts, under development, loss of human life, farm produce and livestock; and loss of property and income due to litigation/legal processes. The eventualities are more severe in all the Sub counties (figure 5).

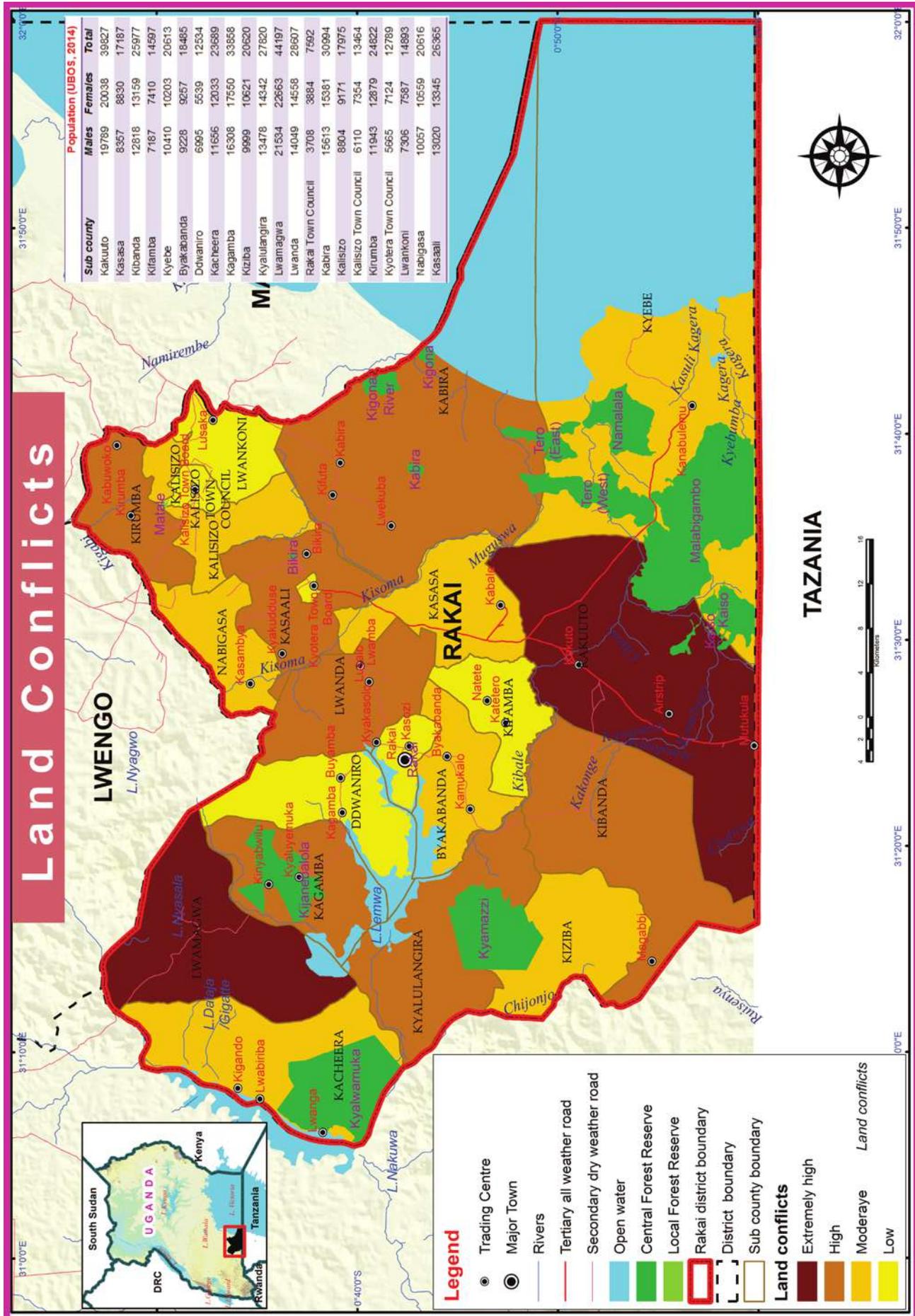


Figure 5: Severity of land conflicts



3.2.7 Deforestation

Deforestation is perceived as the cutting of trees for, farming, settlements, infrastructural developments, wood and timber. The main factors leading to deforestation include search for land for settlement by the growing population, need for reasonably fertile land for cultivation, increasing demand for charcoal and timber products, corruption and weak laws that are not adhered to or enforced 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 are increase in pests, parasites and diseases, loss of wild life habitats and biodiversity, and drought. Others are human resource conflicts, and loss of water quality. There is also land degradation which reduces land productivity, disturbance of the micro-climate and hydrological cycle hence erratic weather patterns and reduction in availability of key forest resources (such as medicinal plants, wood, timber). The activities are prevalent in all the Sub counties; however there are more severe in Kibanda, Kyebe, Kacheera, Kagamba, Kakuuto, Kiziba and Kyalulangira.



Plate 4: Forest degradation in Rakai Town Council

3.2.8 Bush burning

The occurrence and frequency of fires tends to follow a seasonal pattern, with fires being frequent during the dry season. The fires are started by majorly the pastoral cattle keepers to break the cycle of parasites and facilitate pasture. Some of the fires are attributed to charcoal burners', hunters, famers clearing land for cultivation and arsonists involved in land conflicts.



Plate 5: Bush burning in Rakai Town Council

Bush burning is associated with the clearance of vegetation, conversion of wood into charcoal, destruction of crops and property. Vulnerability to the fires is due to the rampant land conflicts, drought, livestock production and inadequate enforcement of conservation policies.

The secondary effects of bush fires include loss of household incomes, food insecurity, exposure of soil to degradation, migration of animals, displacement of people, and loss of biodiversity. Severe fire incidents have been recorded in Lwamagwa, Ddwaniro, Kacheera, Kagamba, Lwanda, Rakai Town Council, Kiziba, Kyalulangira, Byakabanda, Kasasa, Kibanda, Kyebe, Kifamba, Kakuuto Sub counties.

The practice of bush burnig has thrived due to lack of enforcement of existing regulations, and functional ignorance among other factors.

3.2.9 Human and wildlife conflicts

The human and wildlife conflicts are apparently on the increase primarily because of human encroachment on wildlife belts or zones. For example destruction of forests for wood products has deprived wild animals of their habitats therefore compelling them to invade farmlands and people's homes in search for food and shelter.

The attacks are characterized by crop destruction, spread of livestock diseases and loss of human life. On the other hand the stray animals are often killed by the invaded communities which affects biodiversity and tourism potential. The factors that contribute to the vulnerability of communities include the loss of crops and livestock which in turn result in food insecurity and loss of household incomes.



Plate 6: Wetland (habitat for vermin) along Lake Kijanebalola in Dwaniro Sub county

The wildlife-human conflicts are most prevalent in in Lwamagwa, Dwaniro, Kacheera, Kagamba, Lwanda, Rakai Town Council, Kiziba, Kyalulangira, Byakabanda, Kasasa, Kibanda, Kyebe, Kifamba and Kakuuto Sub counties (figure 6).

