

# **BUKWO DISTRICT** Hazard, Risk And Vulnerability Profile



#### ACKNOWLEDGEMENT

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 Mr. Kirungi Raymond, Disaster Preparedness Officer and the team of consultants (GIS/DRR specialists); Dr. Bernard Barasa, and Mr. Nsiimire Peter, who provided technical support.

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My appreciation also goes to Bukwo District Team:

- 1. Sikor Mella Stephen District Natural Resources Officer
- 2. Epido Francis District Production 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**

The multi-hazard vulnerability profile outputs from this assessment was a combination of spatial modeling using socio-ecological spatial layers (i.e. DEM, Slope, Aspect, Flow Accumulation, Land use, vegetation cover, hydrology, soil types and soil moisture content, population, socio-economic, health facilities, accessibility, and meteorological data) and information captured from District Key Informant interviews and Sub-county FGDs using a participatory approach. The level of vulnerability was assessed at Sub-county participatory engagements and integrated with the spatial modeling in the GIS environment. The methodology included five main procedures i.e.

#### Preliminary spatial analysis

Hazard prone areas base maps were generated using Spatial Multi-Criteria Analysis (SMCA) was done in a GIS environment (ArcGIS 10.1).

#### Stakeholder engagements

Stakeholder engagements were carried out in close collaboration with OPM's DRM team and the District Disaster Management focal persons with the aim of identifying the various hazards ranging from drought, floods, landslides, human and animal disease, pests, animal attacks, earthquakes, fires, conflicts etc. Stakeholder engagements were done through Focus Group Discussions (FGDs) and key informant interviews guided by checklist tools (Appendix I). At District level Key Informants included: District Agricultural Officer, District Natural Resources Officer, District Health Inspector and District Planner while at Sub-county level Key informants included: Sub-county and Parish chiefs, community Development mobilizers and health workers.

FGDs were carried out in five purposively selected Sub-counties that were ranked with highest vulnerability. FGDs comprising of an average of 12 respondents (crop farmers, local leaders, nursing officers, police officers and cattle keepers) were conducted at Bukwo, Senendet, Kabei and Sub-counties. Each Parish of the selected Sub-counties was represented by at least one participant and the selection of participants was engendered. FGDs were conducted with utmost consideration to the various gender categories (women, men) with respect to age groups since hazards affect both men and women though in different perspectives irrespective of age.

#### **Participatory GIS**

Using Participatory GIS (PGIS), local communities were involved in identifying specific hazard prone areas on the Hazard base maps. This was done during the FGDs and participants were requested through a participatory process to develop a community hazard profile map.

# Geo-referencing and ground-truthing

The identified hazard hotspots in the community profile maps were ground-truthed and geo-referenced using a handheld Spectra precision Global Positioning System (GPS) unit, model: Mobile Mapper 20 set in WGS 1984 Datum. The entities captured included: hazard location, (Sub-county and Parish), extent of the hazard, height above sea level,

slope position, topography, neighboring land use among others. Hazard hot spots, potential and susceptible areas will be classified using a participatory approach on a scale of "not reported/ not prone", "low", "medium" and "high".

# Data analysis and integration

Data analysis and spatial modeling was done by integrating spatial layers and non-spatial attribute captured from FGDs and KIIs to generate final HRV maps at Sub-county level.

# Data verification and validation

In collaboration with OPM, a-five-day regional data verification and validation workshop was organized by UNDP in Mbale Municipality as a central place within the region. This involved key District DDMC focal persons for the purpose of creating local/District ownership of the profiles.

Multi-hazards experienced in Bukwo District were classified as:

- Geomorphological or Geological hazards including; landslides, rock falls, soil erosion and earth quakes.
- Climatological or Meteorological hazards including; floods, drought, hailstorms, strong winds and lightning
- Ecological or Biological hazards including crop pests and diseases, livestock pests and diseases, human disease outbreaks, vermin, wildlife animal attacks and invasive species.
- Human induced or Technological hazards including; bush fires, road accidents land conflicts.

General findings from the participatory assessment indicated that Bukwo District has over the past two decades increasingly experienced hazards including; landslides, rock falls, soil erosion, floods, drought, hailstorms, strong winds, lightning, crop pests and diseases, livestock pests and diseases, human disease outbreaks, vermin, wildlife animal attacks, invasive species, bush fires, road accidents and land conflicts putting livelihoods at increased risk. Landslides and floods were identified as most serious problems in Bukwo District with almost all Sub-counties being vulnerable to the hazards. This is due to its rugged terrain with a slope percentage rise (20+) which makes it vulnerable to landslides, but also the area is relatively flat with slope percentage rise (0-2) which is very prone to flooding in case of heavy rains.

The limited adaptive capacity (and or/resilience) and high sensitivity of households and communities in the District increase their vulnerability to hazard exposure necessitating urgent external support. To reduce vulnerability at community, local Government and national levels should be a threefold effort hinged on:

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

The following were recommended policy actions targeting vulnerability reduction:

- The Government should improve enforcement of policies aimed at enhancing sustainable environmental health.
- The Government through MAAIF should review the animal diseases control act because of low penalties given to defaulters.
- The Government should establish Systems to motivate support of political leaders toward Government initiatives and Programmemes aimed at disaster risk reduction.
- The Government should increase awareness campaigns aimed at sensitizing farmers/ communities on disaster risk reduction initiatives and practices.
- The Government should revive disaster committees at District level and ensure funding of disaster and environmental related activities.
- The Government through UNRA and the District Authority should fund periodic maintenance of feeder roads to reduce on traffic accidents.
- The Government through MAAIF and the District Production Office should promote drought and disease resistant crop seeds.
- The Government through OPM and Meteorology Authority should increase importation of lightning conductors and also reduce taxes on their importation.
- The Government through OPM and Meteorology Authority should support establishment of disaster early warning Systems.
- The Government through MWE increase funding and staff to monitor wetland degradation and non-genuine agro-inputs.
- The Government through OPM should improve communication between the disaster department and local communities.
- The Government through MWE should promote Tree planting along road reserves.
- The Government through MAAIF should fund and recruit extension workers at Sub-county level and also facilitate them.

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# LIST OF ACRONYMS

BBW	Banana Bacterial Wilt
DDMC	District Disaster Management Committee
DEM	Digital Elevation Model
DLG	District Local Government
DRM	Disaster Risk Management
DWD	Directorate of Water Development
DWRM	Directorate of Water Resources Management
ENSO	El Niño Southern Oscillation
FGD	Focus Group Discussion
GIS	Geographical Information Systems
HRV	Hazard Risk Vulnerability
KII	Key Interview Informant
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
MWE	Ministry of Water and Environment
NCCP	National Climate Change Policy
OPM	Office of the Prime Minister
PGIS	Participatory GIS
SMCA	Spatial Multi-criteria Analysis
STRM	Shuttle Radar Topography Mission
UBOS	Uganda Bureau of Statistics
UNDP	United Nations Development Programme
UNRA	Uganda National Roads Authority
UTM	Universal Transverse Mercator
WGS	World Geodetic System

#### **DEFINITION OF KEY TERMS**

**Climate change:** Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer).

**Drought:** The phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production Systems.

**El Niño:** El Niño, in its original sense, is warm water current that periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. This oceanic event is associated with a fluctuation of the inter tropical surface pressure pattern and circulation in the Indian and Pacific Oceans, called the Southern Oscillation. This coupled atmosphere-ocean phenomenon is collectively known as El Niño Southern Oscillation, or ENSO. During an El Niño event, the prevailing trade winds weaken and the equatorial countercurrent strengthens, causing warm surface waters in the Indonesian area to flow eastward to overlie the cold waters of the Peru Current. This event has great impact on the wind, sea surface temperature, and precipitation patterns in the tropical Pacific. It has climatic effects throughout the Pacific region and in many other parts of the world. The opposite of an El Niño event is called La Niña.

Flood: An overflowing of a large amount of water beyond its normal confines.

**Food insecurity:** A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level. Food insecurity may be chronic, seasonal, or transitory.

Impact: Consequences of climate change on natural and human Systems.

**Risk:** The result of the interaction of physically defined hazards with the properties of the exposed Systems i.e., their sensitivity or vulnerability.

**Susceptibility:** The degree to which a System is vulnerable to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

**Semi-arid:** EcoSystems that have more than 250 mm precipitation per year but are not highly productive; usually classified as rangelands.

**Vulnerability:** The degree of loss to a given element at risk or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude and expressed on a scale from 0 (no damage) to 1 (total damage)" (UNDRO, 1991) or it can be understood as the conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of community to the impact of hazards "(UN-ISDR 2009.)

