Uganda

Climate Risk and Vulnerability Assessment for Subnational Adaptation

Volume 1: Main Report

LoCAL
LOCAL CLIMATE ADAPTIVE LIVING FACILITY

UN CDF
Impact Capital for Development

Uganda

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Central government organizations

- Ministry of Lands, Housing and Urban Development
- Ministry of Local Government
- Ministry of Water and Environment, Climate Change Division
- National Agricultural Research Organization
- National Environment Management Authority
- National Forestry Authority
- National Meteorological Agency
- Office of the Prime Minister, Department of Disaster Preparedness and Management—National Emergency Coordination and Operations Centre

Local government organizations

- Amudat District Local Government
- Amuria District Local Government
- Arua City Government
- Bukomansimbi District Local Government
- Bushenyi District Local Government
- Butambala District Local Government
- Ibanda District Local Government
- Kiryandongo District Local Government
- Masaka District Local Government
- Masindi District Local Government
- Mbarara District Local Government
- Moyo District Local Government
- Mpigi District Local Government
- Mukono District Local Government
- Nakapiripirit District Local Government
- Namisindwa District Local Government
- Namutumba District Local Government
- Rukungiri District Local Government
- Sembabule District Local Government

acronyms

CRVA	climate risk and vulnerability assessment
IPCC	Intergovernmental Panel on Climate Change
LoCAL	Local Climate Adaptive Living Facility
NDC	nationally determined contribution
RCP	representative concentration pathway
UBOS	Uganda Bureau of Statistics
UNCDF	United Nations Capital Development Fund
UNMA	Uganda National Meteorology Authority

executive summary

The Government of Uganda is implementing the Local Climate Adaptive Living Facility (LoCAL)–Uganda mechanism, which it launched in 2022, with the support of the United Nations Capital Development Fund (UNCDF). To inform this effort, a climate change risk and vulnerability assessment (CRVA) was undertaken to provide critical evidence and a scientific analysis to precipitate subnational adaptation to address climate change. It aims to enhance general and specific understanding of Uganda's climate change risks, impacts and vulnerability at the national and district levels, including related trends and future projections; it focuses on population and livelihoods vulnerability and the sustainable development of key development sectors.

This CRVA report for Uganda is based on the climate change risk and impacts model developed by the fifth report of the Intergovernmental Panel on Climate Change (IPCC) and the Paris Agreement. Climate change future projections are defined for 10-year-average time slices and for 2030, 2040 and 2050 future time horizons, based on two IPCC greenhouse gas emissions representative concentration pathway (RCP) scenarios (see Box 1.1)—an intermediate one and the most unfavourable one (RCP 4.5 and RCP 8.5, respectively)—and the assumption that human and natural system trends and interactions will continue without significant change until 2050. The report analyses the risks of climate change for three different major climate hazards—drought, flood and landslide—based on climatological and climate hazard data and identifies current and projected climate hazards and hotspots of vulnerability at the district level in Uganda.

The CRVA is based on foundational climate change downscaling work performed in 2021 which identified and mapped Uganda's climate hazards at the national and subnational levels. This downscaling analysis (Volume 2 of this report) helps in understanding Uganda's climate in the past (1961–1990), changes already recorded (1990–2020) and projected changes under different future projections (2030–2060) in the context of climate change.

The analysed climate hazards (drought, flood and landslide) only turn into a climate risk if they are negatively affecting the population. Climate hazards have therefore been connected to exposure in a specific district, the adaptive capacity of that district and possible impacts they hazards generate for the population and relevant infrastructure (sensitivity). Based on this analysis, climate risks for each of the different hazards can be deduced.

Due to its numerous waterbodies, rivers and lakes, floods pose a significant hazard for Uganda and manifest mostly as riverine floods or flash floods. Most flood-prone areas are in the eastern part of the country, around Mount Elgon and the surrounding lowlands, followed by the area around Lake Albert. Due to the large number of waterbodies and lakes, river and surface flooding is an issue (though with moderate impact) in most parts of the country. Causes for flooding vary, particularly in the case of riverine floods. While heavy rain is one important cause, the rain does not necessarily have to occur at the same place as the flooding, which might make other or additional districts (e.g. adjacent districts) susceptible to flooding. In no future time period under either the RCP 4.5 or 8.5 scenario does any district in Uganda fall in the severe risk category for flood. However, there are significant increases in the level of risk all across the country, and a wide range of districts increase their risk category to significant from moderate over time. This is especially notable in the West Nile subregion, as well as in central Uganda. In contrast, the risk category for the district of Bulambuli decreases to moderate. While there are some differences between the RCP 4.5 and RCP 8.5 scenarios, overall risk is projected to be very similar for the two scenarios, with the districts with significant flood risk extending towards Kayunga and Kamuli for the 2050–2059 projections under the RCP 8.5 scenario.

Drought is a second climate hazard to be considered in Uganda. Although Uganda has not been as severely affected by drought as other countries in the Horn of Africa, it nevertheless has important negative impacts on the country's economic development and food security. For example, the drought that occurred in 2017 left more than 1 million people in urgent need of food assistance (World Bank, 2019). Drought hazard is highest in the semi-arid regions in the north-east, as well as in the West Nile region, with the Karamoja subregion, including Kaabong, Moroto, Kotido, Napak and Amudat, being the most drought-prone. No districts fall into the severe risk category for drought under the RCP 4.5 and RCP 8.5 projections. However, overall drought risk increases significantly, and a large part of the country can be considered to be under significant drought risk in the future. Uganda's entire northern half and parts of western Uganda including Isingiro, Ntungamo, Rukungiri and Mitooma face a significant drought risk in the future. It is of concern that many districts, especially in central Uganda, face a significant flood risk concurrent with facing a significant drought risk due to changes in climate and more extreme weather events.

The landslides examined in this study are those triggered by heavy rains and rain storms. Hilly areas and areas located along steep slopes are particularly prone to landslides. This applies especially to the districts around Mount Elgon, the Rwenzori Mountain range, and the very tip of south-western Uganda at the border with Rwanda and the Democratic Republic of Congo. The risk of landslides is expected to increase in the future, as heavy rain events are expected to become more frequent, making several districts—aside from the three primary areas of vulnerability around Mount Elgon, the Rwenzori Mountains and Muhabura—in the country's north-east (Kaabong) and south-west (Buhweju) with a significant climate risk for landslides.

The CRVA for Uganda at the district level shows that climate change under either the RCP 4.5 or RCP 8.5 scenario increases the risk for floods, droughts and landslide. There appears to be no significant difference for the risk levels between the two scenarios.

Developing adaptation options based on existing hazards and risk profiles is crucial in order to minimize future climate risks. Adaptation to climate change has been a priority for the Government of Uganda throughout the last several years. In this context, a comprehensive process for updating the NDC was undertaken. Additionally, several ministries and other entities have developed regional as well as sectoral adaptation strategies and plans, including the National Adaptation Plan for the Agricultural Sector (MAAIF, 2018). Complementing these efforts, LoCAL has provided an extensive investment menu for local adaptation investments, especially in infrastructure, to local governments.

Many of these documents and plans contain concrete adaptation options that have been widely discussed and approved by a variety of national and subnational stakeholders. For this report, the consultants have analysed existing adaptation strategies and plans and have selected those measures that are relevant for the district level.

Adaptation options have been cross-checked with the sectors most relevant and important to the Ugandan economy and livelihoods at the regional level. In four regional stakeholder consultations in the Northern, Eastern, Central and Western Regions, these adaptation options have been discussed with representatives from local and national government and further refined and adapted. The discussions revealed that, although the individual situation regarding adaptation varies from district to district, priority sectors for adaptation are similar across the region; these priority sectors include governance, infrastructure, water and sanitation, agriculture, forestry, and fisheries.

The district level provides a good basis to define adaptation measures going forward. To be able to start implementation, however, further fine-tuning of the proposed measures through a more in-depth local consultation process will be necessary. This approach will help in further adapting the measures to the specific circumstances at the community and local ecosystem level. The Ministry of Water and Environment is planning such consultations and will use the present report as a basis. Also, the investment officers working with UNCDF will further fine-tune and prepare localized investment strategies before moving ahead with any concrete investment planning.

1 introduction

The Government of Uganda is implementing the Local Climate Adaptive Living Facility (LoCAL)–Uganda mechanism, which it launched in 2022, with the support of the United Nations Capital Development Fund (UNCDF). To inform this effort, a climate change risk and vulnerability assessment (CRVA) was undertaken to provide critical evidence and a scientific analysis to precipitate subnational adaptation to address climate change. The CRVA is based on foundational climate change downscaling work performed in 2021 which identified and mapped Uganda's climate hazards at the national and subnational levels.

1.1 PURPOSE

The main objective of this report is to provide information about current and future risks and the likely impacts of and vulnerability to climate change across the different districts of the country (listed in Annex A, along with political and physical maps of Uganda). The report seeks to enhance general and specific understanding of Uganda's climate change risks, impacts and vulnerability at the national and district levels, including trends and projections, focusing on population and livelihood vulnerability and the sustainable development of key sectors.

The analysis presented will inform adaptation actions and related investment options according to different ecological zones, taking into account the current distinct adaptive capacities existing at the district level. Thus, the findings of this CRVA report will inform short-, medium- and long-term adaptation actions at the district level, including local planning and budgeting.

1.2 SOURCE

This CRVA report for Uganda is based on the climate change risk and impacts model developed by the fifth report of the Intergovernmental Panel on Climate Change (IPCC) and the Paris Agreement. Climate change future projections are defined for 10-year-average time slices and for 2030, 2040 and 2050 future time horizons, based on two IPCC greenhouse gas emissions representative concentration pathway (RCP) scenarios (see Box 1.1)—an intermediate one and the most unfavourable one (RCP 4.5 and RCP 8.5, respectively)—and the assumption that human and natural system trends and interactions will continue without significant change until 2050.

The report is premised on the results of a 2021 Uganda climate change downscaling report undertaken by GlobalCAD and Mancala Consultores that uses an analysis of extreme climate indices and downscales existing climatic data to

BOX 1.1 RCP scenarios

Representative concentration pathway scenarios describe the future evolution of emissions. Depending on the concentration in the atmosphere, emissions will peak at a different point in time. RCP scenarios are concerned with the future evolution of emissions of chemicals that could be radiatively active (e.g. greenhouse gases, aerosols), based on a consistent set of assumptions about the forces that determine them (e.g. demographic and socioeconomic development and technological evolution) and the main relationships between them. The concentration scenarios are obtained from the emissions scenarios, and are inputs for climate models to obtain climate projections.

In its 2014 report (IPCC, 2014b), the IPCC defined four RCP scenarios – a stringent scenario (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0) and a very high emissions scenario (RCP8.5). This report's projections are based on two of these scenarios:

- **RCP 4.5**—a moderate scenario in which emissions peak around 2040 and then decline
- **RCP 8.5**—the highest baseline emissions scenario in which emissions continue to rise throughout the 21st century

the subnational level. The downscaling report is available as Volume 2 of this publication.

1.3 ORGANIZATION

The report is organized into four chapters and five supplementary annexes.