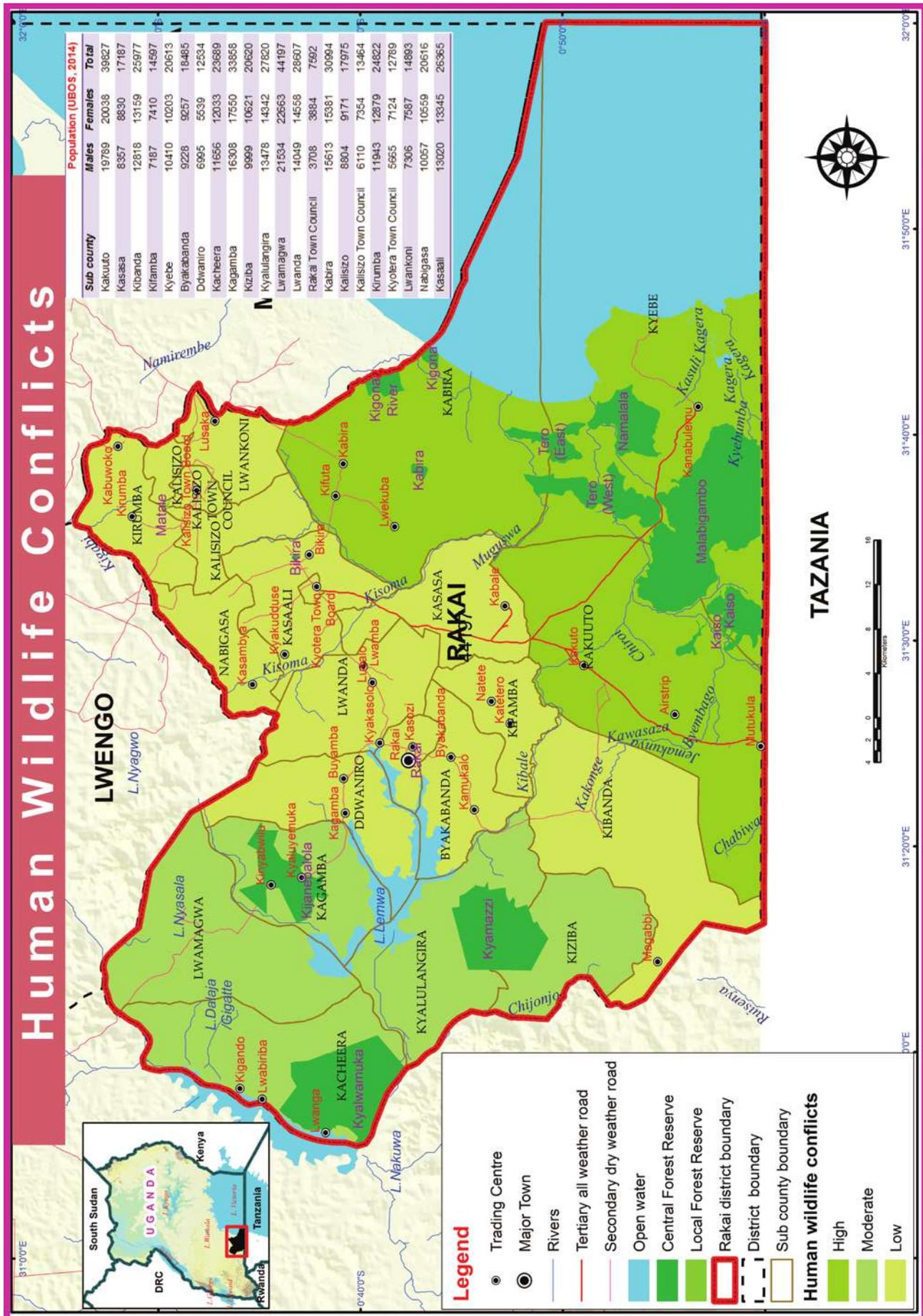


Figure 6: Levels of human and wildlife conflicts



3.2.10 Road and water accidents

Road and water accidents have become a significant hazard the District. The prevalence of accidents is attributed to the driving of cars in dangerous mechanical conditions, reckless driving, lack of road sign posts, poor road conditions, bad weather, overloading, poor driving skills, stray livestock grazing in the road reserves, narrow roads. The accidents mainly involve pedestrians, cars, bicycles, motorcycles and boats.

The road and water accidents often result in physical injuries, fatalities and damage to property and road infrastructure. The incidences tend to escalate during the festive seasons such as Christmas and Easter, political campaigns start and closure of schools. Communities are vulnerable to accidents because of weak enforcement of traffic laws, poor road conditions, and poor mechanical conditions among other causes.

The notable effects of road and water accidents include: loss of human life and livestock, physical disabilities, loss of property and loss of income in compensations. The accident incidents are reported in all the Sub counties throughout the year (figure 7).

The increasing rate of traffic accidents is due to weak enforcement of existing traffic regulations and boats in unseen worthy conditions.