Also Vulnerability can be referred to as the potential to suffer harm or loss, related to the capacity to anticipate a hazard, cope with it, resist it and recover from its impact. Both vulnerability and its antithesis, resilience, are determined by physical, environmental, social, economic, political, cultural and institutional factors" (J. Birkmann, 2006)

**Hazard:** A physically defined source of potential harm, or a situation with a potential for causing harm, in terms of human injury; damage to health, property, the environment, and other things of value; or some combination of these (UNISDR, 2009).

# INTRODUCTION

# 1.1 Background

Uganda has over the past years experienced frequent disasters that range from drought, to floods, landslides, human and animal diseases, pests, animal attacks, earthquakes, fires, conflicts and other hazards which in many instances resulted in deaths, property damage and losses of livelihood. With the increasing negative effects of hazards that accompany population growth, development and climate change, public awareness and pro-active 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 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 encourage mainstreaming of disaster and climate 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 the sub-regions of Rwenzori, Karamoja, Teso, Lango, Acholi and West Nile covering 42 Districts. During the above exercise, local Government officials and community members have actively participated in data collection and analysis. The data collected was used to generate hazard risk and vulnerability maps and profiles. Validation workshops were held in close collaboration with Ministries, District Local Government (DLG), Development Partners, Agencies and academic/research institutions. The developed maps show the geographical distribution of hazards and vulnerabilities up to Sub-county level of each District. The analytical approach to identify risk and vulnerability to hazards in the pilot sub-regions visited of Rwenzori and Teso was improved in subsequent sub-regions.

This final draft report details methodological approach for HRV profiling and mapping for Bukwo District in Eastern Uganda.

# **1.2 Objectives of the study**

The following main and specific objectives of the study were indicated:

# 1.2.1 Main objective

The main objective of the study was to develop Multi-hazard, Risk and Vulnerability Profile for Bukwo District, Eastern Uganda.

# 1.2.2 Specific Objectives

In fulfilling the above mentioned main objective the following are specific objectives as expected:

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- i. Collect and analyze field data generated using GIS in close collaboration and coordination with OPM.
- ii. Develop District specific multi-hazard risk and Vulnerability profile using a standard methodology.
- iii. Preserve the spatial data to enable use of the maps for future information.
- iv. Produce age and sex disaggregated data in the HRV maps.

# 1.3 Scope of Work

Through UNDP's Project: *"Strengthening Capacities for Disaster Risk Management and Resilience Building"* the scope of work entailed following:

- i. Collection of field data using GIS in close collaboration and coordination with OPM in Bukwo District and quantify them through a participatory approach on a scale of "not reported/ not prone", "low", "medium" and "high".
- ii. Analysis of field data and review the quality of each hazard map which should be accompanied by a narrative that lists relevant events of their occurrence. Implications of hazards in terms of their effects on stakeholders with the vulnerability analysis summarizing the distribution of hazards in the District and exposure to multi-hazards in Sub-counties.
- iii. Compilation of the entire District multi-hazard, risk and vulnerability HRV Profiles in the time frame provided.
- iv. Generating complete HRV profiles and maps and developing a database for all the GIS data showing disaggregated hazard risk and vulnerability profiles to OPM and UNDP.

# **1.4 Justification**

The Government recognizes climate change as a big problem in Uganda. The draft National Climate Change Policy (NCCP) notes that the average temperature in semi-arid climates is rising and that there has been an average temperature increase of 0.28°C per decade in the country between 1960 and 2010. It also notes that rainfall patterns are changing with floods and landslides on the rise and are increasing in intensity, while droughts are increasing, and now significantly affect water resources, and agriculture (MWE, 2012). The National Policy for Disaster Preparedness and Management (Section 4.1.1) requires the Office of the Prime Minister to "Carry out vulnerability assessment, hazard and risk mapping of the whole country and update the data annually". UNDP's DRM project 2015 Annual Work Plan; Activity 4.1 is "Conduct national hazard, risk and vulnerability (HRV) assessment including sex and age disaggregated data and preparation of District profiles."

#### 1.5 Structure of the Report

This Report is organized into five Chapters: Chapter 1 provides Introduction on the assignment. Section 2 elaborates on the overview of Bukwo District. Chapter 3 focuses on the methodology employed. Chapter 4 elaborates the Multi-hazard, Risks and Vulnerability profile and Coping strategies for Bukwo District. Chapter 5 describes Conclusions and policy related recommendations.

#### **OVERVIEW OF BUKWO District**

#### 2.1 Location

Bukwo District was carved out of Kapchorwa District in July 2005. It is located between coordinates: 1° 16' 0" N and 34° 44' 0" E situated on the slopes of Mt. Elgon in Eastern Uganda. Bukwo District is bordered by Amudat District to the north, Kenya to the east and south, and Kween District to the west and northwest. The District has a total area of about 528 km<sup>2</sup> and a third of the land area is under Mt. Elgon National Park, another third is under Agriculture and settlement, while the other part has been left vacant due to the effect of the cattle rustling problem which has resulted into migration of the natives to safer places either within or outside the District/ country. However, with the improving security people have started resettling. The District has 11 Sub-counties and 1 town Council. These include; Bukwo, Chepkwasta, Chesower, Kabei, Kaptererwo, Kortek, Riwo, Senendet, Suam, Kamet and Tulel Sub-counties and Bukwo Town Council (Figure 1).



Figure 1: Administrative Boundaries and Protected area; Bukwo District

#### 2.1.1 Geomorphology

Topographically most of the land is located on the Mountain Elgon with altitude ranging between 1200 – 4500 m.a.s.l. The land on the lower side of the District which is also the north eastern is fairly flat while that towards the mountain is rugged. The District has also got rich and fertile volcanic soils derived agglomerate from Mount Elgon. Figure 2 presents the relief of Bukwo District.



Figure 2: Geomorphology; Bukwo District

# 2.1.2 Geology and Soils

Currently exploration is ongoing to ascertain quantities of vermiculate. Gold is being mined on a small scale in Riwo hills and Kapsama, since they stretch from Karamoja region where gold mining also takes places on a small scale.



Figure 3: Geology and Lithological Structures, Bukwo District

#### 2.1.3 Vegetation and Land use Stratification;

Bukwo District is characterized by a number of land uses which include; Tropical High Forests well stocked in the Sub-counties of Suam, Chepkwasta and Chesower. Broad leaved tree plantations especially in the areas of Chesower Sub-county in the western part of the District. Other land uses in the District are; commercial farmlands, subsistence farming, coniferous plantations, woodland, built up areas, bush land among others. Figure 4 presents the Land use stratification, Bukwo District.



Figure 4: Land use stratification, Bukwo District

## 2.1.4 Temperature and Humidity

The temperatures are generally low because of the high altitude on the upper part while generally high on the lower areas. The climate of Bukwo is humid tropical with a fairly uniform average temperature of 23.0 °C throughout the year, as expected; temperatures are lower because of the high altitude on the upper part while generally high temperatures on the lower areas. The relative humidity is higher during rain seasons with maximum levels prevalent in May. The lowest humidity levels occur in dry seasons with minimum levels occurring in February. The average monthly humidity is between 82% and 96%.

Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
At 0600Z	83	82	85	86	88	89	89	88	87	88	86	84
At 1200Z	86	84	83	87	91	91	93	93	93	96	86	85

Source: Buginyanya Met. Station (2014): Data from Meteorology Department

#### 2.1.5 Wind

The long-term wind speed records from the Global Weather Data Website (1979 - 2014) indicate average annual wind speeds of 2 knots and 3 knots at 0600 hours and 1200 hours, for Mbale. The wind speed values indicated, therefore, represent conditions of moderate to strong or turbulent conditions. The average number of calms experienced in the area, are indicated to be experienced for 99days at 0600 hours, and 27 days at 1200 hours, respectively, at Mbale. The general conclusion from these climatic figures is that for most of the year, Mbale experiences moderate to strong and gusty winds, increasing in the afternoon.

# 2.1.6 Rainfall

The District experiences a mono-modal rainfall pattern with an average of 920 – 1650 mm per annum. There is one long rainy season commencing from March/April and ending in October/November with the peak season in the months of June and August.

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Figure 5: Total Annual Rainfall Distribution, Bukwo District

#### 2.1.7 Hydrology

Bukwo District is characterized by a number of numerous rivers which include; Alalam, Kiriki and Siti in the northern part of the District. Other rives are; Riwa, Chamangen, Nyalut, Amanyang, and Saum among others. Figure 2 (refer to page 22) presents some of the main rivers in Bukwo District.

#### 2.1.8 Population

According to the National Population and Housing Census (2014) results, Bukwo District had a total population of 89,253 people. Results also showed that most of the people in Bukwo District reside in rural areas (81,567 (91.4%) compared to (7,686(8.6%) who reside in urban centers. The gender distribution was reported to be males: 44,770 (50.2%) and females: 44,483 (49.8%). About 99.3% (88,657) of the population form the household population and only 0.7% (596) is Non-household. Suam Sub-county had the highest population of 10,694 people while Tulel Sub-county had the least population of 5,238 people (Figure 6). Table 1 shows the population distribution per Sub-county for the different gender.