- Following this introduction, Chapter 2 provides a brief overview of the **approach and methods** that informed the CRVA. It defines key terminology, concepts and indicators and sets out the limitations; more detail is provided in Annex B).
- Chapter 3 highlights the findings of the CRVA in terms of **hazard**, **exposure** and **vulnerability**; the historical and projected **risk profiles** that derive from these elements; and the **adaptation actions** proposed based on the assessment results and in consideration of stakeholder feedback (Annex C and Annex D), Uganda's recently updated nationally determined contribution (NDC; MWE, 2022) and other existing sector-specific strategies and adaptation studies.
- The closing Chapter 4 extracts conclusions and recommendations to facilitate successful implementation of climate change adaptation programmes in Uganda and to strengthen the country's national and subnational capacity to adapt to climate change.

A glossary of key terms is presented in Annex F.

Volume 2 of this report presents the climate change downscaling that provides future climate information for Uganda at spatial and temporal scales (extreme climatic indices) relevant to specific climate impacts on the subnational level by downscaling global climate models to a finer scale. Volume 3 is an Excel file with a detailed overview of all indicators, data sheets, available data and their respective weighing.

2 methods

This section describes the methodology used in this report to assess Uganda's climate risk and vulnerability (also see Annex B and Annex F). As used here, **climate risk** refers to the potential for adverse impacts to occur as a result of climate change. The risk profile for a defined spatial entity (e.g. Uganda or any of its regions or districts) with respect to the changing climate depends on three main factors.

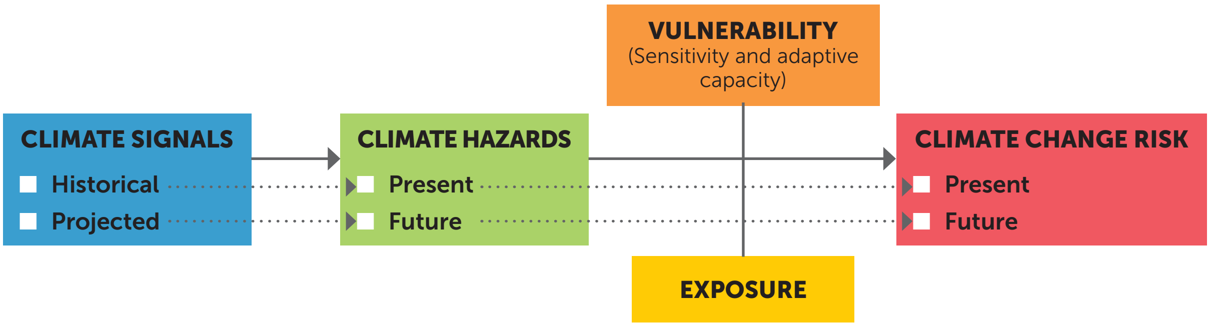
- **Hazard:** "the potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources" (IPCC, 2022, p. 5). The likelihood and severity of climate change–related hazards such as droughts or floods can increase or decrease through changes in climate signals (observed or projected climatic patterns or trends linked to climate change such as precipitation extremes).
- **Exposure:** "the presence of people; livelihoods; species or ecosystems; environmental functions, services and resources; infrastructure; or economic, social or cultural assets in places and settings that could be adversely affected" IPCC, 2022, p. 5).
- **Vulnerability:** "the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt" (IPCC, 2022, p. 5).

  Vulnerability is the combination of susceptibility to harm (sensitivity) and the capacity to cope and adapt (adaptive capacity), which are defined as follows:

  - **Sensitivity:** "The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of flooding)" (IPCC, 2022, p. 2922). In the context of this report, sensitivity refers to adverse effects only.
  - **Adaptive capacity:** "The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities or to respond to consequences" (IPCC, 2022, p. 2899).

Climate risk results from the present and projected prevalence of hazards, the level of exposure and the degree of vulnerability. Figure 2.1 illustrates this overall risk concept, on which this assessment report is based.

FIGURE 2.1 **Climate risk concept for the subnational level in Uganda**



Risk profiles have been established for:

- The present, drawing on historical data covering the period 1990–2019
- Three periods in the future – 2030–2039, 2040–2049 and 2050–2059—based on the RCP 4.5 and 8.5 scenarios, as described in Box 1.1

Extreme climate indices from RCP 4.5 and RCP 8.5 projections derived from the downscaling report (Volume 2) were used to estimate the hazard indices for the three future periods. Annex B provides a description of the methods used for projecting the flood, drought and landslide hazards; Volume 2 provides the indices—i.e. the numerical values describing extreme weather and climate events (such as extreme temperature) in terms of frequency, intensity or duration.

Vulnerability and exposure were not projected because of insufficient data periodicity and poor correlation with available ancillary projected data (i.e. population growth rate). Hence, the same vulnerability and exposure indices were used as for the historical analysis. This approach admittedly has limitations, but was followed in the absence of having no means to project vulnerability and exposure indices with an acceptable level of accuracy.

The assessment draws on publicly available sources, as well as stakeholder consultations. Climate and hazard profiles are based on modelled and observational data using extreme climatic indices. CORDEX was used in the modelling of the climatological data. CORDEX provides daily dynamic downscaled climate change projections that span the entire globe. It was combined with observational data sets that were used to correct a possible bias from the modelled data. The observational data used combine data from stored ground-surface weather stations and from the European Centre for Medium-Range Weather Forecasts' ERA5 fifth-generation atmospheric reanalysis, which provides hourly estimates of a various atmospheric, land and oceanic climate variables. The downscaled historical and projected climate change data formed the climatological basis for the risk and vulnerability assessment. Further details can be found in Volume 2.

The spatial level of analysis corresponds to Uganda's district level. To this end, a shapefile of Uganda containing 122 districts (UNHCR, 2020) was used for the assessment. The full list of districts can be found in Annex A.

The assessment was conducted following the steps outlined in Figure 2.2. Hazard, exposure, vulnerability and climate risk indices were developed according to a standardized scale of values (from 0 to 1), classifying, normalizing and reclassifying indicators and performance ratings.

FIGURE 2.2 **Steps in Uganda CRVA process**

1 Establishing climate hazard profiles

- Historical analysis of climate-hazardous events at local government level
- Determination of historic and current climate-related hazard index at local government level
- Projection of climate-related hazard index at local government level along the RCP 4.5 and 8.5 scenarios, for 2030–2039, 2040–2049 and 2050–2059

2 Establishing climate vulnerability profiles for each hazard

- Analysis of sensitivity at local government level
- Analysis of adaptive capacity at local government level
- Weighting of sensitivity and adaptive capacity indicators through stakeholder consultation
- Establishment of vulnerability index (sensitivity and adaptive capacity) at local government level

3 Establishing exposure profiles for each hazard

- Historical analysis of damages and losses at local government level
- Weighting of exposure indicators through stakeholder consultation
- Establishment of exposure index at local government level

4 Establishing risk profiles for each hazard

- Establishment of exposure-vulnerability profiles at local government level
- Establishment of risk index per district combining hazard levels with exposure-vulnerability profiles
- Validation of CRVA results with stakeholders in each region

5 Developing adaptation options

- Establishment of a long list of adaptation options, taking into account existing strategies and studies
- Prioritization and validation of adaptation options with stakeholders in each region

2.1 HAZARD

Hazard profiles for flood, drought and landslide were established based on the climatic indices analysed in the downscaling report. To support the highest level of accuracy, the climate indices developed in the downscaling report were compared to the National Risk and Vulnerability Atlas (OPM, 2019)—specifically, the integrated flood hazard zonation of Uganda, the integrated drought hazard zonation of Uganda and the landslide susceptibility induced by rainfall. Where applicable and available, these profiles were additionally compared to historic occurrences of hazardous events at the district level, using data from the DesInventar (Disaster Inventory System) database maintained by the United Nations Office for Disaster Risk Reduction. A Pearson correlation coefficient was used to select those extreme climate indices that best related to each hazard and to calculate drought, flood and landslide hazards.

2.2 EXPOSURE

Exposure was determined on the district level. Indicators used for establishing the exposure profile were identified based on data availability at the district level, and validated and weighted during a stakeholder consultation process. Further information with regards to the results of the stakeholder consultation can be found in Annex C. The exposure profile is based on the indicators listed in Table 2.1.

2.3 KEY PERFORMANCE PARAMETERS

A set of key performance parameters were defined for this study to serve as a reference against which to select a series of indicators and indices to measure social performance in efforts to avoid, reduce and reverse the process of the social construction of vulnerability. This implies increasing adaptive capacities while reducing adverse sensitivity.

2.3.1 Governance

Governance, as used here, refers to climate governance, which is defined by the IPCC as the "[p]urposeful mechanisms and measures aimed at steering social systems towards preventing, mitigating, or adapting to the risks posed by climate change" (IPCC, 2018, citing Jagers and Stripple, 2003). Enhancing governance is about clarifying the process of who does what, how and when, to address the climate threat through risk reduction based on sustainable development and adaptation. Reference criteria indicating increased adaptive capacities on this key performance parameter include the following:

- Stakeholders are aware of who does what, how and when, are informed about the risks involved and supported by social-institutional coordination mechanisms.
- Binding agreements are assumed between the parties concerned, and there is mutual trust in compliance with rules and agreements.
- Responsibilities are shared through informed decision-making processes among different stakeholders.
- Adaptation measures are under the leadership of local government, communities and the public and private productive sectors.
- Technical and financial resources are available to develop governance building.
- Land administration is aimed at reducing degradation, and there are institutions that regulate the use of natural resources and land restoration.
- Institutional and social mechanisms address conflict prevention/resolution over natural resource use/management at the local level.

TABLE 2.1 **Summary of exposure indicators used to analyse the different hazards**

Indicator	Description and rationale (source)	Relation to exposure	Relevance	
			For hazard profile	For key stakeholders
3.1 Population density	Number of people per km^2; densely populated areas are more exposed to climate hazards (UBOS census)	+	Flood, drought, landslide	High
3.2 Physical exposure to Flood (high and medium risk)	Districts that face a high to medium risk of being exposed to floods; districts that previously experienced flooding are more exposed to future damage from flooding given increased heavy rains (NRVA)	+	Flood	High
3.3 Physical exposure to landslides induced by rainfall	Districts that face a high to medium risk of being exposed to landslides induced by rainfall; districts that previously experienced rainfall-induced landslides are more exposed to future damage from landslide given increased heavy rains (NRVA)	+	Landslide	High
3.4 Physical exposure of agricultural systems to drought (high and medium risk)	% of different agricultural products exposed to moderate to high drought hazard by district (banana, beans, cassava, maize, millet, rice) (NRVA)	+	Drought	High
3.5 Number of floods and droughts	Number of floods and droughts indicating possible damage and loss due to extreme climate events; higher number of destructive events indicates higher exposure of an area to climate hazards (DesInventar)	+	Flood, drought	High
3.6 Road network vulnerable to flood hazard	Share of road within a district exposed to flood hazard; flood-prone road networks reflect potential infrastructure damage which will affect equity and social cohesion (NRVA)	+	Flood	High
3.7 Road network vulnerable to landslides	Share of road within a district exposed to landslide hazard; landslide-prone road networks reflect potential key infrastructure damage which will affect equity and social cohesion (NRVA)	+	Landslide	Medium
3.8 Hazard exposure of population to flood[a]	% of human population exposed to moderate to high flood hazard (NRVA)	+	Flood	Medium
3.9 Hazard exposure of population to landslides[a]	% of human population exposed to moderate to high landslide hazard (NRVA)	+	Landslide	Medium
3.10 Hazard exposure of population to drought[a]	% of human population exposed to moderate to high drought hazard (NRVA)	+	Drought	Medium
3.11 Hazard exposure of residential buildings to flood[a]	% of residential buildings exposed to moderate to high flood hazard (NRVA)	+	Flood	Medium
3.12 Hazard exposure of residential buildings to landslides[a]	% of residential buildings exposed to moderate to high landslide hazard (NRVA)	+	Landslide	Medium

NOTE: NRVA = National Risk and Vulnerability Atlas; UBOS = Uganda Bureau of Statistics. Indicators are numbered by assessment category as follows: 1.x = sensitivity; 2.x = adaptive capacity; 3.x = exposure. Indicator wording has been lightly edited for clarity and consistency. Based on polls of results and priorities from relevant stakeholders, relative weights (high, medium, low) were assigned to each indicator (see Annex B). Volume 3 contains a detailed overview of all indicators, data sheets, available data and their respective weighting.

b. Suggested during stakeholder consultation; since these indicators were not polled (see Annex B), they were assigned a medium weight.