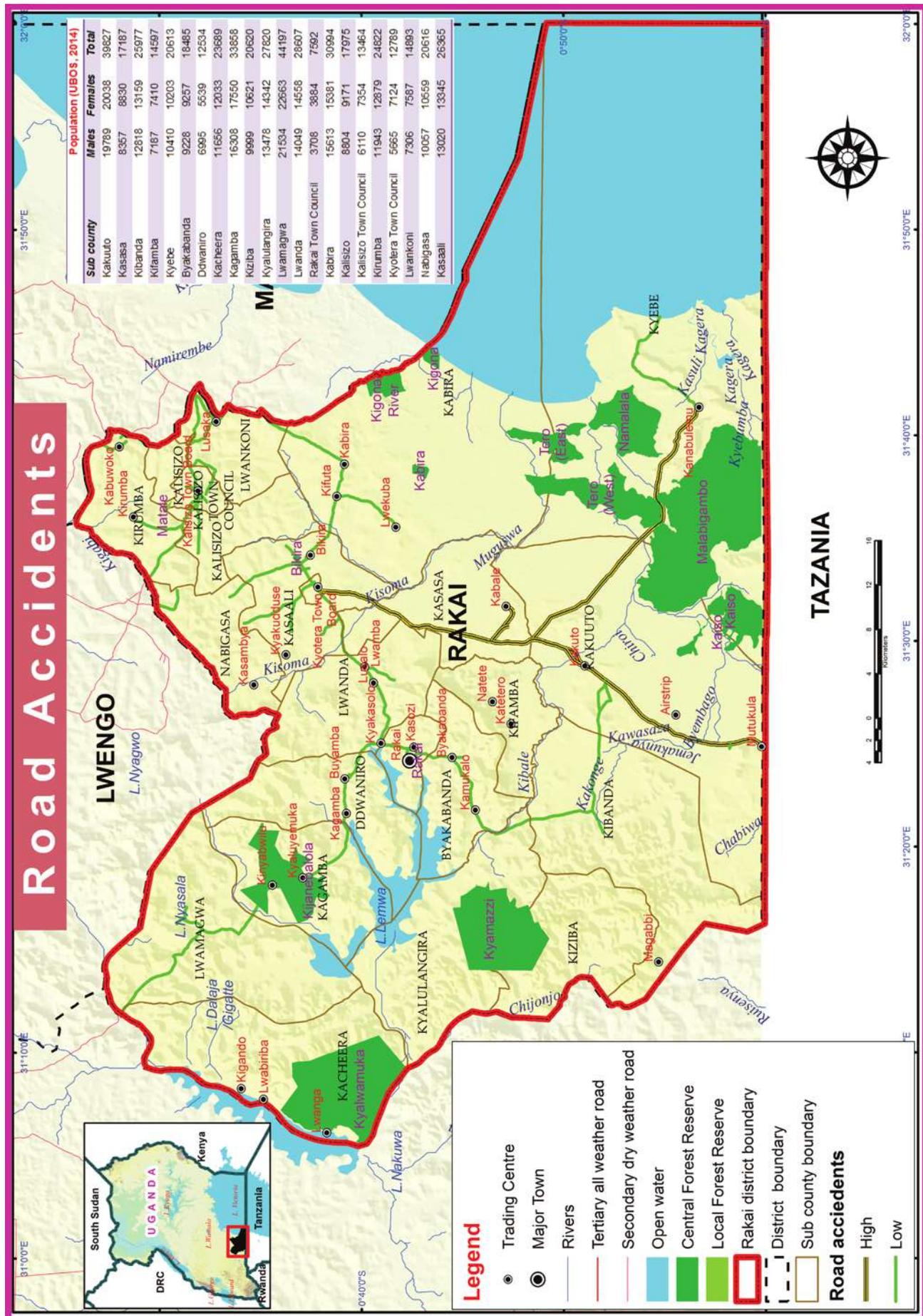


Figure 7: Road and water accidents distribution



3.2.11 Flash floods

Rakai District has many areas that are prone to floods. This is because the District has a number of water bodies and low lying areas with associated flood plains. Such areas include Lake Victoria, Kacheera and Kijanebalola, River Bukoola, Kisoma and Naluddugavu, Lukokoma, Kagera and Sangobay wetlands. Flooding occurs in the wet seasons and is facilitated mainly by wetland degradation, poor drainage and farming methods, and unplanned settlements, The District experiences a bi-model type of rainfall pattern; so the e floods occur in the months of April-May and September-November of each year.

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. During flood periods delivery and access to social services are affected.

The factors that contribute to the vulnerability of households include; poor early warning system, poor physical planning, ignorance, and poorly enforced land use regulations among others.

The adverse effects of flash floods include a reduction in household income levels, low 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. Flooding most severely affects Kasasa, Kabira, Kachera, Lwamaggwa, Byakabanda, Kyebe, Kakuuto, Lwanda, Kirumbaand Rakai Town Council. (Figure 8).

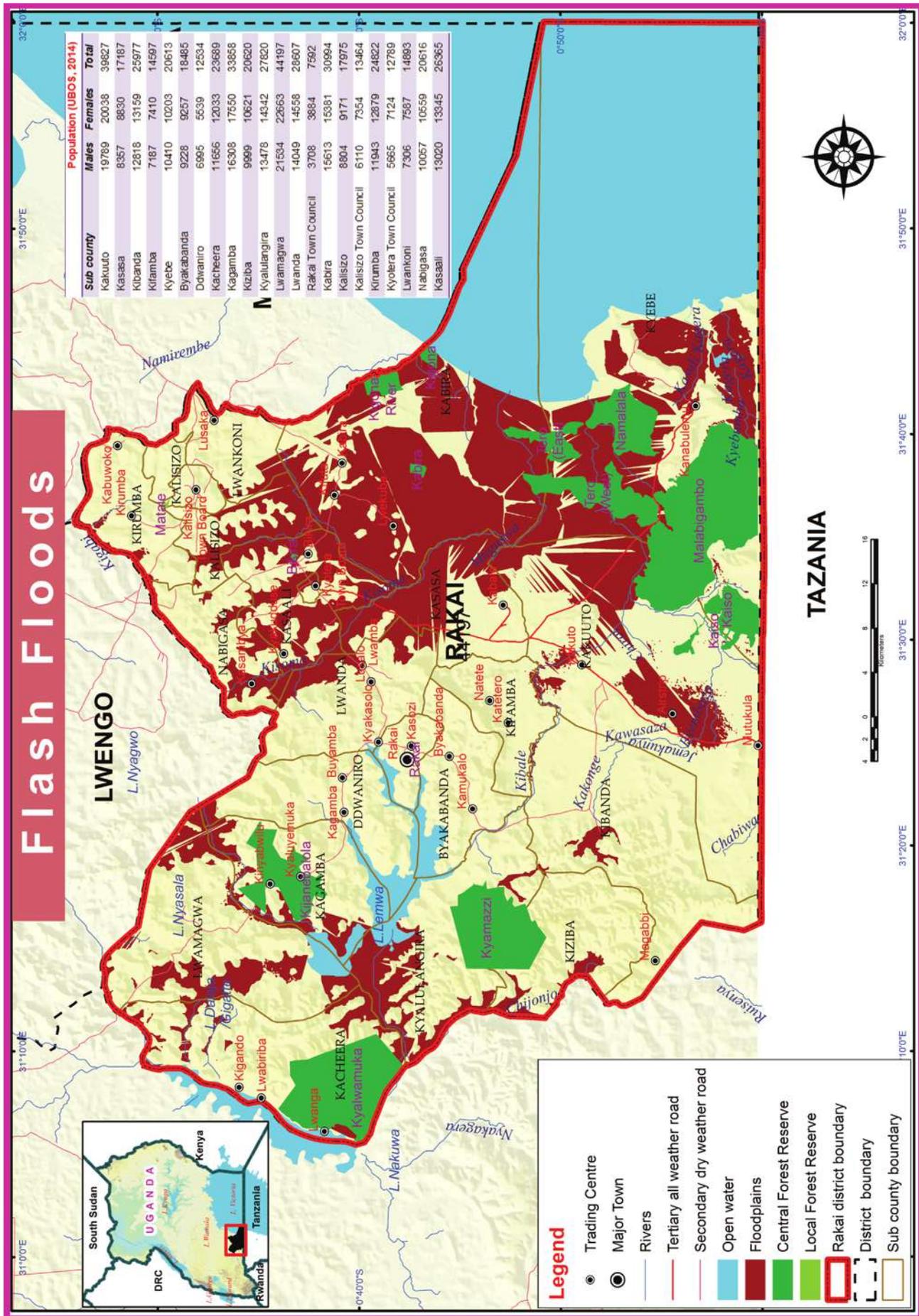


Figure 8: Flood prone/inundation areas



3.2.12 Hailstorms

The occurrence and severity of hailstorms are a frequent phenomenon in Rakai District. The hailstones fall during heavy downpour and these last about 10-30minutes. The frequency and distribution of hailstorms is primarily connected to the onset of rainy seasons especially after prolonged dry spells and are more severe during the second rainy season (September to December). Hailstorms result in vegetation, crop, livestock and property destructions. Deforestation activities have increased the magnitude of severity.

The famers are vulnerable to the effects of hailstorms due to poor early warning systems and the massive clearance of trees (wind breaks).

The adverse effects of hailstorms include destruction of crops, animals and property. The episodes are most frequent in the sub-counties of Kakuuto, Ddwaniro, Kacheera, Kagamba and Lwamagwa (figure 9).