	HOUSEHOLDS POPULATION				
Sub-county	Number	Average Size	Males	Females	Total
Bukwo	1468	5.6	4276	4205	8481
Bukwo Town Council	1406	5.4	3825	3861	7686
Chepkwasta	1521	5.6	4259	4302	8561
Chesower	1162	5.7	3348	3279	6627
Kabei	1204	5.2	3147	3216	6363
Kamet	971	5.4	2675	2584	5259
Kaptererwo	1772	5	4447	4362	8809
Kortek	1043	5.5	2891	2945	5836
Riwo	1305	5.3	3563	3332	6895
Senendet	1507	5.8	4345	4459	8804
Suam	2294	4.7	5420	5274	10694
Tulel	946	5.5	2574	2664	5238

# Table 1: Population Distribution in Bukwo District

Source: UBOS Census 2014



Figure 6: Population Distribution, Bukwo District

#### 2.1.9 Economic activities

The majority of households in Bukwo District are involved in market oriented agriculture where cultivation of food crops such as maize, beans, cassava, Irish potatoes, bananas, wheat and barley is dominant. Livestock farming is also practiced and the animals reared include cattle, goats, pigs, sheep and chicken. There is also gold mining at small scale in the Riwo hills in northern part of the District. In the recent past, there has been emergence of athletics as one of the major activities in the District.

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# METHODOLOGY

## 3.1 Collection and analysis of field data using GIS

#### 3.1.1 Preliminary spatial analysis

Hazard prone areas base maps were generated using Spatial Multi-Criteria Analysis (SMCA) basing on numerical models and guidelines using existing environmental and socioecological spatial layers (i.e. DEM, Slope, Aspect, Flow Accumulation, Land use, vegetation cover, hydrology, soil types and soil moisture content, population, socio-economic, health facilities, accessibility, and meteorological data) in a GIS environment (ArcGIS 10.1).

#### 3.1.2 Stakeholder engagements

Stakeholder engagements were carried out in close collaboration with OPM's DRM team and the District Disaster Management focal persons with the aim of identifying the various hazards ranging from drought, to floods, landslides, human and animal disease, pests, animal attacks, earthquakes, fires, conflicts etc. Stakeholder engagements were done through Focus Group Discussions (FGDs) and key informant interviews guided by checklist tools (Appendix I). At District level, One Key Informant Interview comprising of two respondents (District Agricultural Extension Officer and Sub-county Extension Officer) was held at Bukwo District Headquarters (WGS 1984 UTM Zone 36N: 693544E, 142510N). At Sub-county level Key informants included: Sub-county and Parish chiefs, community Development mobilizers and health workers.

FGDs were carried out in four purposively selected Sub-counties that were ranked with highest vulnerability. FGDs comprising of an average of 12 respondents (crop farmers, local leaders, nursing officers, police officers and cattle keepers) were conducted at Bukwo Sub-county (WGS 1984 UTM Zone 36N: 695625E, 142482N), Senendet Sub-county (WGS 1984 UTM Zone 36N: 693435E, 138020N), Kabei Sub-county (WGS 1984 UTM Zone 36N: 693435E, 138020N), Kabei Sub-county (WGS 1984 UTM Zone 36N: 689939E, 145333N) and Chesower Sub-county (WGS 1984 UTM Zone 36N: 683690E, 148285N. Each Parish of the selected Sub-counties was represented by at least one participant and the selection of participants was engendered. FGDs were conducted with utmost consideration to the various gender categories (women, men) with respect to age groups since hazards affect both men and women though in different perspectives irrespective of age. This allowed for comprehensive representation as well as provision of detailed and verifiable information.

Focus Group discussions and Key Informant Interviews were transcribed in the field for purposes of input into the NVIVO software for qualitative data analysis. Case stories and photographs were documented and captured respectfully. In order to produce age and sex disaggregated data, results from FGDs and KIIs were integrated with the District population census data. This was also input in the multi-hazard, risk and vulnerability profile maps.

## 3.1.3 Participatory GIS

Using Participatory GIS (PGIS), local communities were involved in identifying specific hazards prone areas on the Hazard base maps. This was done during the FGDs and participants were requested through a participatory process to develop a community hazard profile map.

# 3.1.4 Geo-referencing and ground-truthing

The identified hazard hotspots in the community profile maps were ground-truthed and geo-referenced using a handheld Spectra precision Global Positioning System (GPS) unit, model: Mobile Mapper 20 set in WGS 1984 Datum. The entities captured included: hazard location, (Sub-county and Parish), extent of the hazard, height above sea level, slope position, topography, neighboring land use among others (Appendix I). Hazard hot spots, potential and susceptible areas will be classified using a participatory approach on a scale of "not reported/ not prone", "low", "medium" and "high". This information generated through a participatory and transect approach was used to validate modelled hazard, risk and vulnerability status of the District. The spatial extent of a hazard event was established through modelling and a participatory validation undertaken.

# 3.2 District Specific Multi-hazard Risk and Vulnerability Profiles

# 3.2.1 Data analysis and integration

Data analysis and spatial modeling was done by integrating spatial layers and non-spatial attribute captured from FGDs and KIIs to generate final HRV maps at Sub-county level. Spatial analysis was done using ArcGIS 10.1 to generate specific hazard, risk and vulnerability profile for the District.

# 3.2.2 Data verification and validation

In collaboration with OPM, a five days regional data verification and validation workshop was organized by UNDP in Mbale Municipality as a central place within the region. This involved key District DDMC focal persons for the purpose of creating local/District ownership of the profiles.

# 3.3 Preserve the spatial data to enable future use of the maps

HRV profiles report and maps have been verified and validated, final HRV profiles inventory and geo-database have been prepared containing all GIS data in various file formats to enable future use of the maps.

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# **RESULTS FROM MULTI-HAZARD RISK, VULNERABILITY MAPPING**

# 4. Multi-hazards

A hazard, and the resultant disaster can have different origins: natural (geological, Hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity, frequency, probability, duration, area of extent, speed of onset, spatial dispersion and temporal spacing (Cees, 2009).

In the case of Bukwo District, hazards were classified following main controlling factors:

- i. Geomorphological or Geological hazards including landslides, rock falls and soil erosion
- ii. Climatological or Meteorological hazards including floods, long dry spells, hailstorms, strong winds and lightning
- iii. Ecological or Biological hazards including crop pests and diseases, livestock pests and diseases, human epidemic diseases, vermin attacks and wildlife animal attacks,
- iv. Human induced or Technological hazards including bush fires, road accidents land conflicts.

# 4.1 Geomorphological and Geological Hazards

# 4.1.1 Landslides and rock falls

Results from the participatory assessments indicated that incidences of rock falls and landslides were a common occurrence in Bukwo District during the rainy seasons. Participants reported that landslides usually block roads and destroy crops especially banana plantations. In 2008, the bridge at River Siti on Bukwo – Kapchorwa road in Chesower Sub-county was blocked by a mudslide thus paralyzing transport. The most affected Sub-counties include; Chesower, Tulel, Kamet, Kabei, Kortek and Chepkwasta. This information was integrated with the spatial modelling using socio-ecological spatial data i.e. Soil texture (data for National Agricultural Research Laboratories – Kawanda (NARL) 2014, Rainfall (Meteorology Department 2014), Digital Elevation Model (DEM), SLOPE, ASPECT (30m resolution data from SRTM Shuttle Radar Topography Mission (SRTM) to generate Land slide, rock falls and soil erosion vulnerability map.



Landslides and Rock falls



Figure 7: Landslides and Rock fall Prone Areas, Bukwo District

#### 4.1.2 Soil erosion

Results from the participatory assessments indicated that incidences of soil erosion were a common occurrence in Bukwo District during the rainy seasons. Participants reported that soil erosion is responsible for the siltation of rivers, blocking of culverts and drainage channels and poor crop yields. The Sub-counties of Chesower, Tulel, Kamet, Kabei, Kortek and Chepkwasta are the most affected. Figure 8 shows the most prone areas to soil erosion.



Soil Erosion



Figure 8: Soil erosion prone areas, Bukwo District

# 4.1.3 Earthquakes and faults

The participants in the discussions reported that the District only experiences minor tremors which occur occasionally. However, it was noted that earth cracks had developed in the Sub-counties of Kabei and Chesower.


Figure 9: Earthquakes Vulnerability and Fault lines, Bukwo District

# 4.2 Climatological and Meteorological Hazards

### 4.2.1 Floods

Participants in the focus group discussions indicated that flooding mainly occurs along Rivers Bukwo and Nyalit and in the low lying areas of Bukwo District during the rainy seasons. The participants also reported that floods block roads thus rendering them impassable. It was also observed that floods destroy and submerge crops thus causing serious economic losses. The most affected Sub-counties include; Riwo, Kamet and Tulel. This information was integrated with the spatial modelling using socio-ecological spatial data i.e. Soil texture (data for National Agricultural Research Laboratories – Kawanda (NARL) 2014, Rainfall (Meteorology Department 2014), Digital Elevation Model (DEM), SLOPE, ASPECT (30m resolution data from SRTM Shuttle Radar Topography Mission (SRTM) to generate flood susceptibility map.