2.3.2 Knowledge and innovation

Recognizing the importance of expanding knowledge through research, development and innovation is a key factor in modifying practices in organizations, the economy, society and the use of land and natural resources; this understanding—which is crucial for adaptation—is reflected in the correction of the processes of degradation of the climate system and its impact on society and the most vulnerable. Reference criteria indicating increased adaptive capacities on this key performance parameter include the following:

- Effective hydrometeorological surveillance networks with periodic quality registration with sufficient institutional capacity to inform and social skills to respond to warnings and alerts
- Research, development and innovation of local, traditional and ancestral scientific knowledge
- Scientific advice and monitoring by specialized public and private academic institutions
- Devices for the exchange and dissemination of knowledge, successful experiences and lessons learned from the processes and measures to reduce vulnerability and adapt to climate change

2.3.3 Equity and social cohesion

Inequalities are one of the main coefficients of vulnerability and the primary challenge for sustainable development based on risk reduction and adaptation. Social cohesion, through the eradication of inequalities, is the key strategy to change conditions and look to prevent, reduce and reverse vulnerability by increasing adaptive capacity and resilience. Similarly, the eradication of social and gender inequality can increase the capacity of women, groups in conditions of poverty, indigenous groups and other groups in conditions of social exclusion to strengthen the resilience and sustainability of their livelihoods and the quality of their living environment.

Reference criteria indicating increased adaptive capacities on this key performance parameter include the following:

- Equity in sustainable access to housing, nutrition (water), education, health and environmental sanitation; as well as access to productive work, natural resources, energy, telecommunications and service infrastructure
- Diversity of income sources and livelihoods associated with natural resources and ecosystem services or other activities for which productivity variation is strongly related and dependent on climate conditions
- Reduction of intersectional gender dependency, inequity or exclusion: disability, women, children and the elderly; populations belonging to certain ethnic groups or religions; migrants or any other exclusion factor
- Promotion of capacity to organize and participate in decision-making spaces aimed at improving conditions of belonging, self-help networks and institutional support systems

2.3.4 Ecosystem integrity

Halting and reversing land degradation involves restoring degraded ecosystems and sustainably managing resources through a commitment to neutrality in land degradation, in order to preserve food and freshwater production, protect against the dangers of climate change, and sustain future demand without further degrading the finite resource base of regions and localities. Reference criteria indicating increased adaptive capacities on this key performance parameter include the following:

- Sustain and improve the sustainable function of ecosystems and productivity, ensuring biodiversity.
- Improve food security and increase the resilience of land and populations, seeking synergies with other social, economic and environmental objectives.

- Implement productive social practices of a zero carbon or carbon sink nature and land degradation neutrality that support agricultural, livestock and fishery biodiversity, including unharvested/captured species.

2.4 VULNERABILITY

Vulnerability is shaped by a series of drivers originating from politically assumed development paths. Underlying drivers for increased vulnerability are related to, for example, environmental degradation, obstacles to achieving the Sustainable Development Goals, disaster risks etc. For this report, indicators related to the key performance parameters discussed above (governance, knowledge and innovation, equity and social cohesion, and ecosystem integrity) have been identified as important drivers for vulnerability.

2.4.1 Sensitivity

The indicators selected for the sensitivity profile are shown in Table 2.2; all indicators demonstrate adverse sensitivity.

2.4.2 Adaptive capacity

The indicators selected for the adaptive capacity analysis are shown in Table 2.3.

2.4.3 Vulnerability index

The weighted indices of sensitivity and negative adaptive capacity were averaged to define a vulnerability index at the district level. The data set was normalized using the min/max method (see Annex B). The highest possible number is 1, and the lowest 0. The highest number corresponds to the districts that are highly vulnerable, whereas the lowest values show districts that are less vulnerable.

2.5 RISK

Risk is conceptualized as the interaction between vulnerability conditions and the exposed physical elements to hazardous processes and events. To calculate risk, a two-step process has been used (Figure 2.3).

1. The exposure and vulnerability levels of a specific district are combined, resulting in exposure-vulnerability categories. The levels for each main component (exposure, vulnerability and hazard) were determined by categorizing each data set as high, moderate or low. For example, a district x that has low levels of vulnerability and exposure results in a very low exposure-vulnerability combination. Conversely, a district y with high levels

FIGURE 2.3 **Two-step process used to determine risk level for each district**

Step 1		Vulnerability		
		High	Moderate	Low
Exposure	High	Very high	High	Moderate
	Moderate	High	Moderate	Low
	Low	Moderate	Low	Very low

Step 2		Exposure-vulnerability				
		Very high	High	Moderate	Low	Very low
Hazard	High	Severe	Significant	Significant	Moderate	Minor
	Moderate	Significant	Moderate	Moderate	Moderate	Minor
	Low	Significant	Moderate	Moderate	Minor	Negligible

TABLE 2.2 **Summary of indicators used for the sensitivity analysis**

Indicator	Key performance parameter	Description and rationale (source)	Relation to sensitivity	Relevance	
				For hazard profile	For key stakeholders
1.1 Number of houses destroyed or damaged by disasters	Equity and social cohesion	Higher number indicates greater sensitivity to effects of changing climate, specifically a potentially increasing number of related hazards (DesInventar)	+	Flood	High
1.2 Number of people directly and indirectly affected by type of disaster	Equity and social cohesion	Higher number indicates greater sensitivity to climate change–related hazard resulting from unequal access to relevant infrastructure (DesInventar)	+	Flood, drought, landslide	High
1.3 Dead, injured and missing due to natural hazards	Equity and social cohesion	Higher number indicates greater sensitivity to climate change hazards resulting from unequal access to relevant infrastructure such as housing, health or telecommunications (DesInventar)	+	Flood, drought, landslide	High
1.4 Damage to crops	Ecosystem integrity	Amount of cultivated or pastoral land destroyed or affected can have a negative effect on food security; districts with larger area of destroyed crops resulting from climate change hazards indicate greater sensitivity in terms of food security (DesInventar)	+	Flood, drought	High
1.5 Cattle loss due to disaster	Ecosystem integrity	Amount of lost cattle can have a negative effect on livelihoods and food security; districts with larger area of lost cattle resulting from climate change hazards indicate higher vulnerability to climate hazards / higher sensitivity with respect to food security (DesInventar)	+	Flood	High
1.6 Households dependent on subsistence farming	Equity and social cohesion	Districts with a higher share of households dependent on subsistence farming are considered more sensitive to climate change–related hazards, as climate hazard–induced decrease of farming productivity directly threatens livelihoods (UBOS census)	+	Flood, drought, landslide	Low

NOTE: UBOS = Uganda Bureau of Statistics. Indicators are numbered by assessment category as follows: 1.x = sensitivity; 2.x = adaptive capacity; 3.x = exposure. Indicator wording has been lightly edited for clarity and consistency. Based on polls of results and priorities from relevant stakeholders, relative weights (high, medium, low) were assigned to each indicator (see Annex B). Volume 3 contains a detailed overview of all indicators, data sheets, available data and their respective weighting.

TABLE 2.3 **Summary of indicators used for the adaptive capacity analysis**

Indicator	Key performance parameter	Description and rationale (source)	Relation to adaptive capacity	Relevance	
				For hazard profile	For key stakeholders
2.1 Percentage of households headed by women	Equity and social cohesion	Households headed by women are generally considered more vulnerable; thus, a larger share of women-headed households would mean a reduction in adaptive capacity (UBOS regional census)	–	Flood, drought landslide	High
2.2 Households whose members age 5+ years consume < 2 meals/day	Equity and social cohesion	Larger number indicates higher sensitivity to climate change–related hazard resulting from unequal access to relevant infrastructure (UBOS regional census)	–	Flood, drought, landslide	High
2.3 Households more than 5 km away from any health facility	Equity and social cohesion	Households with greater distance to a health facility are considered more vulnerable (UBOS regional census)	–	Flood, drought, landslide	High
2.4 Share of total budget for stakeholder environmental training and sensitization	Governance	Larger share of budget is a proxy indicator of level of training and sensitization of stakeholders towards climate change (Uganda budget)	+	Flood, drought, landslide	High
2.5 Local governments implementing climate change interventions in their district development plans	Governance	District governments with stand-alone projects involving climate change interventions are better prepared and thus demonstrate higher adaptive capacity to climate change (district assessment plans)	+	Flood, drought, landslide	High
2.6 Safeguards for service delivery of investments effectively handled; evidence that environmental, social and climate change interventions have been integrated into local government development plans and annual work plans and budgets complied with	Governance	Climate change interventions as part of local government development plans indicates a certain degree of preparedness for climate change at the local government level (local government assessment reports)	+	Flood, drought, landslide	High

(continued)

TABLE 2.3 **Summary of indicators used for the adaptive capacity analysis** *(continued)*

Indicator	Key performance parameter	Description and rationale (source)	Relation to adaptive capacity	Relevance	
				For hazard profile	For key stakeholders
2.7 Number / density / geographic coverage of UNMA weather and climate observation stations[a]	Knowledge and innovation	The availability of technical resource capacity of weather stations enables provision of timely weather forecasts and early warning services; the more timely and accurate weather information that can be provided, the greater the preparedness and thus the adaptive capacity (UNMA)	+	Flood, drought, landslide	No data available
2.8 Districts with infectious disease institute[b]	Knowledge and innovation	In districts where an infectious disease institute is present, more timely and accurately disease-related information can be provided, enabling greater preparedness and thus adaptive capacity to climate change–induced potential increase of water- and vector-borne diseases (Infectious Diseases Institute)	+	Flood, drought, landslide	Disregarded by stake-holders
2.9 Number of functional health facilities by region/ district capital per 10,000 people	Equity and social cohesion	Larger number of health facilities indicates a higher level of capacity for medical treatment of climate change–induced diseases and emergencies, thus indicating a higher level of adaptive capacity with respect to access to relevant infrastructure (World Health Organization)	+	Flood, drought, landslide	High
2.10 Proportion of poor persons by district	Equity and social cohesion	The greater the share of poor people, the lower the adaptive capacity, assuming limited means to respond to changing climate and higher vulnerability in terms of health conditions (UBOS)	+	Flood, drought, landslide	High
2.11 Forest cover (% of land area)	Ecosystem integrity	Districts with a larger forest area are more able to sustain and improve sustainable functioning of ecosystems and productivity (UBOS)	+	Flood, drought, landslide	High
2.12 Share of people who own mobile phones	Equity and social cohesion	People with mobiles phones can react faster in case of emergencies and inform themselves / be informed more quickly, indicating higher adaptive capacity (UBOS census)	+	Flood, drought, landslide	Medium
2.13 Wetland cover (% of total area)	Ecosystem integrity	Wetlands in general and inland wetlands in particular help buffer against some climate change hazards and therefore increase adaptive capacity	+	Flood, drought	High