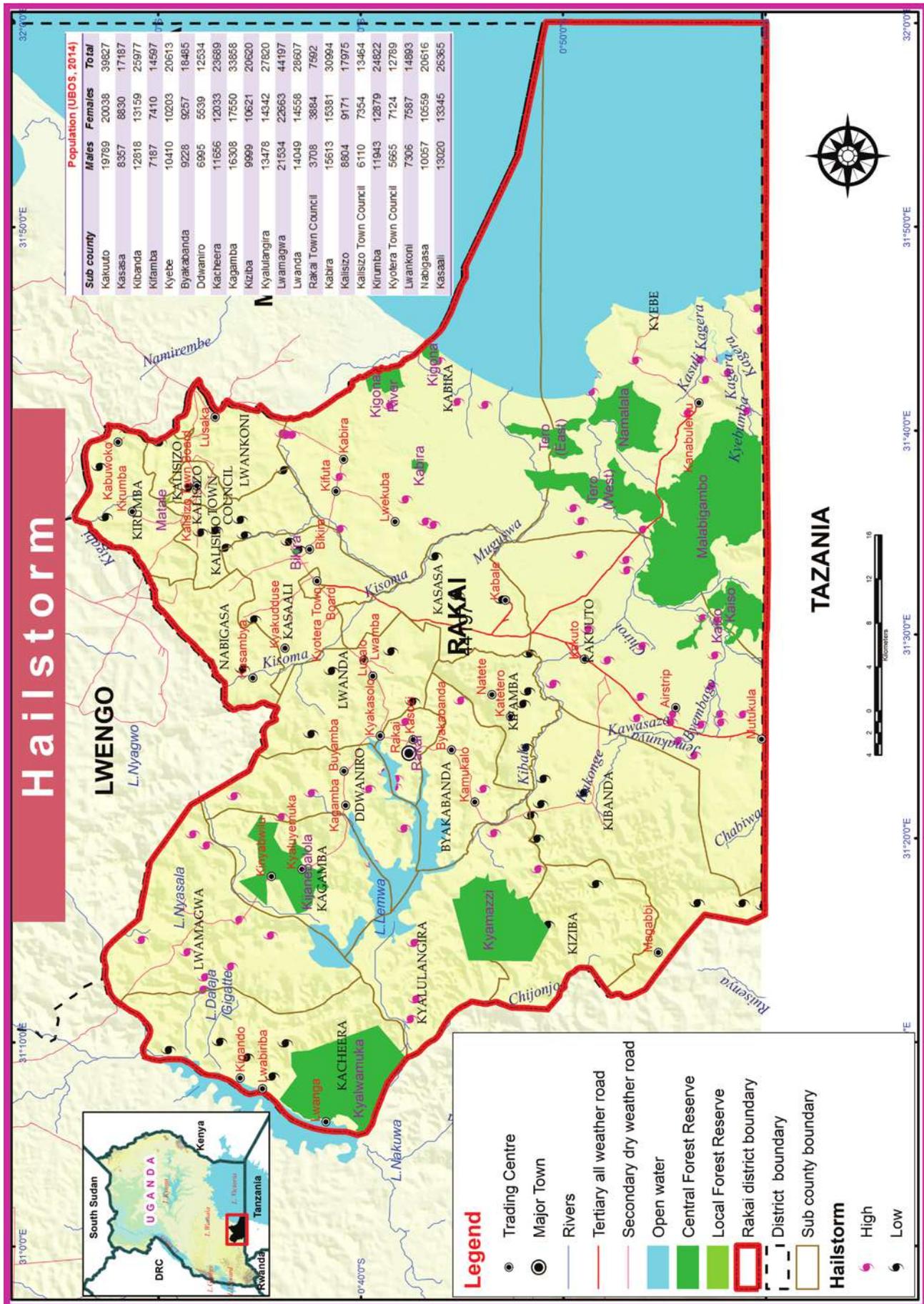


Figure 9: Distribution of hailstorms



3.2.13 Strong winds

The strong winds are normally experienced during the rainy season, but seasonal dry winds are experienced over the Lake Victoria zone during June and July. High deforestation rates and hilly landscape are major contributors to strong winds.

The communities become vulnerable due to poor early warning systems and low forest cover.

The adverse effects of hailstorms include destruction of crops, animals and property. Strong winds have been reported in all the Sub counties (figure 10).



Plate 7: A banana plantation affected by hailstorm in Dwaniro Sub county

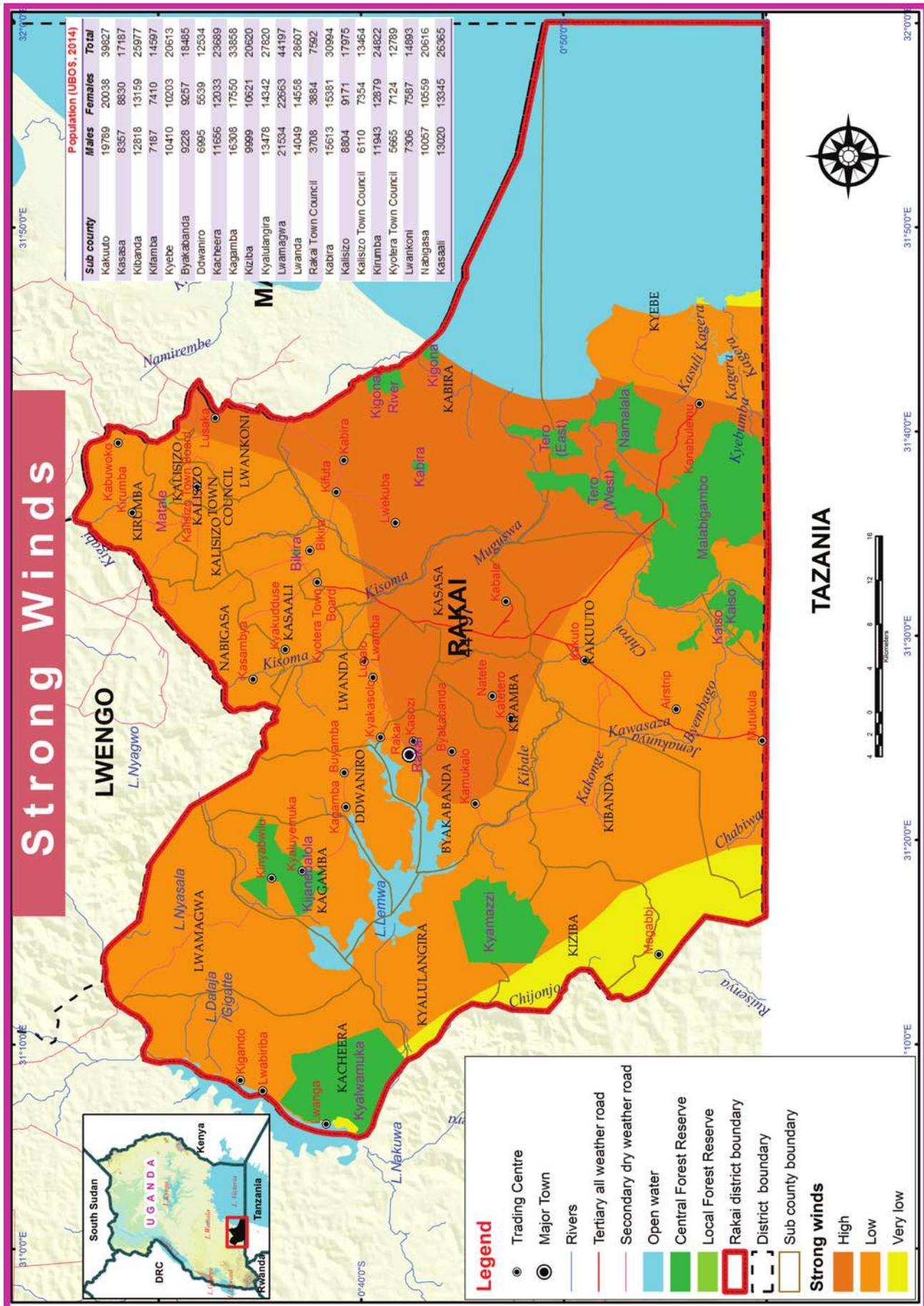


Figure 10: Strong winds levels



3.2.14 Invasive species

The occurrence of invasive species in the District is twofold: those that are land and water based. The invasions on land are mainly in farmlands while the water based can be seen on the lakes, rivers, ponds and wetlands. The frequency and severity of invasive species are determined by both natural and anthropogenic factors. In particular, the invasive species on land are a result of human and animal movements soil erosion, and dispersion by wind. The most significant species is *Lantana sp.* On water, the species are spread by strong winds and human activities, The water hyacinth (*Eichhornia sp*) is the most significant species.

Invasive species on land are quite aggressive and prolific which raises the cost of control in arable systems in comparison with the endemic weed species. On water the invasive weeds cause slow boat movement, increased biological oxygen demand (BOD) which in turn cause unfavourable conditions for fish stocks; high transport costs and blockage of fish landing sites among others.