Floods



Figure 10: Flood Prone Areas and Vulnerability Ranking, Bukwo District

#### 4.2.2 Prolonged Dry spells

Participants in the focus group discussions observed that droughts were experienced in form of prolonged dry spells without any rainfall in Bukwo District. During this period there is scarcity of water, pastures, increased crop failures and high incidences of pests and disease in both crops and livestock. It was reported that the worst effects of prolonged dry spells were recorded in 2009. The most affected Sub-counties include; Kaptererwo, Senendet, Bukwo, Suam, Riwo, Kabei, Kamet, Tulel and Bukwo Town Council. This information was integrated with spatial modelling using socio-ecological spatial data i.e. Rainfall and Temperature (Uganda National Meteorological Authority, 2014) using the Standardized Precipitation Index (SPI) to generate drought vulnerability map.



Figure 11: Dry spells Prone Areas and Vulnerability Ranking, Bukwo District

#### 4.2.3 Hailstorms

Participatory assessments through the focus group discussions indicated that hailstorms are experienced during heavy rains. Participants observed that the effects of hailstorms are more predominant in Tulel, Senendet and Bukwo Sub-counties. Some of these effects include; crop loss such as banana plantations, maize, beans, and Irish potatoes (Figure 11).

#### 4.2.4 Strong winds

In a series of focus group discussions, participants indicated that strong winds mainly occur at the onset of rainy seasons. It was reported that strong winds cause tree falls, banana plantation logging and also blow off roof tops of houses and schools. The most affected Subcounties include: Tulel, Senendet and Bukwo (Figure 11).

# 4.2.5 Lightning

Lightning is a sudden high-voltage discharge of electricity that occurs within a cloud, between clouds, or between a cloud and the ground. The distribution of lightning on Earth is far from uniform. The ideal conditions for producing lightning and associated thunderstorms occur where warm, moist air rises and mixes with cold air above. Results from the participatory assessments showed that there have been increased incidences of lightning in Bukwo District. Participants reported that lightning killed 3 cows in Makotu village, Kapsekek Parish, Chepkwasta Sub-county in 2015 (Figure 11). Other incidences of lightning were reported at Kapkworos Primary School in Senendet Sub-county. It was also reported that lightning struck the District building in Bukwo Town Council recently. The most affected Sub-counties include; Bukwo, Chepkwasta, Chesower, Kabei and Kortek.



Figure 12: Strong winds, Hailstorms, Lightning Hotspots and Vulnerability, Bukwo District

# 4.3 Ecological and Biological Hazards

#### 4.3.1 Crop Pests and Diseases

Participants in Bukwo District revealed that crop pests and diseases were prevalent throughout the year though their severity varied with season. The major crop diseases mentioned included; maize lethal necrosis, banana bacterial wilt, coffee berry disease and coffee leaf rust. While the major crop pests included; maize stalk borer, coffee twig borer, army worms, caterpillars, aphids, thrips, white flies, maize weevils and banana weevils. It was reported that in 2012, there was a serious outbreak of banana bacterial wilt in Bukwo Town Council and Chesower Sub-counties causing economic losses and food insecurity (Figure 13). The respondents revealed that maize varieties from Kenya are the most affected by maize lethal necrosis.



Figure 13: Crop Pests and Diseases Vulnerability, Bukwo District

# 4.3.2 Livestock Pests and Diseases

The most reported livestock diseases in Bukwo District included; foot and mouth disease, black quarter disease, rabies and Newcastle. Ticks, leeches, liver flukes and worms were the most common parasites and vectors in the District. Participants reported that foot and mouth disease outbreaks are common in Riwo and Kaptererwo Sub-counties while black quarter disease was reportedly is common in Suam and Chesower Sub-counties.



Figure 14: Livestock Pests and Diseases Vulnerability, Bukwo District

# 4.3.3 Human Diseases outbreaks

Participants indicated that malaria, typhoid and HIV/AIDS were the most common diseases in Bukwo District (Figure 15). Malaria was regarded to be prevalent in the entire District despite Government efforts of providing every household with mosquito nets in 2014. It was reported that the prevalence rates of HIV/AIDS were high at the border town of Suam.



Figure 15: Human Disease Prevalence and Health Facilities, Bukwo District

### 4.3.4 Vermin and Wildlife Animal Attacks

Participatory assessments through focus group discussions indicated that incidences of vermin and wildlife animal attacks were common especially in areas adjacent to Mt. Elgon National Park. Baboons, hyenas and monkeys are some of the animals that attack communities and destroy crops such as sorghum and maize. The most affected Sub-counties are Suam, Chepkwasta, Chesower, Senendet, Kortek, Kamet and Kabei (Figure 16).



Figure 16: Vermin and Wildlife Animal Conflicts and Vulnerability, Bukwo District

# 4.3.5 Invasive species

Results from the discussions showed that *Lantana spp.*, *oxalis spp.*, *cyperus spp.*, fox tail grass and Sodom apple (*Solanum incanum*) were the most prominent invasive species in Bukwo District. Participants revealed that fox tail grass suppresses the growth of wheat and barley in Suam Sub-county (Figure 17).



Plate 4: Invasive species



Figure 17: Invasive species vulnerability, Bukwo District

# 4.4 Human Induced and Technological Hazards

# 4.4.1 Bush Fires

Participants indicated that most bush fires in Bukwo District occur during the dry season. It was reported that fires (management fires) are usually started by cattle keepers to allow regeneration of fresh forage for livestock. However, these management fires spread over and burn adjacent property. Some of the fires are maliciously started by hunters and honey harvesters in Mt. Elgon national park. Accidental fires were also reported in Bukwo Town Council where a shop was burnt in early 2016 as a result of selling petrol in jericans and mineral water bottles. The most affected Sub-counties are; Riwo, Kamet, Tulel and Chesower (Figure 18).



Figure 18: Bush/Forest fires Hotspot Areas and Vulnerability, Bukwo District

#### 4.4.2 Land conflicts

Land conflicts were reported to be so common in Bukwo District because most of the land is under customary ownership. Participants revealed that about 90% of the cases in the magistrate's court are land disputes. In the recent past, it was observed that the District has been under threat from cattle rustling as the District borders with Karamoja. Reports indicated that there are administrative boundary conflicts between Sub-counties of Tulel and Kamet in areas down the cliff of Tuyobei. The most affected Sub-counties include; Riwo, Kamet, Kaptererwo, Tulel, Chesower and Chepkwasta (Figure 18). This is due to displacement of the people as result of historical insecurity from 1960s to 2004 caused by the Karamojong and Pokot cattle rustlers. Some people had migrated to Kenya and to neighboring Districts. However, there has been resettling of the displaced people thus causing land grabbing and land dispute related issues especially in the camp area in Kapsekek ( temporal camp in Mt.Elgon National Park).



Figure 19: Land Conflicts Ranking, Bukwo District

# 4.4.3 Environmental Degradation

Results from the participatory assessments indicated that the most reported forms of environmental degradation in Bukwo District were; brick making in Riwo, Bukwo and Kaptererwo Sub-counties which causes a lot of swamp degradation. Participants also reported that river bank degradation had increased through over cultivation along river banks thus causing siltation of these rivers.



Plate5: Environmental Degradation



Figure 20: Environmental Degredation Ranking, Bukwo District

#### 4.4.4 Road Accidents

Participatory assessments through the discussions indicated that road accidents mainly occur on the Bukwo – Kapchorwa and Bukwo – Aralam roads. Participants reported that accidents mostly occur at the very steep sections of these roads in the rainy seasons. Motorcycle accidents are the most registered since it is the most common form of transport in the entire District.



Plate6: Road section in a rainy season



Figure 21: Road Accidents Hotspots and Vulnerability, Bukwo District

#### **4.5 VULNERABILITY PROFILE**

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 of Bukwo District were assessed based on exposure, susceptibility and adaptive capacity at community (village), Parish, Sub-county and District levels highlighting their sensitivity to a certain risk or phenomena. 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. Differences in socio-economic vulnerability can often be linked to differences in socio-economic status, where a low status generally means that you are more vulnerable.

Vulnerability was assessed basing on two broad criteria i.e. socio-economic and environmental components of vulnerability. Participatory approach was employed to assess these vulnerability components by characterizing the exposure agents, including hazards, elements at risk and their spatial dimension. Participants also characterized the susceptibility of the District including identification of the potential impacts, the spatial disposition and the coping mechanisms. Participants also identified the resilience dimension at different spatial scales (Table 2).