(continued)

TABLE 2.3 **Summary of indicators used for the adaptive capacity analysis** *(continued)*

Indicator	Key performance parameter	Description and rationale (source)	Relation to adaptive capacity	Relevance	
				For hazard profile	For key stakeholders
2.14 Percentage of households with a permanent roof	Equity and social cohesion	Households with permanent roofs are less exposed to heavy weather events such as strong rain and therefore considered to demonstrate higher adaptive capacity to climate change (UBOS census)	+	Flood, drought, landslide	High
2.15 Percentage of households with a radio	Equity and social cohesion	Households with radios can be informed quickly about potential climate threats and related measures, indicating a higher adaptive capacity (UBOS census)	+	Flood, drought, landslide	Medium
2.16 Percentage of households with mosquito nets	Equity and social cohesion	Households with mosquito nets can protect themselves better from potentially climate change induced increase of vector spreading infectious diseases (UBOS census)	+	Flood, drought	Medium
2.17 Percentage of households with access to piped water	Equity and social cohesion	Households with access to piped water are more likely to have access to clean water in case of severe climate events or illness (UBOS census)	+	Flood, drought, landslide	Medium
2.18 Percentage of households with a bank account	Equity and social cohesion	Households with bank accounts are assumed to have greater financial security to respond to climate change–induced damages and are therefore considered to demonstrate a higher adaptive capacity (UBOS census)	+	Flood, drought, landslide	Low
2.19 Percentage of households with electric lighting	Equity and social cohesion	Indicator used as proxy for access to electricity in general; households with access to electricity are considered to have a higher adaptive capacity, as electricity allows e.g. better access to electronic communication devices and therefore better access to relevant information (UBOS census)	+	Flood, drought, landslide	Suggested during consultation
2.20 Percentage of households headed by 10- to 17-year-olds	Equity and social cohesion	Households headed by children are generally considered more vulnerable; thus, a larger share of children-headed households would mean lower adaptive capacity (UBOS census)	–	Flood, drought, landslide	Suggested during consultation

NOTE: UBOS = Uganda Bureau of Statistics; UNMA = Uganda National Meteorological Authority. Indicators are numbered by assessment category as follows: 1.x = sensitivity; 2.x = adaptive capacity; 3.x = exposure. Indicator wording has been lightly edited for clarity and consistency. Based on polls of results and priorities from relevant stakeholders, relative weights (high, medium, low) were assigned to each indicator (see Annex B). Volume 3 contains a detailed overview of all indicators, data sheets, available data and their respective weighting.

a. Data were not available to calculate this indicator.

b. Indicator was determined to be not relevant during stakeholder consultation and was subsequently not considered.

of vulnerability and exposure results in a very high exposure-vulnerability combination.

2. Those results were combined with existing hazard levels to obtain the risk index. For instance, a district x with a very low exposure-vulnerability combination and a corresponding low hazard level results in a negligible risk. Conversely, district y with a very high exposure-vulnerability combination and a corresponding low hazard level results in a significant risk.

2.6 DEVELOPMENT OF ADAPTATION OPTIONS

Adaptation options, strategies and measures for the district level will be developed in light of the following considerations:

- Uganda recently completed a comprehensive NDC review process that was conducted based on a scientific assessment as well as consultation with a wide range of national and subnational stakeholders. Any adaptation options to be proposed at the subnational level should be in line with the results of the adopted NDC process.
- A number of existing strategies and studies focus on adaptation at the sectoral level in Uganda—e.g. the recently developed risk and vulnerability assessment for the water and sanitation sector, and the 2018 National Adaptation Plan for the Agricultural Sector (MAAIF, 2018); these include a wide range of adaptation strategies and recommendations.

The consultants analysed the results of the above-mentioned strategies and studies and matched them to the results of the CRVA to propose a list of suitable adaptation and investment options. The list of climate actions was discussed with stakeholders at the regional level to confirm their utility and viability.

2.7 DATA LIMITATIONS

The CRVA relied on available data at the local government level. Indicators were chosen based on their relevance as well as on their availability at the local government level.

- For most of the indicators on sensitivity and one indicator of adaptive capacity, historical data from DesInventar have been used. This database registers events that led to damages and losses between 1960 and 2020. Data for Uganda are available for a wide number of events; however they are most likely not complete, as data had to be publicly recorded to appear in DesInventar.[1]
- Uganda's National Risk and Vulnerability Atlas was one of the most valuable data sources used for the CRVA at the subnational level. As the consultants did not have access to the source data, normalized data from the maps produced for the atlas were used as a basis for all calculations in this report. These provide a relevant proxy for information at the local government level, but do not reflect the exact data used to construct the maps in the atlas. For this reason, the calculations in this CRVA using atlas data do not have the same degree of accuracy as does the National Risk and Vulnerability Atlas.
- Data for the different indicators are not available in all cases for the same point in time or period looked at (e.g. data drawn from the Uganda census refer to 2014, whereas the proportion of poor people per district is based on data from 2016). This has two implications for the study methodology and results.
- The data basis for some indicators is more up to date or recent than for others.
- Over the past decades, Uganda has continuously divided its districts into smaller units.

[1] For limitations of DesInventar data sources, see "The challenge of information sources" on the DesInventar Sendai website.

In consequence, the district for which a specific data point for one indicator was available in a certain year in the past might not exist today. Similarly, for a district that was only recently formed, data might not be available for earlier years. In those cases, data from old districts (from the same geographical location) were used as proxies for the new districts (see Annex A for a list of districts used).

- Maps have been constructed based on a shapefile that does not include the district cities. Information on those can be found in the corresponding Excel files in Volume 3.

3 results

This chapter provides an overview of the CRVA results for flood, drought and landslide at the subnational level. Paralleling the structure of the methodology, it presents results for hazards, exposure and vulnerability, followed by the development of risk profiles for each of the hazards. See Figure A.1 and Figure A.2 in Annex A for maps of Uganda showing, respectively, regions/districts and topography.

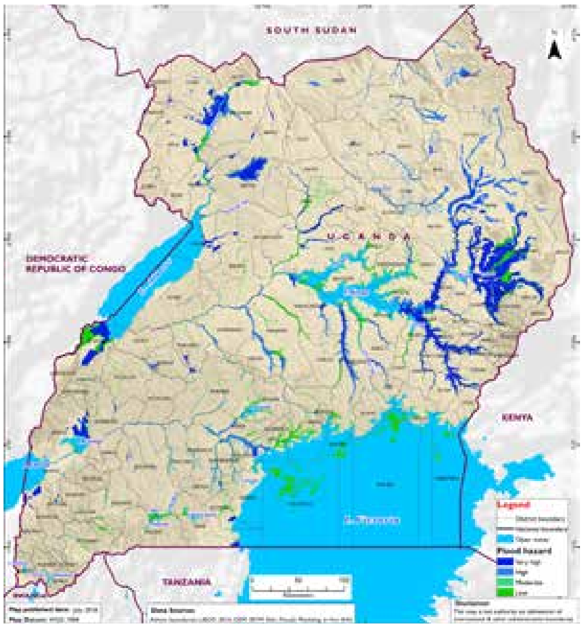
3.1 HAZARD PROFILES

3.1.1 Flood

Flood is the overflow of normally dry areas caused by an overflow of waterbodies, surface water that is not able to run off, abnormal erosion or an undermining of the shoreline (Mukherjee, 2016). In Uganda, given its large number of rivers, lakes and other waterbodies, floods are mostly riverine floods or flash floods. Based on its comprehensive overview of flood hazards in Uganda, the National Risk and Vulnerability Atlas (OPM, 2019) has demarcated the country's flood hazard zones (Figure 3.1). Using this flood hazard zonation and averaged extreme climate indices from the downscaling report, an integrated flood hazard profile was developed (Figure 3.2).

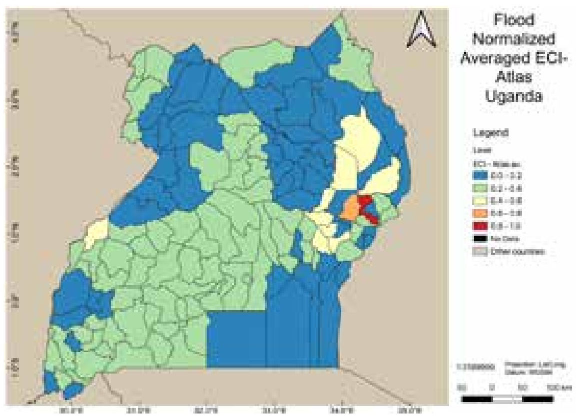
Most flood-prone areas are in the eastern part of the country, around Mount Elgon and the

FIGURE 3.1 **Flood hazard zones**



SOURCE: OPM, 2019.

FIGURE 3.2 **Flood hazard profile**



SOURCE: Data from Climate Change Downscaling Report.
NOTE: ECI = extreme climate indices.

surrounding lowlands, followed by the area around Lake Albert. Due to the large number of waterbodies and lakes, river and surface flooding is an issue (though with moderate impact) in most parts of the country.

As noted above, floods in Uganda are mainly riverine or flash floods. Causes for flooding vary, particularly in the case of riverine floods. While heavy rain is one important cause, the rain does not necessarily have to occur at the same place as the flooding, which might make other or additional districts (e.g. adjacent districts) susceptible to flooding.

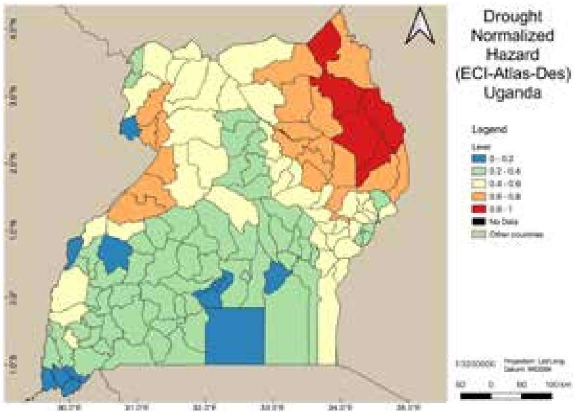
3.1.2 Drought

Droughts are sustained periods of below-average water availability. Although Uganda has not been as severely affected by drought as other countries in the Horn of Africa, it nevertheless has important negative impacts on the country's economic development and food security. For example, the drought that occurred in 2017 left more than 1 million people in urgent need of food assistance (World Bank, 2019). To best represent Uganda's drought hazard, extreme climate indices from the downscaling report were combined with the integrated drought zonation drawn from the National Risk and Vulnerability Atlas and DesInventar data for Uganda to reflect those areas where damages and losses caused by drought were most severe.[1]

Drought hazard is highest in the semi-arid areas in the north-east of the country as well as in the West Nile subregion (Figure 3.3); the Karamoja subregion, including the Kaabong, Moroto, Kotido, Napak and Amudat districts, is the most drought-prone.

[1] The DesInventar (Disaster Inventory System) Uganda profile covers the period 1933–2020.

FIGURE 3.3 **Drought hazard profile**



SOURCE: Data from Climate Change Downscaling Report.
NOTE: ECI = extreme climate indices.