Landbased invasive species are common in open rangelands in varying degrees in all sub-counties. The water species are mostly in Kyebe and Kabira Sub-counties. (figure 11).

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	Floods	<ul style="list-style-type: none"> • Digging of drainage trenches • Installation of road culverts • Sensitization of communities • Seasonal migrations of humans and livestock from flooded to drier areas 	<ul style="list-style-type: none"> • Early warning strategies Sensitization on wetland degradation • Implement physical planning and soil and water conservation measures • Protect wetland buffer zones
2	Drought	<ul style="list-style-type: none"> • Tree planting to increase atmospheric water vapour for rain formation • Planting drought tolerant crops • Agro forestry that includes shade trees • Food preservation and storage • Planting quick maturing crops • Practicing conservation agriculture • Rain water harvesting 	<ul style="list-style-type: none"> • Ensure disaster preparedness through the following; • Provision of tree seedlings • Food relief • Construction of water valley dams • Promote irrigation technologies • Diversify sources of livelihood • Construction of food storage facilities • Construction of more boreholes • Law enforcement on wetland degradation • Strengthen SWC practices • Environmental information and communication (EIC)
3	Pests, parasites and Diseases	<ul style="list-style-type: none"> • Crop rotation • Application of agrochemicals • Vaccination of livestock • Treatment of animals • Using disease tolerant varieties • Distribution of nets (mosquito and tsetse flies) 	<ul style="list-style-type: none"> • Strengthen farm advisory services community level • Strengthen farmer-based production and marketing approaches (e.g FID, bulk purchase of agro-chemicals, farmer subsidies) • Sensitization on control measures (IP&DM strategies) • Provide improved seed and stock • Regulate movement of crop and livestock products • Encourage sedentary livestock farming • Put in place diagnostic facilities (Labs, mobile clinics among others)
4	Invasive Species	<ul style="list-style-type: none"> • Mixed planting • Crop rotation • Uprooting • Planting tolerant crops • Sensitization 	<ul style="list-style-type: none"> • More research on invasive species • Regulation of movement of flora and fauna (Establish phyto and zoo sanitary centres) • Promote biological, manual and mechanical control of water weeds.
5	Hailstorms	<ul style="list-style-type: none"> • Tree planting 	<ul style="list-style-type: none"> • Provision of tree seedlings • Strengthen early warning systems • Disaster response actions (food relief, temporary shelters among others)

No	Multi-Hazards	Adaptation Responses	Recommendations
6	Soil erosion	<ul style="list-style-type: none"> • 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, particularly soil and water conservation practices • Agro-forestry • Provision of tree seedlings • Enforce environmental protection laws and regulations • Promote physical farm planning
7	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"> • Reducing the costs involved in acquiring land registration • Sensitization of the community on land ownership • Survey and demarcate private, public and institutional land. • Popularize the land policy and land Act • Strengthen local council courts
8	Wetland degradation	<ul style="list-style-type: none"> • Sensitization on the dangers of encroaching wetlands • Wetland demarcation • Practicing conservation agriculture 	<ul style="list-style-type: none"> • Strict enforcement of wetland laws • Diversify sources of livelihood e.g. Apiary • Improved irrigation technologies • Demarcation of wetlands • Water harvesting for agriculture
9	Road/water accidents	<ul style="list-style-type: none"> • Law enforcement • Installation of road signs • Road user sensitisation • Road maintenance • Wearing reflectors and helmets 	<ul style="list-style-type: none"> • Enforcement of traffic laws • Maintenance of roads • Strengthen driver/rider training and certification • Improve road design to include mapping of black spots • Promote use of water safety devices • Mechanical inspection and certification of vehicles.
10	Strong winds	<ul style="list-style-type: none"> • Planting trees as wind breaks • Planned constructions 	<ul style="list-style-type: none"> • Sensitization of the community on wind storm disaster mitigation
11	Bush fires	<ul style="list-style-type: none"> • Sensitization • Fire lanes 	<ul style="list-style-type: none"> • Enforce by-laws on bush fires • Increased sensitization
12	Human wildlife conflicts	<ul style="list-style-type: none"> • Community conservation areas • Use of scare crows • Boundary marking between farms and conservation areas • Conservation law enforcement • Trapping and hunting 	<ul style="list-style-type: none"> • Strengthen vermin control sector • Conduct massive awareness campaigns • Sensitization of the community • Re-gazetting encroached wild life habitats • Increasing the surveillance and early warning systems
13	Deforestation	<ul style="list-style-type: none"> • Use of energy saving devices • Sensitization • Tree planting • Law enforcement and evictions • Gazetting and rehabilitation of forests 	<ul style="list-style-type: none"> • More sensitization • Strengthen law enforcement • Increase resources to sectors involved in forest management • Promote community based tree nurseries

CHAPTER FOUR

4.1 Risk assessment

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

Table 6: Risk assessment of multi-hazards for Rakai 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>	
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	5	3	15	Kasasa, Kyebe, Kakuuto, Rakai Town Council
Droughts	5	4	20	Kakuuto, Kasasa, Kibanda, Kifamba, Kyebe, Byakabanda, Ddwaniro, Kacheera, Kagamba, Kiziba, Kyalulangira, Lwamagwa, Lwanda, Rakai Town Council, Kabira, Kalisizo, Kalisizo Town Council, Kirumba, Kyotera Town Council, Lwankoni, Nabigasa, Kasaali
Hail storms	3	4	12	Kakuuto, , Ddwaniro, Kacheera, Kagamba, Lwamagwa
Pests, parasites and diseases	5	4	20	Kakuuto, Kasasa, Kibanda, Kifamba, Kyebe, Byakabanda, Ddwaniro, Kacheera, Kagamba, Kiziba, Kyalulangira, Lwamagwa, Lwanda, Rakai Town Council, Kabira, Kalisizo, Kalisizo Town Council, Kirumba, Kyotera Town Council, Lwankoni, Nabigasa, Kasaali
Land conflicts	4	4	16	Kakuuto, Kasasa, Kibanda, Kifamba, Kyebe, Byakabanda, Ddwaniro, Kacheera, Kagamba, Kiziba, Kyalulangira, Lwamagwa, Lwanda, Rakai Town Council, Kabira, Kalisizo, Kalisizo Town Council, Kirumba, Kyotera Town Council, Lwankoni, Nabigasa, Kasaali

	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>	
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	
Strong winds	3	4	12	Kakuuto, Kasasa, Kibanda, Kifamba, Kyebe, Byakabanda, Ddwaniro, Kacheera, Kagamba, Kiziba, Kyalulangira, Lwamagwa, Lwanda, Rakai Town Council, Kabira, Kalisizo, Kalisizo Town Council, Kirumba, Kyotera Town Council, Lwankoni, Nabigasa, Kasaali
Invasive species	3	3	9	Kyebe, Kabira, Kyalulangira, Kakuuto, Kibanda, Kifamba, Kasasa, Kachera, Kasaali
Road, water accidents	4	4	16	Kirumba, Kalisizo, Kasaali, Kyotera, Kasasa, kakuuto, Kyebe, Kabira, Lwanda, Rakai T/C, Byakabanda, Kyalulangira, dwanir, Kagamba, Lwamaggwa, Kacheera
Soil erosion	5	4	20	Lwamagwa, Ddwaniro, Kacheera, Kagamba, Lwanda, Rakai Town Council, Kiziba, Kyalulangira, Byakabanda, Kibanda, Kyebe, Kifamba, Kakuuto,
Human wild life conflicts	4	3	12	Lwamagwa, Ddwaniro, Kacheera, Kagamba, Lwanda, Rakai Town Council, Kyalulangira, Kasasa, Kyebe, Kakuuto, Kabira
Bush fire	4	3	12	Lwamagwa, Kacheera, Rakai Town Council, Kiziba, Kyalulangira, Byakabanda, Kasasa, Kibanda, Kakuuto
Wetland degradation	4	4	16	Kakuuto, Kasasa, , Kifamba, Kyebe, Byakabanda, Ddwaniro, Kacheera, Kagamba, , Lwamagwa, Lwanda, Rakai Town Council, Kirumba, Kyotera Town Council, Kasaali
Deforestation	4	4	16	Kabira, Kyebe, Kacheera, Kagamba, Kyalulangira