Table 3 (Vulnerability Profile) shows the relation between hazard intensity (probability) and degree of damage (magnitude of impacts) depicted in the form of hazard intensity classes, and for each class the corresponding degree of damage (severity of impact) is given. It reveals that climatological and meteorological hazards in form of drought and hailstorms predispose the community to high vulnerability state. The occurrence of pests and diseases and lightning, also create a moderate vulnerability profile in the community (Table 3). Table 4 shows Hazard assessment for Bukwo District.

Mud a such i litur	P						Desiliance
vuirerability	Hazards	Elements at Risk	Geographical	Susceptibility	Geographical	Coping strategies	Geographical
	Landslides, Rock falls and Soil erosion	<ul> <li>Human and livestock adjacent to hill slopes</li> <li>Crops on hill slopes</li> <li>Intrastructure e.g. houses, schools, intrastructure to hill slopes</li> </ul>	Parish	<ul> <li>Loss of lives</li> <li>Complete crop failure</li> <li>Destruction of infrastructure e.g. homes, and schools</li> </ul>	Parish	-Migration -Sensitization by both Government and non- Governmental agencies	Parish
	Earth quakes	- Infrastructure e.g. houses, schools	District	- Loss of lives - Destruction of Infrastructure e.g. houses. schools	District	-No much measure so far	District
	Floods	<ul> <li>Livestock adjacent to flood plain</li> <li>Crops on flood plain</li> <li>Infrastructure e.g. houses, schools, froads adjacent to flood plain</li> </ul>	Parish	- Livestock loss - Destruction of crops - Destruction of infrastructure e. On buses. schorois, roads adiacent to flood plain	Parish	-Migration -Sensitization on wetland conservation -Dig trenches	Parish
	Drought	- Livestock - Crops - Human population	Village	- Hunger & poverty - Livestock loss - Crop failure - Shortage of pasture - Shortage of water	Village	-Migration -Sensitization on tree planting -Buy food from elsewhere	Village
	Hailstorms, strong winds and Lightning	<ul> <li>Human and livestock populations</li> <li>Crops</li> <li>Infrastructure e.g. houses, schools, health centres</li> </ul>	Parish	<ul> <li>Loss of lives</li> <li>Destruction of crops</li> <li>Destruction of infrastructure</li> <li>Bestruction of infrastructure</li> <li>e.g. houses, schools, roads adjacent to flood plain</li> </ul>	Parish		Parish
	Crop Pests and Diseases	-Crops	District	- Complete crop failure	District	- Spraying - Cut and burry affected crops -Sensitization on crop disease management	District
	Livestock Pests and Diseases	-Livestock (cattle, goats etc.)	District	<ul> <li>Loss of livestock</li> <li>Reduced livestock productivity</li> </ul>	District	<ul> <li>Vaccination</li> <li>Burry and burn animals that have died from infection</li> <li>Quarantine</li> </ul>	District
	Human Disease outbreaks	- Human Population	District	- Loss of lives	District	- Mass Immunization - Use of mosquito nets	District
Socio-economic component	Invasive species	-indigenous species -Animals	District	<ul> <li>Outcompete the indigenous spp., suppress growth of indigenous spp</li> <li>Loss of indigenous spp.</li> <li>Complete crop Failure</li> <li>suppress growth of pasture</li> </ul>	District	- Cut and burn - Sensitization on Invasive species management	District
	Bush fires	- Livestock - Crops - Infrastructure e.g. houses, schools	Sub-county	<ul> <li>Loss of livestock</li> <li>Shortage of pasture</li> <li>Destruction of crops</li> <li>Destruction of infrastructure e.g. houses,</li> </ul>	Sub-county	Sensitization	Sub-county
	Road accidents	- Human population - Infrastructure adjacent to accident black spots e.g. houses, schools etc.	Sub-county	<ul> <li>Loss of lives</li> <li>Destruction of vehicles</li> <li>Destruction of vehicles Infrastruction adjacent to accident black spots</li> <li>e. A houses, schools efc.</li> </ul>	Sub-county	-Humps on roads -Signage on speed limits -Sensitization on traffic rules	Sub-county
	Land conflicts	- Human population	Village	-Loss of lives -Family violence and break outs	Village	<ul> <li>Community dialogue</li> <li>District court in charge of land issues</li> </ul>	Village
	Vermin and Wildlife animal attacks	- Human population - Livestock - Crops	Parish	-Loss of lives -Livestock loss -Crop destruction	Parish	- Report to UWA - Guard gardens - Poison - Hunt and kill -Fence water collection points with Wildlife animals	Village
	Environmental degradation	- Hurnan and livestock populations - Crops - Natural vegetation	Sub-county	-Crop failure -Shortage of pasture -Shortage of water -Decline of water quality	Sub-county	-Sensitization on wettand conservation -Sensitization on tree plating -Setting bi-laws	Sub-county

Table 2: Components of Vulnerability in Bukwo District

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-Migration -Senstitzation by both Government and non- Governmental agencies	-No much measure so far	-Migration -Senstitization on wetland conservation -Dig trenches	-Migration -Sensitization on tree planting -Buy food from elsewhere		<ul> <li>- Spraying</li> <li>- Cut and burry affected crops</li> <li>- Sensitization on crop disease management</li> </ul>	<ul> <li>Vaccination</li> <li>Burry and burn animals that have died from infection</li> <li>Quarantine</li> </ul>	- Mass Immunization - Use of mosquito nets	- Cut and burn -Sensitization on Invasive species management	-Sensitization	-Humps on roads -Signage on speed limits -Sensitization on traffic rules	<ul> <li>Community dialogue</li> <li>District court in charge of land issues</li> </ul>	<ul> <li>Report to UWA</li> <li>Guard gardens</li> <li>Poison</li> <li>Hunt and kill</li> <li>Fence water collection points with Wildlife animals</li> </ul>	-Sensitization on wetland conservation -Sensitization on tree plating -Setting bi-laws
Parish	District	Parish	Village	Parish	District	District	District	District	Sub-county	Sub-county	Village	Parish	Sub-county
- Loss of lives - Complete crop failure - Destruction of infrastructuree.g. homes, and schools	<ul> <li>Loss of lives</li> <li>Destruction of Infrastructure e.g. houses, schools</li> </ul>	<ul> <li>Livestock loss</li> <li>Destruction of crops</li> <li>Destruction of infrastructure</li> <li>Destruction of infrastructure</li> <li>e.g. houses, schools, roads adjacent to flood plain</li> </ul>	- Hunger & poverty - Livestock loss - Crop failure - Shortage of pasture - Shortage of water	<ul> <li>Loss of lives</li> <li>Destruction of crops</li> <li>Destruction of infrastructure</li> <li>Destruction of infrastructure</li> <li>a.g. houses, schools, roads adjacent to flood plain</li> </ul>	- Complete crop failure	<ul> <li>Loss of livestock</li> <li>Reduced livestock productivity</li> </ul>	- Loss of lives	<ul> <li>Outcompete the indigenous spp., suppress growth of indigenous spp</li> <li>Loss of indigenous spp.</li> <li>Complete crop Failure</li> <li>Suppress growth of pasture</li> </ul>	<ul> <li>Loss of livestock</li> <li>Shortage of pasture</li> <li>Destruction of crops</li> <li>Destruction of infrastructure e.g. houses,</li> </ul>	<ul> <li>Loss of lives</li> <li>Destruction of vehicles</li> <li>Destruction of Infrastructure adjacent to accident black spots</li> <li>e.g. houses, schools etc.</li> </ul>	-Loss of lives -Family violence and break outs	-Loss of lives -Livestock loss -Crop destruction	-Crop failure -Shortage of pasture -Shortage of water -Decline of water quality
Parish	District	Parish	Village	Parish	District .	District .	District	District	Sub-county	Sub-county	/illage	Parish	Sub-county
- Human and livestock adjacent to hill slopes     - Crops on hill slopes     - Infrastructure     e.g. houses, schools, roads adjacent     to hill slopes	- Infrastructure e.g. houses, schools	<ul> <li>Livestock adjacent to flood plain</li> <li>Crops on flood plain</li> <li>Infrastructure</li> <li>Infrastructure</li> <li>Louses, schools, roads adjacent</li> <li>In flood plain</li> </ul>	- Livestock - Crops - Human population	- Human and livestock     populations     - Crops     - Crops     - Indicatructure     - Indicatructure     - Indicatructure     - Indicatructure	-Crops	-Livestock (cattle, goats etc.)	- Human Population	-indigenous species -Animals	- Livestock - Crops - Infrastructure e.g. houses, schools	- Human population - Infrastructure adjacent to accident black spots e.g. houses, schools etc.	- Human population	- Human population - Livestock - Crops	- Human and livestock populations - Crops - Natural vegetation
Landslides, Rock falls and Soil erosion	Earth quakes	Floods	Drought	Hailstorms, strong winds and Lightning	Crop Pests and Diseases	Livestock Pests and Diseases	Human Disease outbreaks	Invasive species	Bush fires	Road accidents	Land conflicts	Vermin and Wildlife animal attacks	Environmental degradation
E Component component a < C T T C T C T C T C T C T C T C T C T													