Overall, drought susceptibility increases from the beginning of the year and only declines towards the second heavy rain season between September and November (OPM, 2019).[2]

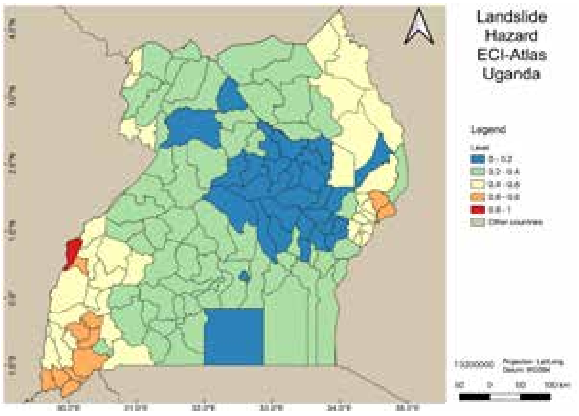
3.1.3 Landslide

Rainfall-induced landslides predominantly occur in hilly areas or areas located along steep terrain.[3] In Uganda, these areas are mostly around Mount Elgon, the region around the Muhabura plains, and the Rwenzori Mountains, all of which exhibit a high to very high level of landslide hazard. Based on hazard calculations combining extreme climate indices and data from the National Risk and Vulnerability Atlas, the districts most prone to landslides induced by rainfall include Kween and Bukwo in the east around Mount Elgon; and Kisoro, Rubanda, Kabale, Rukiga, Bushenyi, Sheema, Buhweju, Bundibugyo and Bunyangabu in western Uganda (Figure 3.4). Other districts around Mount Elgon, including Kapchorwa, Sironko, Bududa, Mbale and Namisindwa, are also highly susceptible to rainfall-triggered landslides but are not shown in the map because of inaccuracies in the extreme climate indices data (see Annex B for further detail).

[2] The first heavy rain season is from March to May.

[3] Landslides in Uganda are mostly triggered by rainfall or earthquakes; those triggered by earthquakes are not considered in this report, as these are not a climate-related hazard.

FIGURE 3.4 **Landslide hazard profile**



SOURCE: Data from Climate Change Downscaling Report.
NOTE: ECI = extreme climate indices.

3.2 EXPOSURE

Exposure was calculated separately for the three hazards (flood, drought and landslide), as districts are exposed to each type of hazard differently depending on their geographic location.

3.2.1 Flood

Flood exposure was calculated using the indicators listed in Table 3.1.

Overall flood exposure is highest in central Uganda, specifically, Kampala; north-east districts (Bulambuli, Butaleja and Katakwi); followed by districts in the east such as Bukedea, Nakapiripirit, Sironko, Napak, Ngora, Pallisa, Kibuku, Tororo

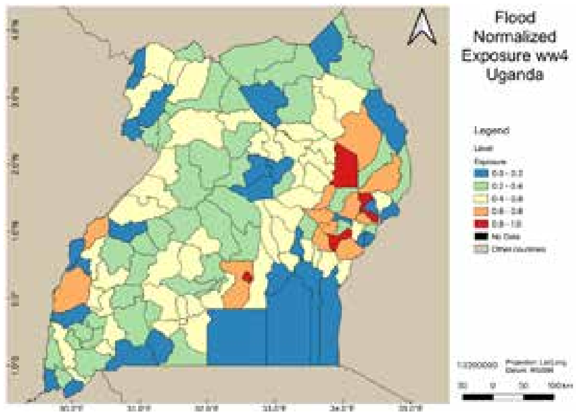
TABLE 3.1 **Indicators used to calculate flood exposure**

	Indicator
■	3.1 Population density
■	3.2 Physical exposure to flood (high and medium risk)
■	3.5 Number of floods and droughts
■	3.6 Road network vulnerable to flood hazard
■	3.8 Hazard exposure of population to flood
■	3.11 Hazard exposure of residential buildings to flood

NOTE: Indicator numbering reflects master list (Volume 3); indicator wording has been lightly edited for clarity and consistency. Shading designates indicator's relevance as prioritized by key stakeholders: ■ high; ■ medium; ■ low.

and Namutumba, Wakiso in central Ntoroko and Kasese in the west are also in this second category of vulnerability to floods. A flood exposure map (Figure 3.5) has been constructed based on a weighted average of indicators representing different aspects of exposure related to population, ecosystems and infrastructure. Exposure for each aspect differs depending on the indicator: for example, districts with a high exposure for their infrastructure do not necessarily have a similarly high exposure for their human population.

FIGURE 3.5 **Flood exposure weighted by district**

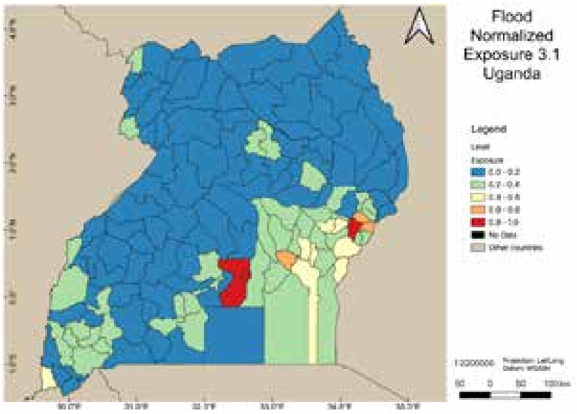


SOURCE: Data from Climate Change Downscaling Report.

Population density is highest in Kampala and Wakiso, followed by Mbale (Figure 3.6). Overall population density is an important proxy for exposure, as the more people who live in a district per square kilometre, the greater the possibility they will be exposed to climate hazards.

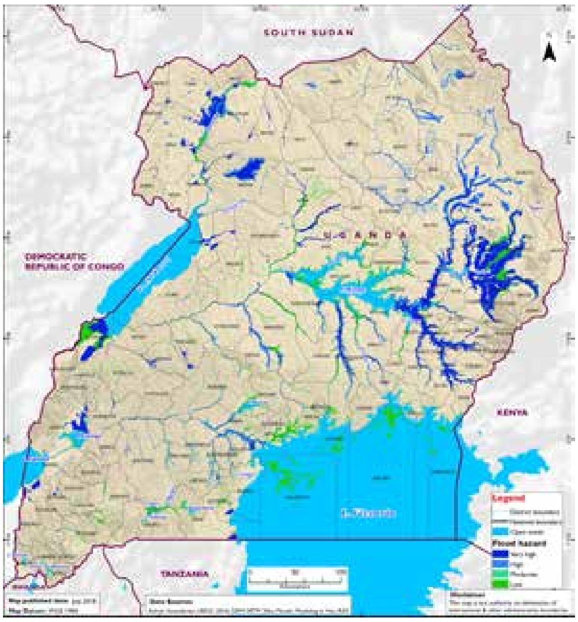
The National Risk and Vulnerability Atlas places all districts with a high to medium risk of being exposed to floods in an integrated flood hazard zonation. To calculate exposure, the atlas data for the districts have been normalized on a scale of 0–1 for the different districts (Figure 3.7). Based on the normalized data, the Eastern Region around Bulambuli as well as the lowlands in eastern Uganda are found to be the most affected, followed by Ntoroko in the west and Adjumani and Moyo in the north.

FIGURE 3.6 **Population density (Indicator 3.1)**



SOURCE: Data from Climate Change Downscaling Report.

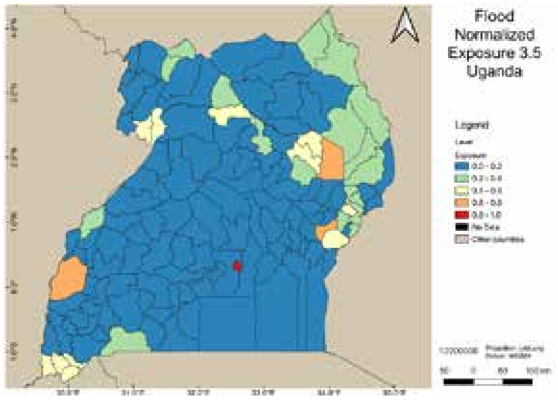
FIGURE 3.7 **Physical exposure to flood (Indicator 3.2)**



SOURCE: OPM, 2019.

Kampala is the area most affected by floods, in terms of loss and damage incurred (Figure 3.8). Its high population density and urban environment explain the city's high exposure to floods. Other districts where floods and subsequent losses and damages reflect a higher exposure of people, ecosystems and infrastructure to floods are Butaleja, Katakwi and Kasese.

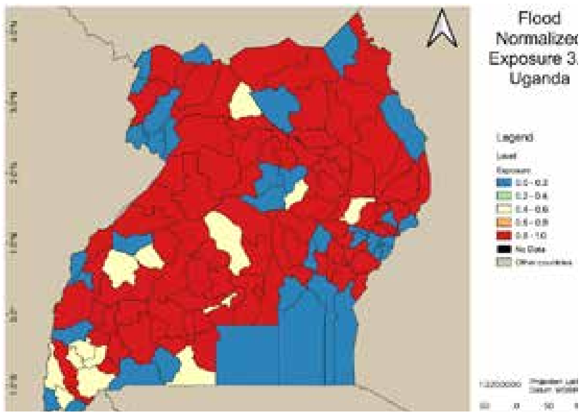
FIGURE 3.8 **Number of floods (Indicator 3.5)**



SOURCES: Data from Climate Change Downscaling Report; DesInventar.

The map in Figure 3.9 normalizes the data for exposure of the road network of the National Risk and Vulnerability Atlas, showing in red those districts where part of the road network is very highly or highly exposed to flood hazard. The atlas provides detailed information on which parts of the network are at risk. Overall, the most exposed roads are in the Kitgum, Katakwi, Sembabule and Kalungu districts.

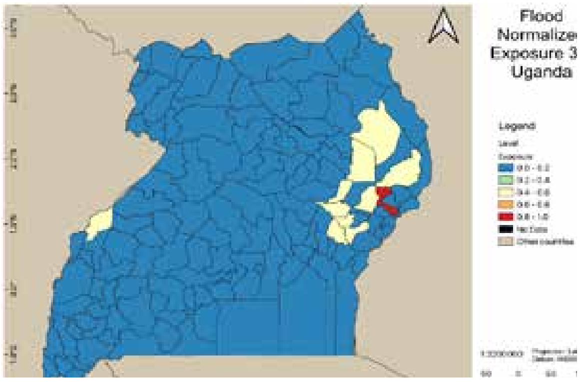
FIGURE 3.9 **Road network vulnerable to flood hazard (Indicator 3.6)**



SOURCES: Data from Climate Change Downscaling Report; OPM, 2019.

Based on normalized atlas data, the population of the Eastern Region, especially in Bulambuli, is most exposed to flooding, followed by Ntoroko in the Western Region (Figure 3.10).

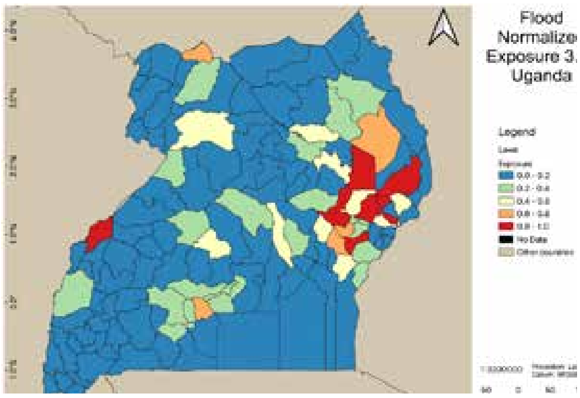
FIGURE 3.10 **Hazard exposure of population to flood (Indicator 3.8)**



SOURCES: Data from Climate Change Downscaling Report; OPM, 2019.