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	Pests, parasites and diseases	30	1986-2016	12	40
2	Drought	20	1995-2016	2	20
3	Hailstorms	10	2006-2016	2	20
4	Bush fires	30	1986-2016	2	6
5	Invasive species	26	1990-2016	12	46
6	Human wildlife conflicts	30	1986-2016	12	40
7	Wetland degradation	30	1986-2016	12	40
8	Soil erosion	15	2001-2016	2	6
9	Strong winds	30	1986-2016	2	6
10	Land conflicts	30	1986-2016	12	40
11	Floods	19	1997-2016	2	950
12	Water, Road accidents	15	2001-2016	12	80
13	Deforestation	15	2001-2016	12	80

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 Rakai 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 inform 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, deforestation and land conflicts predispose the community to high vulnerability state in the Rakai District (table 8).

Table 8: Components of vulnerability in Rakai District

Vulnerability Components	Exposure	Elements at risk	Geographical Scale	Susceptibility	Geographical Scale	Resilience	Geographical Scale
Social components	Hazards					Coping strategies	
	Land conflicts	<ul style="list-style-type: none"> • Humans • Crops • Livestock 	District	<ul style="list-style-type: none"> • Loss of life and property • Displacement of people • Retards developments 	District	<ul style="list-style-type: none"> • Sensitise people on land developments and land use • Clearly demarcating and defining land owner ship • L.C. Courts • Land registration and certification 	District
	Invasive species	<ul style="list-style-type: none"> • Crops • Livestock • Fisheries 	Sub county	<ul style="list-style-type: none"> • -Interfere with water transport. • -Low crop yields • Loss of grazing and fishing grounds • Blockage of landing sites 	Sub county	<ul style="list-style-type: none"> • Integrated Pest Management (IPM) 	District
	Soil erosion	<ul style="list-style-type: none"> • Humans • Crops • Infrastructures like roads • Water reservoirs 	District	<ul style="list-style-type: none"> • Loss of soil fertility • Siltation of water bodies • Reduced water quality • Destruction of property • Spread of unwanted varieties of plants 	District	<ul style="list-style-type: none"> • Tree planting/agroforestry • Sensitization • Soil and water conservation practices • Restricting people to use lake shore lines 	District
	pests, parasites and diseases	<ul style="list-style-type: none"> • Humans • Livestock • Crops 	District	<ul style="list-style-type: none"> • Loss of livestock and crops • Reduced livestock and crop productivity 	District	<ul style="list-style-type: none"> • Vaccination • Application of agrochemicals • Sensitization • IP&DM Strategy • Mosquito nets • Alternative non-farm income sources 	District
	Hail storms	<ul style="list-style-type: none"> • Humans • Livestock • Crops 	District	<ul style="list-style-type: none"> • Loss of crops • Destruction of property 	District	<ul style="list-style-type: none"> • Provision of tree seedlings • Strengthen early warning systems • Disaster response actions (food relief, temporary shelters among others) 	District
	Wetland degradation	<ul style="list-style-type: none"> • Lakes/rivers • Crops • Humans 	District	<ul style="list-style-type: none"> • Flooding • Drying of water sources • Migration of wildlife • Diseases • Loss of water quality and quantity • Loss of grazing grounds • Conflicts over water use rights 	District	<ul style="list-style-type: none"> • Sensitisation through media • Enforcement of wetland laws • Demarcation of wetlands 	District



Vulnerability Components	Exposure	Elements at risk	Geographical Scale	Susceptibility	Geographical Scale	Resilience	Geographical Scale
Social components	Hazards	<ul style="list-style-type: none"> Human Livestock Road infrastructure 	District	<ul style="list-style-type: none"> Injuries (which may lead to disabilities) Loss of life Destruction of property 	District	<ul style="list-style-type: none"> Enforcement of traffic laws Maintenance of roads Strengthen driver/rider training and certification Improve road design to include mapping of black spots Promote use of water and road safety devices Mechanical inspection and certification of vehicles. Construction of humps and road signs 	District
	Floods/Water logging	<ul style="list-style-type: none"> Humans Livestock Crops Infrastructure including roads 	<ul style="list-style-type: none"> Sub county 	<ul style="list-style-type: none"> Spread of water-borne diseases Loss of soil fertility Displacement of people Accidents Food insecurity Poor Service delivery 	Sub county	<ul style="list-style-type: none"> Early warning strategies Sensitization on wetland degradation Implement physical planning and soil and water conservation measures Protect wetland buffer zones 	District
	Drought	<ul style="list-style-type: none"> Humans Livestock Crops 	Sub county	<ul style="list-style-type: none"> Food insecurity which may lead famine 	Sub county	<ul style="list-style-type: none"> Planting drought tolerant crops Sensitization Water harvesting and storage Promote soil and water conservation practices Tree planting Promote micro Irrigation 	District
	Human wild life conflicts	<ul style="list-style-type: none"> Crops Humans Livestock 	Sub county	<ul style="list-style-type: none"> Spread of diseases 	Sub county	<ul style="list-style-type: none"> Trapping Hunting Gazetting natural resources UWA intervention Strengthen vermin control sector 	District
	Deforestation	<ul style="list-style-type: none"> Humans 	Sub county	<ul style="list-style-type: none"> Loss of water quality Loss of source of forest wood products 	Sub county	<ul style="list-style-type: none"> Tree planting Use alternative sources of fuel like bio gas Use of energy saving stoves Community Awareness and sensitization 	Sub county



Vulnerability Components	Exposure	Elements at risk	Geographical Scale	Susceptibility	Resilience	Geographical Scale	
Social components	Hazards						
	Bush fires	<ul style="list-style-type: none"> • Crops • Livestock 	Sub county	<ul style="list-style-type: none"> • Fire lanes • Community sensitisation and awareness • Enforce bye-laws 	Sub county	Sub county	
	Strong winds	<ul style="list-style-type: none"> • Humans • Crops • Infrastructure including homes, schools and hospitals • Natural vegetation including trees 	District	<ul style="list-style-type: none"> • Increased plants, human and animal diseases 	<ul style="list-style-type: none"> • Promote afforestation • Establish community-level wind breaks 	District	
	Invasive species	<ul style="list-style-type: none"> • Crops • Livestock 	Sub county	<ul style="list-style-type: none"> • Low income due to reduced productivity • High costs of control • Increased costs of production 	<ul style="list-style-type: none"> • Promote Integrated Pest Management Strategy (IPM) 	Sub county	District
Economic component	Land conflicts	<ul style="list-style-type: none"> • Human population 	Sub county	<ul style="list-style-type: none"> • Retards personal and community development • High court expenses 	<ul style="list-style-type: none"> • Sensitize people on land developments and land use • Clearly demarcating and defining land owner ship • LC Courts • Acquiring land titles 	District	
	Wetland degradation	<ul style="list-style-type: none"> • Lakes and rivers • Human population 	District	<ul style="list-style-type: none"> • High water supply costs 	<ul style="list-style-type: none"> • Sensitization through mass media • Enforcement of wetland laws • Demarcation of wetlands 	District	
	pests, parasites and diseases	<ul style="list-style-type: none"> • Livestock • Crops 	District	<ul style="list-style-type: none"> • Loss of farm income • Loss of Government revenue • Increased expenditure on pesticides and drugs 	<ul style="list-style-type: none"> • Promote Integrated Pest Management Strategy (IPM) • Alternative income sources 	District	District
	Soil erosion	<ul style="list-style-type: none"> • Human population • Crops • Infrastructures like roads 	Sub county	<ul style="list-style-type: none"> • Increased cost of soil and water management on farm 	<ul style="list-style-type: none"> • Tree planting/agroforestry • Sensitization • Soil and water conservation practices • Restricting people to use lake shore lines 	District	District