	PROBABILITY	SEVERITY OF	RELATIVE RISK	VULNERABLE SUB COUNTIES
	Relative likelihood this will occur	Overall Impact (Average)	Probability x Impact Severity	
Hazards	1 = Not occur 2 = Doubtful 3 = Possible 4 = Probable 5 = Inevitable	1 = No impact 2= Low 3=medium 4 = High	0-1= Not Occur 2-10= Low 11-15=Medium 16-20= High	
Floods	4	3	12	Riwo, Kamet and Tulel Sub- counties.
Long dry spells	4	3	12	Kaptererwo,Senendet, Bukwo, Swamu, Riwo, Kabei, Kamet and Tulel Sub-counties and Bukwo town Council.
Soil erosion, rock falls and landslides	5	4	20	Chesower, Tulel, Kamet, Kabei.Kortek and Chepkwasta Sub-counties.
Hail storms, lightning and strong winds	4	3	12	Bukwo, Chepkwasta, Kabei, Kortek,Tulel,Chesower Sub- counties.
Bush fires and Forest fires and other fire outbreaks	4	2	8	Riwo, Kamet, Tulel and Chesower Sub-counties.
Crop pests and diseases	5	3	15	All sub counties but the most affected are Chesower and Bukwo town Council.
Livestock pests and diseases	5	3	15	All sub counties but most affected are Riwo, Kaptererwo and Suam.
Human Diseases outbreaks	5	3	15	Riwo and Suam Sub-counties and Bukwo town Council.
Land conflicts	4	3	12	Riwo, Kamet, Kaptererwo, Tulel, Chesower and Chepkwasta Sub-counties.
Vermin and Wild-life animal attacks	3	2	6	Suam, Chepkwasta, Chesower, Senendet, Kamet, Kabei and Kortek Sub- counties.
Earthquakes and faults	2	2	4	Kabei and Chesower Sub- counties.
Road accidents	3	2	6	Bukwo town Council.
Environmental degradation	5	3	15	Riwo, Bukwo, Kaptererwo and Senendet Sub-counties.
Invasive species	3	2	6	Suam and Riwo Sub- counties.

# Table 3: Vulnerability Profile for Bukwo District

Note: This table presents relative risk for hazards to which the community was able to attach probability and severity scores.

# Key for Relative Risk

High
Medium
Low
Not reported/ Not prone

# Table 4: Hazard Risk Assessment

Hazard	Riwo	Chesower	Bukwo	Kaptererwo	Senendet	Swam Silam	Bukwo T/C	Tulel	Kortek	Kamet	Kabei	Chepkwaster
Floods	М	L	L	L	L	L	L	L	L	М	L	L
Long dry spells	М	L	М	М	М	Μ	М	М	L	М	М	L
Landslides, Rock falls and Erosion	L	н	L	L	L	L	L	н	н	н	н	н
Strong winds, Hailstorms and Lightning	L	М	М	L	М	L	L	М	М	L	М	М
Crop pests and Diseases	М	М	L	L	L	L	М	L		L	L	L
Livestock pests and Diseases	М	М	L	М	L	М	L	L	L	L	L	L
Human disease outbreaks	М	L	L	L	L	м	м	L	L	L	L	L
Vermin and Wildlife animal attacks	L	м	L	L	М	М	L	L	м	L	м	М
Land conflicts	М	М	L	М	L	L	L	М	L	М	L	М
Bush fires and Forest fires	М	М	L	L	L	L	м	L	L	м	L	L
Environmental degradation	М	М	М	М	М	L	L	L	L	L	L	L
Earthquakes and faults	L	М	L	L	L	L	L	L	L	L	М	L
Road accidents	L	L	L	L	L	L	L	L	L	L	L	L
Invasive species	М	L	L	L	L	М	L	L	L	L	L	L

# Key

Н	High
М	Medium
L	Low
	Not reported/ Not prone

#### 4.5.1 Gender and Age groups mostly affected by Hazards

Hazard	Gender and Age mostly affected
	dender and Age mostly anected
Drought	Affects mostly women and children since most water
	wells dry up increasing distance for fetching water
Erosion	All age groups and gender are affected
Hailstorms	All gender and age groups
Lightning	Children in schools are mostly affected
Crop pests and Diseases	All gender and age groups
Livesteck peets and Diseases	All gooder and ago groups
Livestock pests and Diseases	All gender and age groups
Human disease outbreaks	All gender and age groups
	All gender and age groups
Vermin and Wildlife animal attacks	
Land conflicts	All gender and age groups
Bush fires	All gender and age groups
Environmental degradation	All gender and age groups
Road accidents	All gender and age groups

# Table 5: Gender and age groups mostly affected by hazards

# 4.5.2 Coping Strategies

In response to the various hazards, participants identified a range of coping strategies that the community employs to adjust to, and build resilience towards the challenges. The range of coping strategies are broad and interactive often tackling more than one hazard at a time and the focus of the communities leans towards adaptation actions and processes including social and economic frameworks within which livelihood and mitigation strategies take place; ensuring extremes are buffered irrespective of the direction of climate change and better positioning themselves to better face the adverse impacts and associated effects of climate induced and technological hazards (Table 6).

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No	Multi-Hazards		Coping strategies					
1	Geomorphological or Geological	Landslides, Rock falls and Erosion	<ul> <li>Migration to safe areas</li> <li>Terracing/ contour farming</li> <li>Plant trees to control water movement on hill slopes</li> <li>Mulching in banana plantations</li> <li>Plant grass in banana plantations on hill slopes</li> <li>Removal of stones from banana farmlands</li> </ul>					
2		Earthquakes and faults	<ul> <li>Designs of houses (pillars)</li> <li>Early warning System</li> <li>Vigilance</li> <li>Sensitization</li> <li>Emergency response mechanisms</li> </ul>					
3	Climatological or Meteorological	Floods	<ul> <li>Digging up of trenches in the flood plains</li> <li>Planting trees to control water movement to flood plains</li> <li>Migration to other areas</li> <li>Seek for Government food aid</li> </ul>					
4		Drought	<ul> <li>Leave wetlands as water catchments</li> <li>Plant trees as climate modifiers</li> <li>Buy food elsewhere in case of shortage</li> <li>Buy water from the nearby areas</li> <li>Food Storage especially dry grains</li> </ul>					
5		Strong winds, Hailstorms and Lightning	<ul> <li>Plant trees as wind breakers</li> <li>Use of stakes against wind in banana plantations</li> <li>Use of ropes to tire banana against wind</li> <li>Installation of lightning conductors</li> <li>Stay indoors during rains</li> <li>Changing building designs and roof types</li> <li>Removal of destroyed crops</li> <li>Request for aid from the Office of the Prime Minister</li> <li>Installation of lightning conductors on newly constructed schools</li> </ul>					
6	Ecological or Biological	Crop pests and Diseases	<ul> <li>Spraying pests</li> <li>Cutting and burying BBW affected crops</li> <li>Burning of affected crops</li> <li>Vigilance</li> </ul>					
7		Livestock pests and Diseases	<ul> <li>Spraying pests</li> <li>Vaccinations</li> <li>Burying animals that have died from infection</li> <li>Quarantine</li> </ul>					
8		Human epidemic Diseases	<ul><li>Mass immunisation</li><li>Visiting health centres</li><li>Use of mosquito nets</li></ul>					
9		Vermin and Wild-life animal attacks	<ul> <li>Guarding the gardens</li> <li>Poisoning</li> <li>Hunt and kill</li> <li>Report to UWA</li> <li>Hugo group</li> <li>Mauritius thorns</li> <li>Plant tea as buffer</li> <li>Dig trenches</li> <li>Chain link</li> <li>Plant red pepper as buffer</li> <li>Recommend vermin guards</li> </ul>					
10		Invasive species	<ul> <li>Uproot</li> <li>Spray with herbicides (e.g 2-4-D)</li> <li>Biological control (e.g beetles)</li> <li>Cut and burn</li> <li>Sensitization on Invasive species management</li> <li>Blacklisting exotic species</li> </ul>					