Based on normalized atlas data, residential buildings in districts in the Eastern Region (especially the Katakwi, Butaleja, Pallisa, Ngora, Bulambuli and Bukedea districts), as well as in Ntoroko in the Western Region, are most affected by flooding. They are followed by Moyo in the Northern Region and Kalungu in the Central (Figure 3.11).

FIGURE 3.11 **Hazard exposure of residential buildings to flood (Indicator 3.11)**



SOURCES: Data from Climate Change Downscaling Report; OPM, 2019.

3.2.2 Drought

Drought exposure was calculated using the indicators listed in Table 3.2.

Overall, drought exposure is highest in the Northern and Eastern Regions of the country, with exposure highest in Moroto, Kaabong and Kotido in the north; Mbale in the east; and Isingiro in the south. Additionally, all districts surrounding the

TABLE 3.2 **Indicators used to calculate drought exposure**

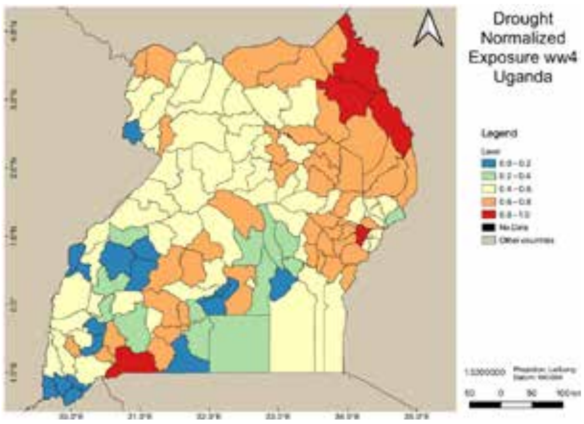
	Indicator
■	3.1 Population density
■	3.4 Physical exposure of agricultural systems to drought (high and medium risk)
■	3.5 Number of floods and droughts
■	3.10 Hazard exposure of population to drought

NOTE: Indicator numbering reflects master list (Volume 3); indicator wording has been lightly edited for clarity and consistency. Shading designates indicator's relevance as prioritized by key stakeholders: ■ high; ■ medium; ■ low.

above-mentioned areas (the Northern Region, the region south of Mount Elgon, and the cattle corridor) have a significant drought exposure.

The drought exposure map was constructed based on a weighted average of different indicators representing different aspects of exposure related to population, ecosystems and infrastructure (Figure 3.12). Exposure for each of these aspects varies depending on the indicator and district. High exposure of agricultural crops, for example, does not necessarily correspond with a high rate of exposure of the human population.

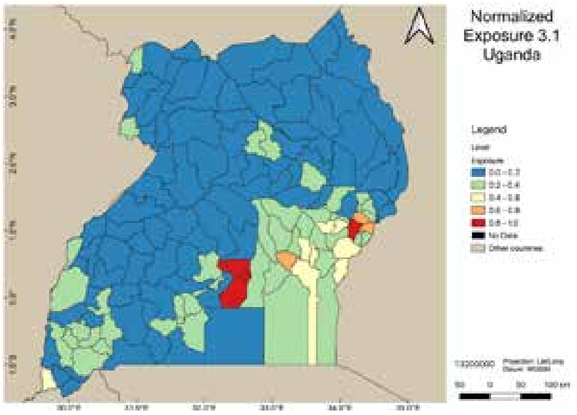
FIGURE 3.12 **Drought exposure weighted by district**



SOURCE: Data from Climate Change Downscaling Report.

Population density is highest in Kampala and Wakiso, followed by Mbale (Figure 3.13). Overall population density is an important proxy for exposure, as the more people who live in a district per square kilometre, the greater the possibility that they will be exposed to climate hazards.

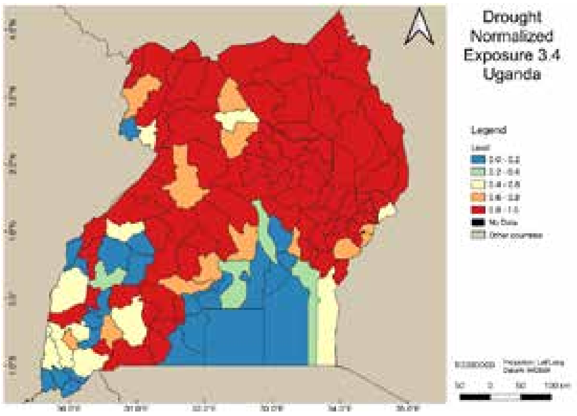
FIGURE 3.13 **Population density (Indicator 3.1)**



SOURCE: Data from Climate Change Downscaling Report.

The National Risk and Vulnerability Atlas provides information on six different crops and their exposure to droughts. This map combines exposure of bananas, beans, cassava, maize, millet and rice production to drought and identifies those districts that are at high and medium risk. Because different crops are involved and agricultural systems' exposure to drought is widespread, a large proportion of districts are highly affected (Figure 3.14).

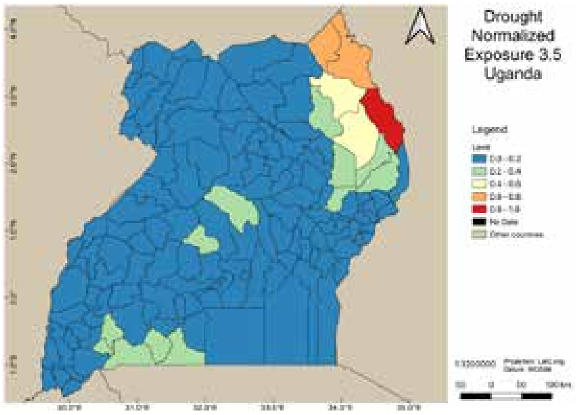
FIGURE 3.14 **Physical exposure of agricultural systems to drought (Indicator 3.4)**



SOURCE: Data from Climate Change Downscaling Report.

Regarding registered loss and damage caused by droughts, the northern part of the country, especially the districts bordering Kenya, are most affected: Moroto is the leading district, followed by Kaabong and Karenga (Figure 3.15).

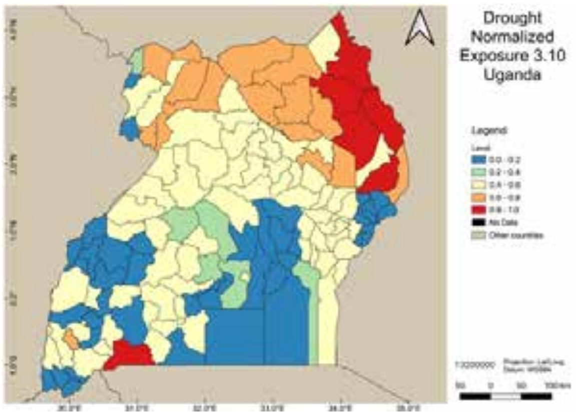
FIGURE 3.15 **Number of droughts (Indicator 3.5)**



SOURCES: Data from Climate Change Downscaling Report; DesInventar.

Based on normalized atlas data, populations in the Northern Region—especially Moroto, Kaabong, Kotido, Napak and Nakapiripirit—as well as the district of Isingiro are severely exposed to drought hazards (Figure 3.16). These areas are closely followed by a wide range of other districts in the north and east, as well as by Mitooma in the south.

FIGURE 3.16 **Hazard exposure of population to drought (Indicator 3.10)**



SOURCES: Data from Climate Change Downscaling Report; OPM, 2019.

3.2.3 Landslide

Exposure to landslide was calculated using the indicators listed in Table 3.3.

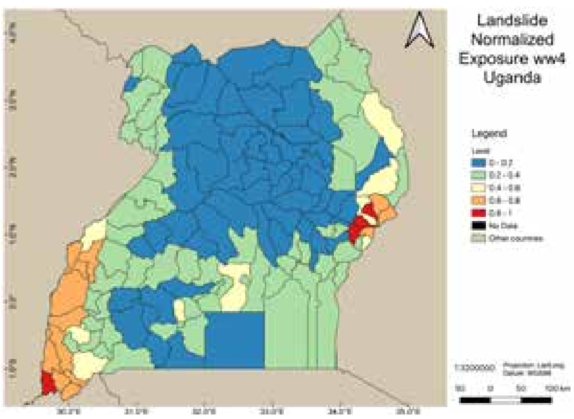
TABLE 3.3 Indicators used to calculate landslide exposure

	Indicator
	3.1 Population density
	3.3 Physical exposure to landslides induced by rainfall
	3.7 Road network vulnerable to landslide hazard
	3.9 Hazard exposure of population to landslides
	3.12 Hazard exposure of residential buildings to landslides

NOTE: Indicator numbering reflects master list (Volume 3); indicator wording has been lightly edited for clarity and consistency. Shading designates indicator's relevance as prioritized by key stakeholders: ■ high; ■ medium; ■ low.

Overall, landslide exposure is highest in the Eastern Region (around Mount Elgon) and to the south-west around the Muhabura plains as well as around the Rwenzori Mountains (Figure 3.17). The landslide exposure map was constructed based on a weighted average of indicators representing different aspects of exposure related to population, ecosystems or infrastructure. Exposure for each of the different aspects varies depending on the indicator and district. However, as rain-induced landslides in Uganda are a geographically contained phenomenon (located at hilly areas or areas located along steep slope terrain), district exposure to landslides is similar for all indicators.

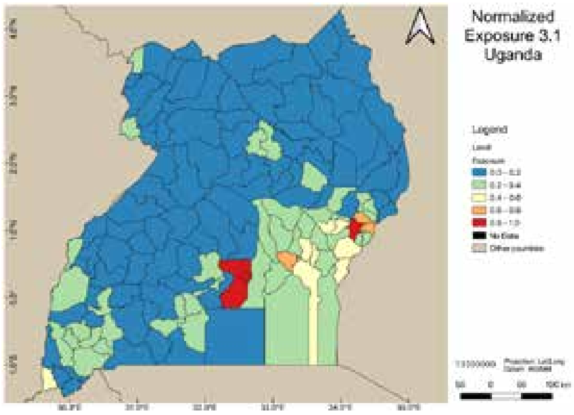
FIGURE 3.17 Landslide exposure weighted by district



SOURCE: Data from Climate Change Downscaling Report.

Population density is highest in Kampala and Wakiso, followed by Mbale (Figure 3.18). In general, population density is an important proxy for exposure, as the more people who live in a district per square kilometre, the greater the possibility they will be exposed to climate hazards.

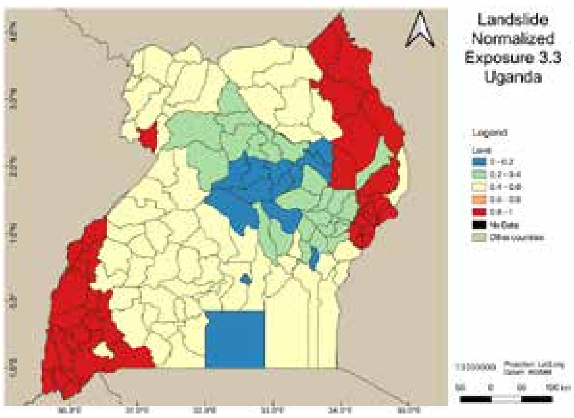
FIGURE 3.18 Population density (Indicator 3.1)



SOURCE: Data from Climate Change Downscaling Report.