Vulnerability Components	Exposure	Elements at risk	Geographical Scale	Susceptibility	Resilience	Geographical Scale
Economic component	Hazards	<ul style="list-style-type: none"> • Humans • Livestock • Crops 	District	<ul style="list-style-type: none"> • Loss of income • Loss of Government revenue 	<ul style="list-style-type: none"> • Provision of tree seedlings • Strengthen early warning systems • Disaster response actions (food relief, temporary shelters among others) 	District
	Drought	<ul style="list-style-type: none"> • Crops • Humans • Livestock 	Sub county	<ul style="list-style-type: none"> • Loss of income due to low productivity 	<ul style="list-style-type: none"> • Planting drought tolerant crops • Sensitization • Water harvesting and storage • Promote soil and water conservation practices • Tree planting • Promote micro Irrigation 	District
	Water, Road accidents	<ul style="list-style-type: none"> • Humans 	District	<ul style="list-style-type: none"> • High cost of medical attention and maintenance of damaged infrastructure 	<ul style="list-style-type: none"> • Enforcement of traffic laws • Maintenance of roads • Strengthen driver/rider training and certification • Improve road design to include mapping of black spots • Promote use of water safety devices • Mechanical inspection and certification of vehicles. 	District
	Water logging	<ul style="list-style-type: none"> • Humans • Livestock • Crops • Natural vegetation • Infrastructure including roads 	Sub county	<ul style="list-style-type: none"> • Loss of farm income • High cost of drainage 	<ul style="list-style-type: none"> • Early warning strategies • Sensitization on wetland degradation • Implement physical planning and soil and water conservation measures • Protect wetland buffer zones • Raising of roads by use of culverts • Eviction • Wetland restoration 	District
	Wetland degradation	<ul style="list-style-type: none"> • Crops, • Humans • Livestock 	District	<ul style="list-style-type: none"> • Increased incidences of water borne diseases • Degradation of water sources leading to high cost of safe water 	<ul style="list-style-type: none"> • Strict enforcement of wetland laws • Diversify sources of livelihood e.g. Apiary • Improved irrigation technologies • Demarcation of wetlands • Water harvesting for agriculture 	District



Vulnerability Components	Exposure	Elements at risk	Geographical Scale	Susceptibility	-	Resilience	Geographical Scale
Economic component	Hazards	Elements at risk	Geographical Scale	Potential impacts	-	Coping strategies	Geographical Scale
	Human wild life conflicts	<ul style="list-style-type: none"> • Crops • Humans and livestock 	Sub county	<ul style="list-style-type: none"> • Loss of income 	Sub county	<ul style="list-style-type: none"> • Promote community-based tourism and sport hunting 	District
	Deforestation	<ul style="list-style-type: none"> • Humans and livestock 	Sub county	Loss of tree cover	Sub county	<ul style="list-style-type: none"> • Promote multi-purpose tree planting (woodlots and community nurseries) 	Sub county
	Bush fires	<ul style="list-style-type: none"> • Crops • Biodiversity 	Sub county	<ul style="list-style-type: none"> • Low income 	Sub county	<ul style="list-style-type: none"> • Fire lanes • Community sensitisation and awareness • Enforce bye-laws 	Sub county
	Strong winds	<ul style="list-style-type: none"> • Humans, crops and livestock • Infrastructure including homes, schools and hospitals • Natural vegetation including trees 	District	<ul style="list-style-type: none"> • Low income • Loss of Government revenue 	District	<ul style="list-style-type: none"> • Afforestation • Constructing planned houses 	District
Environmental component	Invasive species	<ul style="list-style-type: none"> • Crops • Fisheries • Livestock • Biodiversity 	Sub county	<ul style="list-style-type: none"> • Contamination of habitats and farmlands 	Sub county	<ul style="list-style-type: none"> • Promote research into the epidemiology and management of the invasive species 	District
	Land conflicts	<ul style="list-style-type: none"> • Crops • Humans • Livestock 	District	<ul style="list-style-type: none"> • Loss of lives and property 	District	<ul style="list-style-type: none"> • Sensitise people on land developments and land use policies • Clearly demarcating and defining land owner ship • LC Courts • Land registration and certification 	District
	Wetland degradation	<ul style="list-style-type: none"> • Lakes and rivers 	District	<ul style="list-style-type: none"> • Loss of bio diversity • Drying/loss of water resources • Changes in the micro-climate 	District	<ul style="list-style-type: none"> • Strict enforcement of wetland laws • Use sustainable farming methods in wetlands e.g. Apiary • Demarcation of wetlands • Community sensitisation 	District

Vulnerability Components	Exposure	Elements at risk	Geographical Scale	Susceptibility	Resilience	Geographical Scale
Environmental component	Hazards	Elements at risk	Geographical Scale	Potential impacts	Coping strategies	Geographical Scale
	Soil erosion	<ul style="list-style-type: none"> • Crops and livestock • Infrastructures like roads 	Sub county	<ul style="list-style-type: none"> • Loss of vegetation cover including trees, and crops • Land degradation 	<ul style="list-style-type: none"> • Sensitization • Promote Soil and water conservation technologies 	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 	<ul style="list-style-type: none"> • Promote IPM approaches 	District
	Hailstorms	<ul style="list-style-type: none"> • Humans • Livestock • Crops 	District	<ul style="list-style-type: none"> • Destruction of crops, livestock and human dwellings 	<ul style="list-style-type: none"> • Strengthen early warning systems • Disaster response actions 	District
	Drought	<ul style="list-style-type: none"> • Human and livestock populations • Crops 	Sub county	<ul style="list-style-type: none"> • Wild fires • Straying of wildlife into human community zones • Outbreaks of diseases and pests 	<ul style="list-style-type: none"> • Soil and water conservation • Planting drought tolerant crops • Sensitization 	District
	Human wild life conflicts	<ul style="list-style-type: none"> • Crops • Humans and livestock 	Sub county	<ul style="list-style-type: none"> • Destruction of crops • Death of livestock 	<ul style="list-style-type: none"> • Promote community-based ecotourism • Strengthen UWA's and the District Vermin sector's rapid response strategy to stray wildlife 	District
	Strong winds	<ul style="list-style-type: none"> • Humans, • Crops • Infrastructure including homes, schools and hospitals • Natural vegetation including trees 	District	<ul style="list-style-type: none"> • Destruction of crops 	<ul style="list-style-type: none"> • Afforestation • Constructing planned buildings • Early warning systems 	District
	Deforestation	<ul style="list-style-type: none"> • Human and wild life 	Sub county	<ul style="list-style-type: none"> • Loss of biodiversity • Soil degradation 	<ul style="list-style-type: none"> • Tree planting • Use alternative sources of fuel like bio gas • Use of energy saving stoves • Community Sensitisation 	Sub county
	Bush fires	<ul style="list-style-type: none"> • Crops • Biodiversity 	Sub county	<ul style="list-style-type: none"> • Loss of bio diversity • Destruction of crops • Migration of wildlife 	<ul style="list-style-type: none"> • Fire lanes • Community sensitisation and awareness • Enforce bye-laws 	Sub county