# Table 6: Coping strategies to the Multi-hazards in Bukwo District

11	Human induced or technological	Land conflicts	<ul> <li>Report to court</li> <li>Migration</li> <li>Resettlement</li> <li>Surveying and titling</li> <li>Strengthen Land management structures</li> <li>Sensitization on land ownership</li> <li>Proper demarcation (live fencing)</li> <li>Stop the first in some of first outbrook</li> </ul>				
12		Bush fires/ Forest fires	<ul> <li>Stop the fires in case of fire outbreak</li> <li>Fire lines (may be constructed, cleared grass)</li> <li>Fire breaks planted along gardens e.g. euphorbia spp.</li> <li>Vigilance especially in dry seasons where most burning is done</li> <li>Bye-laws</li> <li>Sensitization on dangers of fires</li> </ul>				
13		Road accidents	Construction of humps Road Signage including speed limits Separate lanes on sharp corners Sensitisation Widen narrow roads Plant trees on road reserve, as road guards Deployment of Traffic officers				
14		Environmental degradation	<ul> <li>Leave wetlands as water catchments</li> <li>Plant appropriate tree species as climate modifiers</li> <li>Sensitization</li> <li>Bye-laws</li> <li>Enforcement</li> <li>Gazatte and demarcate wetlands</li> <li>Restore wetlands and other fragile ecoSystems</li> <li>EIA for new developments</li> <li>No land titles for wetland areas</li> <li>Cancellation of existing wetland land titles</li> <li>Developing land use plans and enforce them</li> </ul>				

# **GENERAL CONCLUSION AND RECOMMENDATIONS**

#### 5.1 Conclusion

The multi-hazard vulnerability profile output from this assessment was a combination of spatial modeling using socio-ecological spatial layers (i.e. DEM, Slope, Aspect, Flow Accumulation, Land use, vegetation cover, hydrology, soil types and soil moisture content, population, socio-economic, health facilities, accessibility, and meteorological data) and information captured from District Key Informant interviews and Sub-county FGDs using a participatory approach. The level of vulnerability was assessed at Sub-county participatory engagements and integrated with the spatial modeling in the GIS environment.

Results from the participatory assessment indicated that Bukwo District has over the past two decades increasingly experienced hazards including; landslides, rock falls, soil erosion, floods, long dry spells, hailstorms, strong winds, lightning, crop pests and diseases, livestock pests and diseases, human disease outbreaks, vermin, wildlife animal attacks, invasive species, bush fires and land conflicts putting livelihoods at increased risk. Generally landslides, rock falls and soil erosion and flooding were identified as most serious problems in Bukwo District with almost all Sub-counties being vulnerable to the hazards. The limited adaptive capacity (and or/resilience) and high sensitivity of households and communities in Bukwo District increase their vulnerability to hazard exposure necessitating urgent external support.

Hazards experienced in Bukwo District can be classified as:

- i. Geomorphological or Geological hazards including; landslides, rock falls, soil erosion and earth quakes.
- ii. Climatological or Meteorological hazards including; floods, long dry spells, hailstorms, strong winds and lightning.
- iii. Ecological or Biological hazards including crop pests and diseases, livestock pests and diseases, human disease outbreaks, vermin and wildlife animal attacks and invasive species.
- iv. Human induced or Technological hazards including bush fires, road accidents 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.

# **5.2 Policy-related Recommendations**

The following recommended policy actions targeting vulnerability reduction include:

- i. The Government should improve enforcement of policies aimed at enhancing sustainable environmental health.
- ii. The Government through MAAIF should review the animal diseases control act because of low penalties given to defaulters.
- iii. The Government should establish Systems to motivate support of political leaders toward Government initiatives and Programmemes aimed at disaster risk reduction.
- iv. The Government should increase awareness campaigns aimed at sensitizing farmers/ communities on disaster risk reduction initiatives and practices.
- v. The Government should revive disaster committees at District level and ensure funding of disaster and environmental related activities.
- vi. The Government through UNRA and the District Authority should fund periodic maintenance of feeder roads to reduce on traffic accidents.
- vii. The Government through MAAIF and the District Production Office should promote drought and diseases resistant crop seeds.
- viii. The Government through OPM and Meteorology Authority should increase importation of lightning conductors and also reduce taxes on their importation.
- ix. The Government through OPM and Meteorology Authority should support establishment of disaster early warning Systems.
- x. The Government through MWE increase funding and staff to monitor wetland degradation and non-genuine agro-inputs.
- xi. The Government through OPM should improve communication between the disaster department and local communities.
- xii. The Government through MWE should promote Tree planting along road reserves.
- xiii. The Government through MAAIF should fund and recruit extension workers at Subcounty level and also facilitate them.

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# References

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#### **APPENDIX I: DATA COLLECTION TOOLS**

#### FOCUS GROUP DISCUSSION GUIDE FOR District DISASTER RISK MANAGEMENT FOCAL PERSONS

Interviewer	District:	GPS Coordinates
Team	Sub- county:	
Name(s)	Parish:	X·
	Village:	
		Y:
		Altitude

No.	Name of Participants	Designation	Contact	Signature

#### Introduction

- i. You have all been requested to this session because we are interested in learning from you. We appreciate your rich experiences and hope to use them to strengthen service delivery across the District and the country as whole in a bid to improve access to information on Hazards and early warning.
- ii. There is no "right" or "wrong" answers to any of the questions. As a Focus Group Discussion leader, I will try to ask all people here today to take turns speaking. If you have already spoken several times, I may call upon someone who has not said as much.
  I will also ask people to share their remarks with the group and not just with the person beside them, as we anxious to hear what you have to say.
- iii. This session will be tape recorded so we can keep track of what is said, write it up later for our report. We are not attaching names to what you have to what is said, so whatever you say here will be anonymous and we will not quote you by name.
- iv. I would not like to keep you here long; at most we should be here for 30 minutes- 1 hour.

## Section A: Geomorphological or Geological Hazards (Landslides, rock falls, soil erosion and earth quakes)

- 1. Which crops are majorly grown in your area of jurisdiction?
- 2. Which domestic animals are dominant in your area of jurisdiction?
- 3. What challenges are faced by farmers in your area of jurisdiction?
- **4.** Have you experienced landslides and rock falls in the past 10 years in your area of jurisdiction?
- **5.** Which Villages, Parishes or Sub-counties have been most affected by landslide and rock falls?
- **6.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?
- 7. Which crops are majorly affected by landslides and rock falls in your area of jurisdiction?
- 8. In which way are the crops affected by landslides and rock falls?
- **9.** Which domestic animals are majorly affected by landslides and rock falls in your area of jurisdiction?
- 10. In which way are the domestic animals affected by landslides and rock falls?
- **11.** Which agricultural practices are being adopted by farmers in a bid to mitigate the above challenges?
- **12.** What are the relevant Government's interventions focusing at helping farmers mitigate the challenges mentioned?

- **13.**Do you have any earth faults or earth cracks as lines of weakness in your area of jurisdiction?
- 14. Have you experienced any earth quakes in the past 10 years in your area of jurisdiction?
- **15.** Which particular Villages, Parishes or Sub-counties have been majorly affected by earth quakes in your area of jurisdiction?
- **16.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?
- 17. What impacts have been caused by earth quakes?
- **18.** To what extent have the earth quakes affected livelihoods of the local communities in your area of jurisdiction?
- **19.** Which mitigation measures have been adopted local communities in a bid to mitigate the above challenges?
- **20.** What are the relevant Government's interventions focusing at helping local communities mitigate the challenges mentioned?

## Section B: Meteorological or climatological hazards (Floods, Droughts, Lightning, strong winds, hailstorms)

- 21. Have you experienced floods in the past 10 years in your area of jurisdiction?
- 22. Which Villages, Parishes or Sub-counties have been most affected by floods?
- **23.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?
- 24. Which crops are majorly affected by floods in your area of jurisdiction?
- **25.** In which way are the crops affected by floods?
- 26. Which domestic animals are majorly affected by floods in your area of jurisdiction?
- 27. In which way are the domestic animals affected by floods?
- **28.** Which agricultural practices are being adopted by farmers in a bid to mitigate the above challenges?
- **29.** What are the relevant Government's interventions focusing at helping farmers mitigate the challenges mentioned?
- **30.** Have you experienced drought in the past 10 years in your area of jurisdiction?
- 31. Which Villages, Parishes or Sub-counties have been most affected by drought?
- **32.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?

- 33. Which crops are majorly affected by drought in your area of jurisdiction?
- 34. In which way are crops affected by drought?
- 35. Which domestic animals are majorly affected by drought in your area of jurisdiction?
- 36. In which way are the domestic animals affected by drought?
- **37.** Which agricultural practices are being adopted by farmers in a bid to mitigate the above challenges?
- **38.** What are the relevant Government's interventions focusing at helping farmers mitigate the challenges mentioned?
- **39.** Have you experienced hailstorms or lightning in the past 10 years in your area of jurisdiction?
- **40.**Which Villages, Parishes or Sub-counties have been most affected by hailstorms or lightning?
- **41.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?
- 42. What impacts have been caused by hailstorms or lightning?
- **43.** To what extent have the hailstorms or lightning affected livelihoods of the local communities in your area of jurisdiction?
- **44.** Which mitigation measures have been adopted local communities in a bid to mitigate the above challenges?
- **45.** What are the relevant Government's interventions focusing at helping local communities mitigate the challenges mentioned?