The rainfall-induced landslide susceptibility map shown in Figure 3.19 was generated based on a normalization of National Risk and Vulnerability Atlas data. Districts that have previously experienced heavy rain–induced landslides are more exposed to such landslides in the future as well. The map notably contains districts with hilly areas

FIGURE 3.19 Physical exposure to landslides induced by rainfall (Indicator 3.3)

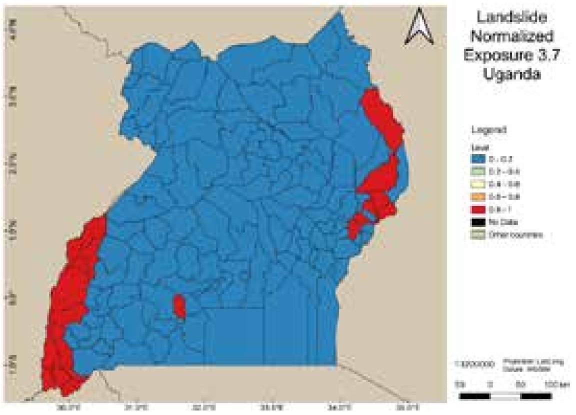


SOURCES: Data from Climate Change Downscaling Report; OPM, 2019.

and steep slope terrains, such as Bududa, Bukwo, Kisoro, Kabale, Rubanda and Kasese.

Figure 3.20 normalizes the National Risk and Vulnerability Atlas map for exposure of the road network, showing in red those districts where part of the road network is very highly or highly exposed to landslide hazard. The atlas provides detailed information on which parts of the network are at risk. Overall, the most exposed roads are in the west and the south; notably, the murram roads in Kasese and Bukwo are highly exposed.

FIGURE 3.20 Road network vulnerable to landslide hazard (Indicator 3.7)

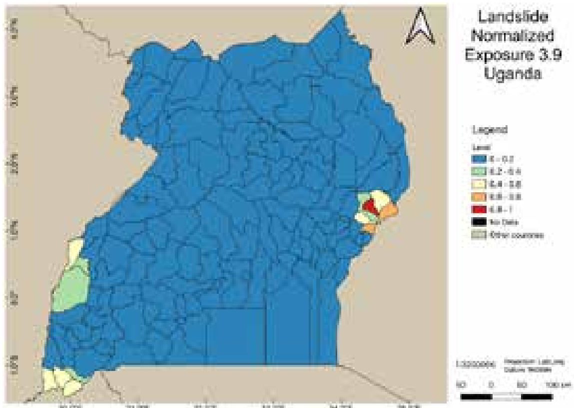


SOURCES: Data from Climate Change Downscaling Report; OPM, 2019.

Based on normalized atlas data, the population in the Eastern Region—especially Kapchorwa, Bududa and Bukwo—is highly exposed to landslides (Figure 3.21), closely followed by the area around the Muhabura volcano and Kasese. Based on information from the atlas, more than 80 percent of the population near Mount Elgon and Muhabura are exposed to landslides.

Again based on normalized atlas data, residential buildings most exposed to landslides are in the Eastern Region (especially in the Mount Elgon area, as well as in the districts bordering Kenya) and in south-western Uganda (around the Muhabura volcano and the districts located between Lake Albert and Lake Edward) (Figure 3.22). Based on atlas data, the districts

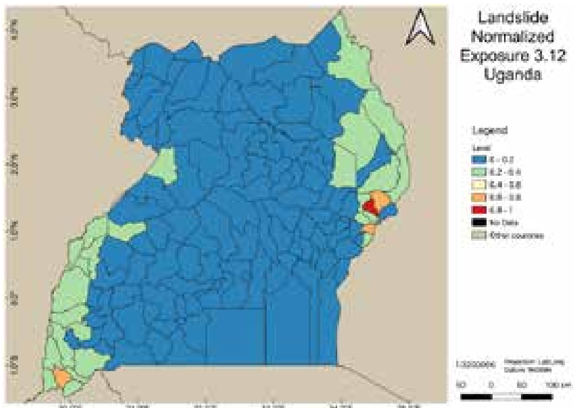
FIGURE 3.21 Hazard exposure of population to landslides (Indicator 3.9)



SOURCES: Data from Climate Change Downscaling Report; OPM, 2019.

with more than 60 percent of residential buildings exposed are Kapchorwa, Bulambuli, Kween, Bukwo and Kisoro.

FIGURE 3.22 Hazard exposure of residential buildings to landslides (Indicator 3.12)



SOURCES: Data from Climate Change Downscaling Report; OPM, 2019.

3.3 VULNERABILITY

A district's vulnerability profile is based on its degree of sensitivity and its degree of adaptive capacity; these are discussed in the following subsections. For this CRVA, sensitivity was calculated separately for each of the three hazards (flood, drought and landslide). Adaptive capacity was not determined separately for each hazard, as it refers to reducing the adverse impacts of climate change overall and is thus not hazard-specific.

3.3.1 Sensitivity

TO FLOODS

The indicators listed in Table 3.4 were used to establish the by-district sensitivity profile to floods.

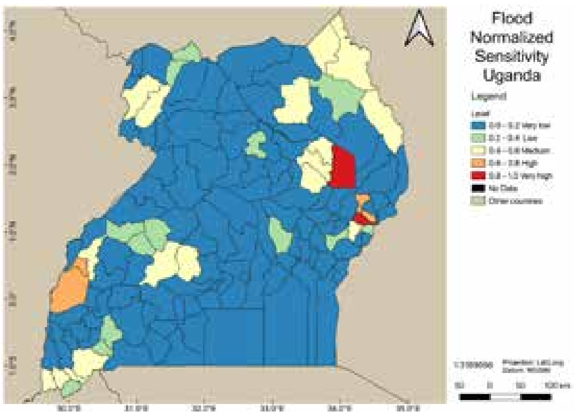
TABLE 3.4 **Indicators used to calculate flood sensitivity**

	Indicator
■	1.1 Number of houses destroyed or damaged by floods
■	1.2 Number of people directly and indirectly affected by floods
■	1.3 Dead, injured and missing due to floods
■	1.4 Damage to crops
■	1.5 Cattle loss due to floods
■	1.6 Households dependent on subsistence farming

NOTE: Indicator numbering reflects master list (Volume 3); indicator wording has been lightly edited for clarity and consistency. Shading designates indicator's relevance as prioritized by key stakeholders: ■ high; ■ medium; ■ low.

Figure 3.23 shows the combined flood sensitivity level of each district, estimated based on the above indicators, and normalized and weighted according to their relevance.

FIGURE 3.23 **Flood sensitivity**



SOURCE: Data from Climate Change Downscaling Report.

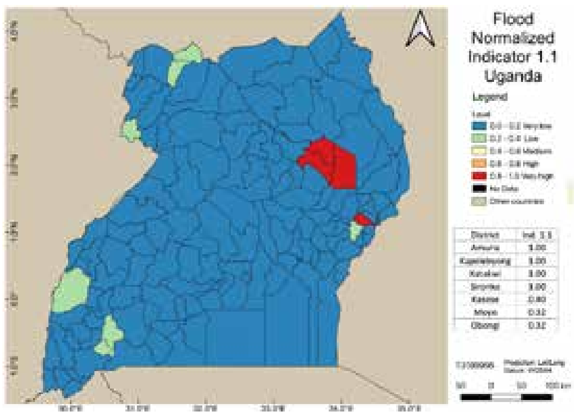
DesInventar reports over 1,000 damaging flood events since 2000, leaving almost 500 dead, and indirectly affecting over 4 million people. While the number of people directly affected it is not known precisely, the World Bank (2019) estimates that at least 20,000 people are relocated or evacuated annually.

Historically, the districts most sensitive to flood hazards (very high flood sensitivity level) are Katakwi and Sironko in the east, located in the country's most flood-prone areas. Sironko's northern neighbouring district Bulambuli is just slightly less sensitive (high flood sensitivity level). High levels of sensitivity to flood are also found in Kasese and Bunyangabu in the west.

The individual flood sensitivity level of each of the included indicators is reflected in Figures 3.24–3.29. The figures show that the most flood-sensitive districts differ for each indicator, although the Eastern Region around Mount Elgon seems to be particularly sensitive to floods along most of the indicators.

The highest level of flood sensitivity in terms of housing is found in the most flood-prone areas of Eastern Uganda (Figure 3.24), especially in the Teso and Elgon subregions—namely the Amuria, Soroti, Katakwi and Sironko districts. A low sensitivity level was registered for Moyo and Zombo (Northern Region), Kasese and Mbarara (Western Region) and Mbale (Eastern Region).

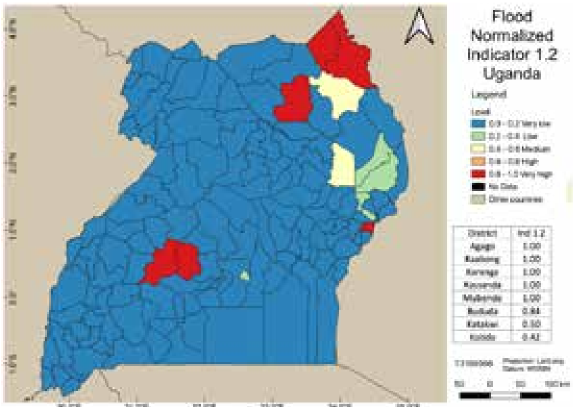
FIGURE 3.24 **Number of houses destroyed or damaged by floods (Indicator 1.1)**



SOURCE: Data from Climate Change Downscaling Report.

People in the Northern and Eastern Regions have an especially heightened sensitivity to floods (Figure 3.25). A very high sensitivity level is found in Kaabong and Agago (Northern Region), Bududa (Eastern Region), and Mubende (Central Region); historically in these areas, the most people were identified as being directly and indirectly affected by floods. The populations of the Kotido and Katakwi districts also have a high level of sensitivity towards floods.

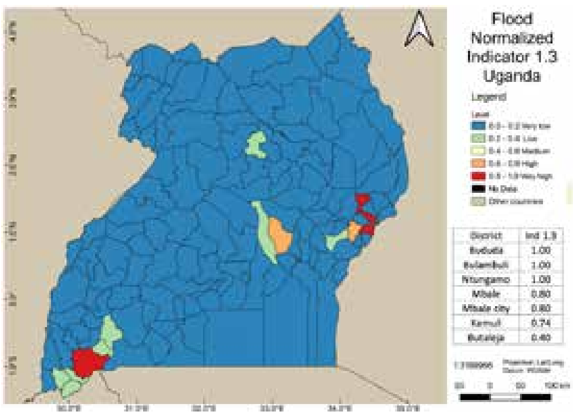
FIGURE 3.25 **Number of people directly and indirectly affected by floods (Indicator 1.2)**



SOURCE: Data from Climate Change Downscaling Report.

Most people reported missing, injured or dead due to floods in Uganda since 1960 were located in the Bulambuli and Bududa districts in the Eastern Region and the Ntungamo district in the Western Region (Figure 3.26). Mbale and Kamuli also have a high sensitivity level on this indicator.