Vulnerability Components	Exposure	Elements at risk	Geographical Scale	Susceptibility	Resilience	Geographical Scale
Environmental component	Hazards	<ul style="list-style-type: none"> Human Livestock Crops Natural vegetation Infrastructure including roads 	Sub-county	<ul style="list-style-type: none"> Potential impacts Loss of bio diversity Destruction of crops 	<ul style="list-style-type: none"> Early warning strategies Sensitization on wetland degradation Implement physical planning and soil and water conservation measures Raising of roads by use of culverts Eviction Wetland restoration 	District
		<ul style="list-style-type: none"> Crops Livestock Fisheries Biodiversity Infrastructure like landing sites 	Sub county	<ul style="list-style-type: none"> Reduce fish stocks due to habitat degradation Colonise habitats for other organisms Blocakage of water ways and landing sites 	<ul style="list-style-type: none"> Destruction through physical elements of integrated pest management Bio control approach 	District
Physical components		<ul style="list-style-type: none"> Humans, livestock and crops Natural vegetation 	District	<ul style="list-style-type: none"> Loss of crops livestock and humans and natural vegetation 	<ul style="list-style-type: none"> Destruction of through physical elements of integrated pest management 	District
		<ul style="list-style-type: none"> Lakes, rivers, domestic water sources and biodiversity Human population 	District	<ul style="list-style-type: none"> Drying of water sources Bio diversity destruction 	<ul style="list-style-type: none"> Enforcement of wetland laws Diversify sources of livelihood e.g. Apiary Improved irrigation technologies Demarcation of wetlands Water harvesting for agriculture 	District
		<ul style="list-style-type: none"> Crops Infrastructures like roads 	District	<ul style="list-style-type: none"> Loss of crops and fertile soil Siltation of water bodies Degradation of micro-habitats Destruction of property and infrastructure 	<ul style="list-style-type: none"> Sensitization of the farmers on proper farming methods, particularly soil and water conservation practices Agro-forestry Enforce environmental protection laws and regulations Promote physical farm planning 	District

Vulnerability Components	Exposure	Elements at risk	Geographical Scale	Susceptibility	Geographical Scale	Resilience	Geographical Scale
Physical components	Hazards						
	Water, Road accidents	<ul style="list-style-type: none"> • Humans, property and livestock 	District	<ul style="list-style-type: none"> • Human injuries and loss of property and infrastructure 	District	<ul style="list-style-type: none"> • Enforcement of traffic laws • Maintenance of roads • Strengthen driver/rider training and certification • Improve road design to include mapping of black spots • Promote use of water safety devices • Mechanical inspection and certification of vehicles. 	District
	Hailstorms	<ul style="list-style-type: none"> • Humans • Livestock • Crops • Human dwellings 	District	<ul style="list-style-type: none"> • Physical injuries and loss of lives • Destruction of crops, property and infrastructure 	District	<ul style="list-style-type: none"> • Strengthen early warning systems • Strengthen disaster response actions 	District
	Land conflicts	<ul style="list-style-type: none"> • Humans, livestock, crops, and property 	Sub county	<ul style="list-style-type: none"> • Loss of lives and property • Displacement of people 	District	<ul style="list-style-type: none"> • Sensitize people on land developments and land use policies • Clearly demarcating and defining land owner ship • LC Courts • Land registration and certification 	District
	Drought	<ul style="list-style-type: none"> • Humans, crops and livestock Biodiversity 	District	<ul style="list-style-type: none"> • Loss of livestock and crops • Loss of vegetation cover • Receding of water levels 	Sub county	<ul style="list-style-type: none"> • Planting drought tolerant crops • Sensitization • Water harvesting and storage • Promote soil and water conservation practices • Tree planting • Promote micro Irrigation 	District
	Floods/Water logging	<ul style="list-style-type: none"> • Human, crops and livestock • Infrastructure including roads 	Sub county	<ul style="list-style-type: none"> • Loss of bio diversity • Destruction of crops • Blockage of delivery and access to social services • Spread of human, livestock and pests, parasites and diseases 	Sub county	<ul style="list-style-type: none"> • Early warning strategies • Sensitization on wetland degradation • Implement physical planning and soil and water conservation measures • Protect wetland buffer zones 	District



Vulnerability Components	Exposure	Elements at risk	Geographical Scale	Susceptibility	-	Resilience	Geographical Scale
Physical components	Hazards	<ul style="list-style-type: none"> • Crops • -Humans and livestock 	Sub county	<ul style="list-style-type: none"> • Reduce fish stocks due to habitat degradation • Colonise habitats for other organisms • Blockage of water ways and landing sites 	Sub county	<ul style="list-style-type: none"> • Strengthen UWA's and the District Vermin sector's rapid response strategy to stray wildlife • Lay traps to capture straying animals • Promote sport hunting • Gazette natural resources 	District
	Strong winds	<ul style="list-style-type: none"> • Humans, crops • Infrastructure including homes, schools and hospitals • Natural vegetation including trees 	District	<ul style="list-style-type: none"> • Destruction of crops and social infrastructure like homes, schools, hospitals and places of worship 	District	<ul style="list-style-type: none"> • Afforestation • Constructing planned buildings • Early warning systems 	District
	Deforestation	<ul style="list-style-type: none"> • Humans and livestock 	Sub county	<ul style="list-style-type: none"> • Escalation of human-wildlife conflicts • Escalation of soil erosion • Loss of tree cover and other biodiversity 	Sub county	<ul style="list-style-type: none"> • Promote multi-purpose tree planting (woodlots and community nurseries) 	Sub county
	Bush fires	<ul style="list-style-type: none"> • Crops, grazing lands and biodiversity 	Sub county	<ul style="list-style-type: none"> • Loss of bio diversity • Destruction of crops and grazing lands • Migration of wildlife • Loss of property 	Sub county	<ul style="list-style-type: none"> • Fire lanes • Community sensitization and awareness • Enforce bye-laws 	Sub county
	Wetland degradation	<ul style="list-style-type: none"> • Lakes, rivers, domestic water sources and biodiversity • Human population 	District	<ul style="list-style-type: none"> • Drying of water sources • Biodiversity destruction • Facilitates flooding 	District	<ul style="list-style-type: none"> • Strict enforcement of wetland laws • Diversify sources of livelihood e.g. Apiary • Improved irrigation technologies • Demarcation of wetlands • Water harvesting for agriculture 	District



CONCLUSION AND RECOMMENDATION

It was established that Rakai District has over the last 35 years increasingly experienced multi-hazards including floods, drought, invasive species, strong winds, human and wildlife conflicts, pests, parasites and diseases for crops and livestock, soil erosion, land conflicts, 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 Rakai District increase their vulnerability to multi-hazard exposure necessitating urgent external support.

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

- i. Geomorphological and geological hazards including soil erosion
- ii. Climatological or hydro-meteorological including flash floods, hailstorms, 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 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 Disaster Risk 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 capacity of District disaster committees by developing guidelines and providing trainings
- viii. Fund and equip extension workers
- ix. Establish a fund aimed at Disaster Preparedness and Management at District levels
- x. Increase funding and staff to monitor wetland degradation and non-genuine agro-inputs
- xii. Support establishment of a disaster risk early warning systems
- xiii. Provide support in form of free seedlings to promote afforestation and reforestation programmes

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