### Section C: Biological hazards (Crop pests and diseases, Livestock pests and Diseases, Invasive species, vermin and wild-life animal attacks)

- **46.** Have you experienced any epidemic animal disease outbreaks in the past 10 years in your area of jurisdiction?
- **47.** Which Villages, Parishes or Sub-counties have been most affected by epidemic animal disease outbreaks?
- **48.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?
- **49.** Specify the epidemic animal disease outbreaks that have majorly affected animals in your area of jurisdiction?
- **50.** Which domestic animals are majorly affected by epidemic animal disease outbreaks in your area of jurisdiction?

- **51.** In which way are the domestic animals affected by epidemic animal disease outbreaks?
- **52.** Which mitigation practices are being adopted by farmers in a bid to mitigate the above epidemic animal disease outbreaks?
- **53.** What are the relevant Government's interventions focusing at helping farmers mitigate the epidemic animal disease outbreaks mentioned?
- **54.** Have you experienced any crop pests and disease outbreaks in the past 10 years in your area of jurisdiction?
- **55.** Which Villages, Parishes or Sub-counties have been most affected by epidemic animal disease outbreaks?
- **56.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?
- **57.** Specify the crop pests and disease outbreaks that have majorly affected animals in your area of jurisdiction?
- **58.** Which crops are majorly affected by crop pests and disease outbreaks in your area of jurisdiction?
- **59.** In which way are the crops affected by crop pests and disease outbreaks?
- **60.** Which mitigation practices are being adopted by farmers in a bid to mitigate the above crop pests and disease outbreaks?
- **61.**What are the relevant Government's interventions focusing at helping farmers mitigate the crop pests and disease outbreaks mentioned?
- **62.** Have you experienced any epidemic human disease outbreaks in the past 10 years in your area of jurisdiction?
- **63.** Specify the epidemic human disease outbreaks that have majorly affected animals in your area of jurisdiction?
- 64. In which way are the humans affected by epidemic human disease outbreaks?
- **65.** Which mitigation measures have been adopted by local communities in a bid to mitigate the above epidemic human disease outbreaks?
- **66.** What are the relevant Government's interventions focusing at helping local communities mitigate the epidemic human disease outbreaks mentioned?
- 67. Do you have any national park or wildlife reserve in your area of jurisdiction?
- 68. Have you experienced wildlife attacks in the past 10 years in your area of jurisdiction?
- **69.** Which particular Villages, Parishes or Sub-counties have been majorly affected by wildlife attacks in your area of jurisdiction?

- **70.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?
- 71. What impacts have been caused by wildlife attacks?
- **72.** To what extent have the wildlife attacks affected livelihoods of the local communities in your area of jurisdiction?
- **73.** Which mitigation measures have been adopted local communities in a bid to mitigate the above challenges?
- **74.** What are the relevant Government's interventions focusing at helping local communities mitigate the challenges mentioned?
- 75. Are there invasive species in your area of jurisdiction?
- 76. Specify the invasive species in your area of jurisdiction?
- **77.** Which Villages, Parishes or Sub-counties have been most affected by invasive species in your area of jurisdiction?
- **78.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?
- 79. Which crops or animals are majorly affected by invasive species in your area of jurisdiction?
- 80. In which way are the crops or animals affected by invasive species?
- **81.**Which mitigation practices are being adopted by farmers in a bid to mitigate the above invasive species?
- **82.** What are the relevant Government's interventions focusing at helping farmers mitigate the invasive species mentioned?

# Section D: Human induced or Technological hazards (Land conflicts, bush and forest fires, road accidents, water accidents and environmental degradation)

- 83. Have you experienced environmental degradation in your area of jurisdiction?
- **84.** What forms of environmental degradation have been experienced in your area of jurisdiction?
- **85.** Which Villages, Parishes or Sub-counties have been most affected by environmental degradation?
- **86.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?
- 87. What impacts have been caused by environmental degradation?

- **88.** Which measures have been adopted by local communities in a bid to mitigate the above challenges?
- **89.** What are the relevant Government's interventions focusing at helping local communities mitigate the challenges mentioned?
- 90. Have you experienced land conflicts in the past 10 years in your area of jurisdiction?
- **91.** Which particular Villages, Parishes or Sub-counties have been majorly affected by land conflicts in your area of jurisdiction?
- **92.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?
- 93. What impacts have been caused by land conflicts?
- **94.** To what extent have the land conflicts affected livelihoods of the local communities in your area of jurisdiction?
- **95.** Which conflict resolution measures have been adopted local communities in a bid to mitigate the above challenges?
- **96.** What are the relevant Government's interventions focusing at helping local communities mitigate the challenges mentioned?
- 97. Have you experienced Road accidents in the past 20 years in your area of jurisdiction?
- 98. Which roads have experienced Road accidents?
- 99. What impacts have been caused by Road accidents?
- **100.** To what extent have the Road accidents affected livelihoods of the local communities in your area of jurisdiction?
- **101.** Which conflict resolution measures have been adopted local communities in a bid to mitigate the above challenges?
- **102.** What are the relevant Government's interventions focusing at helping local communities mitigate the challenges mentioned?
- **103.** Have you experienced any serious bush and or forest fires in the past 10 years in your area of jurisdiction?
- **104.** Which particular Villages, Parishes or Sub-counties have been majorly affected by bush and or forest fires in your area of jurisdiction?
- **105.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?
- 106. What impacts have been caused by serious bush and or forest fires?

- **107.** To what extent have the serious bush and or forest fires affected livelihoods of the local communities in your area of jurisdiction?
- **108.** Which mitigation measures have been adopted local communities in a bid to mitigate the above challenges?
- **109.** What are the relevant Government's interventions focusing at helping local communities mitigate the challenges mentioned?

#### FOCUS GROUP DISCUSSION GUIDE FOR LOCAL COMMUNITIES

Interviewer Team	District: Sub- county:	GPS Coordinates
Name(s)	Parish: Village:	X:
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No.	Name of Participants	Village/Parish	Contact	Signature

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- **74.** What are the relevant Government's interventions focusing at helping local communities mitigate the challenges mentioned?
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- 77. Which Villages and Parishes have been most affected by invasive species in your community?
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### Section D: Human induced or Technological hazards (Land conflicts, bush and forest fires, road accidents, water accidents and environmental degradation)

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- **101.** Which conflict resolution measures have been adopted local communities in a bid to mitigate the above challenges?
- **102.** What are the relevant Government's interventions focusing at helping local communities mitigate the challenges mentioned?
- **103.** Have you experienced any serious bush and or forest fires in the past 10 years in your community?
- **104.** As a way of ranking from Low, Medium, High and Very high, rank the Villages, Parishes or Sub-counties that have been most affected?
- 105. What impacts have been caused by serious bush and or forest fires?
- **106.** To what extent have the serious bush and or forest fires affected livelihoods of the local communities in your community?
- **107.** Which mitigation measures have been adopted local communities in a bid to mitigate the above challenges?
- **108.** What are the relevant Government's interventions focusing at helping local communities mitigate the challenges mentioned?

#### FOCUS GROUP ATTENDANCE LIST FOR District DISASTER RISK MANAGEMENT FOCAL PERSONS

Name of Participant	Designation	Contact

#### FOCUS GROUP DISCUSSION ATTENDANCE LIST FOR LOCAL COMMUNITIES

Name of Participant

Village/Parish

Contact

Name of Participant

Village/Parish

Contact

# SPATIAL DATA COLLECTION SHEET FOR HAZARD VULNERABILITY AND RISK MAPPING

Observer Name: Date:		District: Sub- county: Parish: Village:		Coordinates				
				X:				
				Y:				
				Altitude				
Slope characterization		Bio-physical characterization		Vegetation characterizatio	on		1	
Slope degree (e.g 10, 20,)		Soil Texture		Veg. cover (%)		Land use ty (tick) Bush Grassland Wetland Tree plantatio Natural fores Cropland Built-up are Grazing lan	type	
Slope length (m) (e.g 5, 10,)		Soil Moisture		Tree cover (%)			Bush Grassland Wetland	nd d
Aspect (e.g N, NE…)		Rainfall		Shrubs cover (%)			ation	
Elevation (e.g high, low…)		Drainage		Grass / Herbs cover (%)			Cropland Built-up area	nd area
Slope curvature (e.g concave, covex)		Temperature		Bare land cover		Others		

Area Description (Susceptibility ranking: landslide, mudslide, erosion, flooding, drought, hailstorms, lightning, cattle disease outbreaks, human disease outbreaks, land conflicts, wildlife conflicts, bush fires, earthquakes, faults/ cracks, pictures, any other sensitive features) Available online: http://www.necoc-opm.go.ug/

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