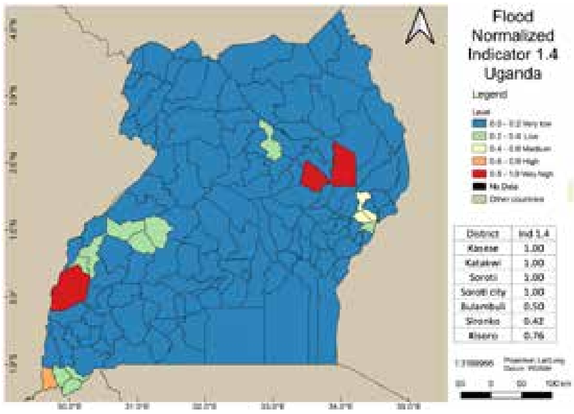
FIGURE 3.26 **Dead, injured and missing due to floods (Indicator 1.3)**



SOURCE: Data from Climate Change Downscaling Report.

Sensitivity to flood-induced damage to crops is very high in three districts (Figure 3.27): Katakwi and Soroti in the east, and Kasese in the Western Region. Kisoro, at the very south-western tip of Uganda, has a high sensitivity, and Bulambuli and Sironko in the Eastern Region have a medium sensitivity for crop damages caused by floods. In contrast, the majority of the country shows a very low to low sensitivity on this indicator.

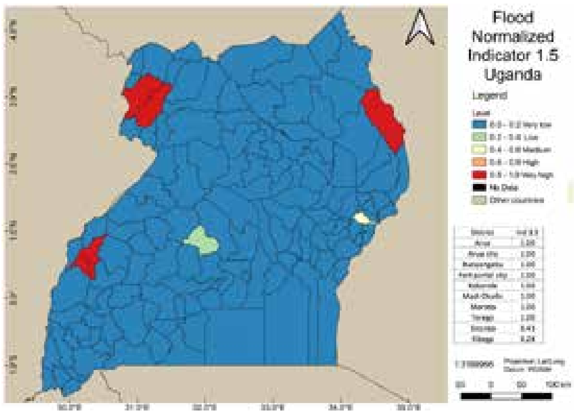
FIGURE 3.27 **Damages to crops caused by floods (Indicator 1.4)**



SOURCE: Data from Climate Change Downscaling Report.

Floods have an impact on cattle husbandry; most cattle lost due to floods were registered in Moroto, Arua, Bunyangabu and Kabarole (Figure 3.28). In Sironko, cattle were lost to floods to a sufficient extent that the district can be classified as having a medium sensitivity to this indicator.

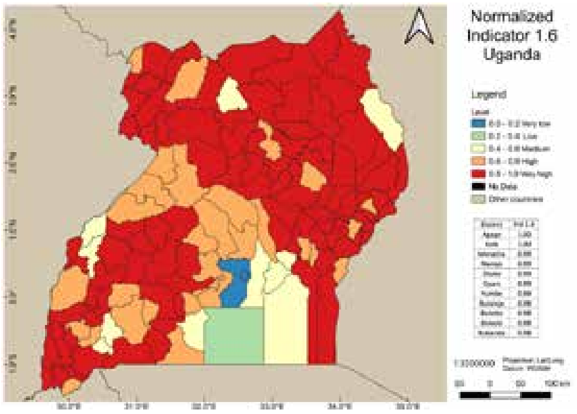
FIGURE 3.28 **Cattle loss due to floods (Indicator 1.5)**



SOURCE: Data from Climate Change Downscaling Report.

Households dependent on subsistence farming are sensitive to all three hazards considered in this CRVA. For example, crop failures induced by floods can significantly affect food security and livelihoods. Given that subsistence farming is less common in urban areas, it is not surprising that sensitivity to this indicator is low in and around Kampala. However, as Figure 3.29 shows, the majority of the country relies on subsistence farming and therefore is highly or very highly sensitive in this respect.

FIGURE 3.29 **Households dependent on subsistence farming (Indicator 1.6)**



SOURCE: Data from Climate Change Downscaling Report.

TO DROUGHTS

The indicators listed in Table 3.5 were used to establish the sensitivity profile to droughts. An additional Indicator 1.5, cattle loss due to droughts, was initially included, but no data were available in DesInventar. The indicator therefore was dropped, although considered relevant by stakeholders.

Figure 3.30 shows the combined drought sensitivity level of each district in Uganda, estimated based on the above indicators, normalized and weighted according to their relevance. The individual drought sensitivity level to each of the included indicators is reflected in Figures 3.31–3.34.

The districts most sensitive to drought hazards (very high sensitivity level) are Kaabong, Moroto, Amuria, Nebbi and Pakwach, all of which are in areas with high or very high drought susceptibility. High levels of sensitivity to drought are also found in Nakasongola, Zombo and Namutumba; all of these are located in areas with overall low to moderate drought susceptibility.

People in Moroto, Amuria, Nakasongola, Nebbi and Pakwach (very high) as well as Zombo and Namutumba (high) are sensitive to the effects of droughts in the form of damage to their individual or collective goods and service or deficiencies in commerce or work (Figure 3.31).

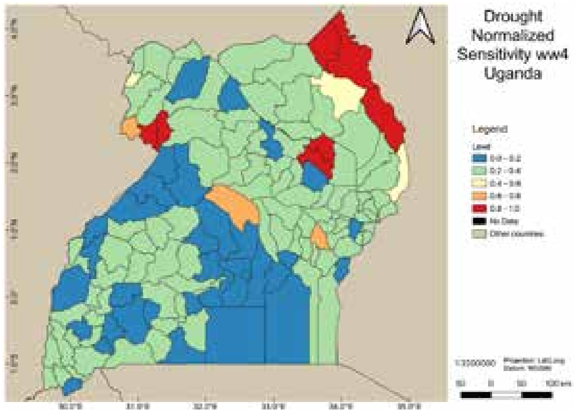
TABLE 3.5 **Indicators used to calculate drought sensitivity**

	Indicator
■ (high)	1.2 Number of people directly and indirectly affected by drought
■ (high)	1.3 Dead, injured and missing due to drought[a]
■ (high)	1.4 Damages to crops
■ (low)	1.6 Households dependent on subsistence farming

NOTE: Indicator numbering reflects master list (Volume 3); indicator wording has been lightly edited for clarity and consistency. Shading designates indicator's relevance as prioritized by key stakeholders: ■ high; ■ medium; ■ low.

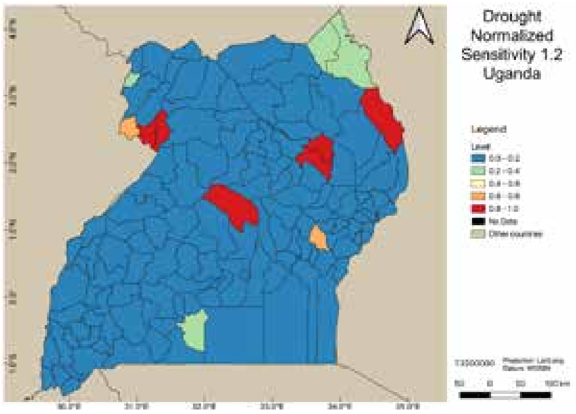
a. The indicator's standard wording is retained here, even though drought does not result in missing or injured people; deaths related to drought are reported as a consequence of hunger (specifically in the Karamoja subregion).

FIGURE 3.30 **Drought sensitivity (normalized)**



SOURCE: Data from Climate Change Downscaling Report.

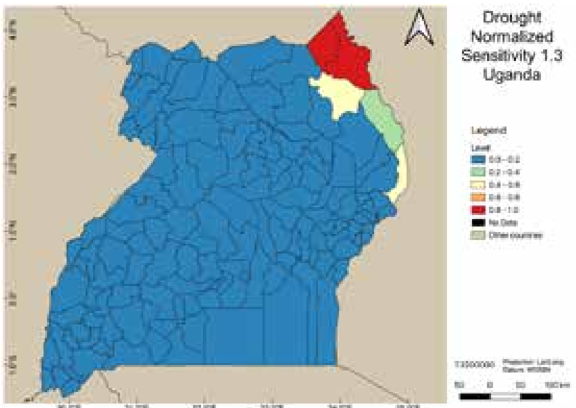
FIGURE 3.31 **Number of people directly and indirectly affected by drought (Indicator 1.2)**



SOURCE: Data from Climate Change Downscaling Report.

The greatest number of people reported missing, injured or dead due to droughts was registered in Kaabong (Figure 3.32). Sensitivity to drought for people in the neighbouring districts of Kotido and Moroto, as well as in Amudat, can be categorized as medium to low; the sensitivity level to drought for the remainder of the country is very low.

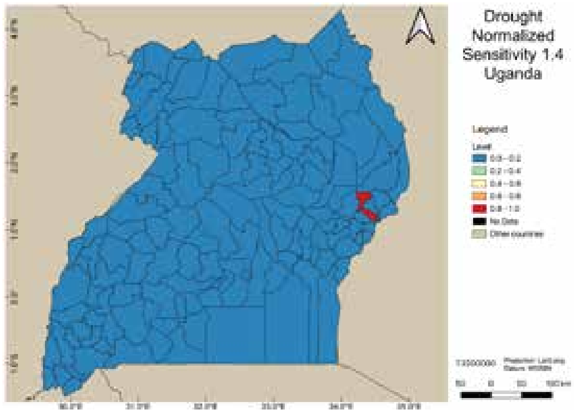
FIGURE 3.32 **Number of dead, injured and missing due to drought (Indicator 1.3)**



SOURCE: Data from Climate Change Downscaling Report.

Sensitivity to drought-induced damage to crops is critical (very high) only in Bulambuli, where almost 7,000 hectares were damaged during a drought in 2017 (Figure 3.33). Here the limitations of the DesInventar data are apparent. News and studies suggest that crop damage caused by droughts is more widespread and frequent, especially in the northern region of Uganda (see e.g. IRIN News, 2011; Epule et al., 2017).

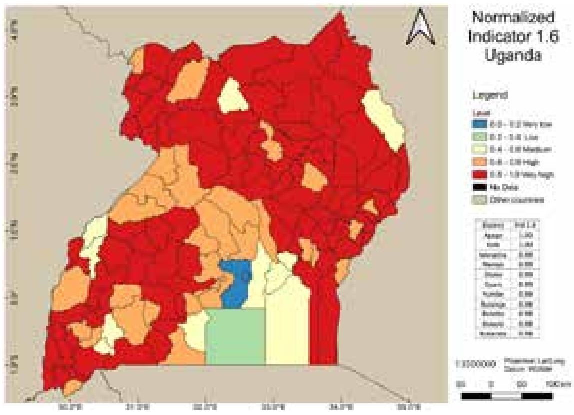
FIGURE 3.33 **Damages to crops caused by droughts (Indicator 1.4)**



SOURCE: Data from Climate Change Downscaling Report.

Drought-induced crop damage can significantly affect food security and livelihoods when subsistence farming is practiced. As noted for floods above, this practice tends to be limited in urban areas, making the related sensitivity low in and around Kampala. In comparison, the majority of the country relies on subsistence farming, making its sensitivity to drought-induced crop damage high or very high (Figure 3.34).

FIGURE 3.34 **Households dependent on subsistence farming (Indicator 1.6)**



SOURCE: Data from Climate Change Downscaling Report.

TO LANDSLIDE

The indicators listed in Table 3.6 were used to establish the sensitivity profile to landslides. As stated earlier, the landslides examined in this study are those triggered by heavy rains and rain storms.

TABLE 3.6 **Indicators used to calculate landslide sensitivity**

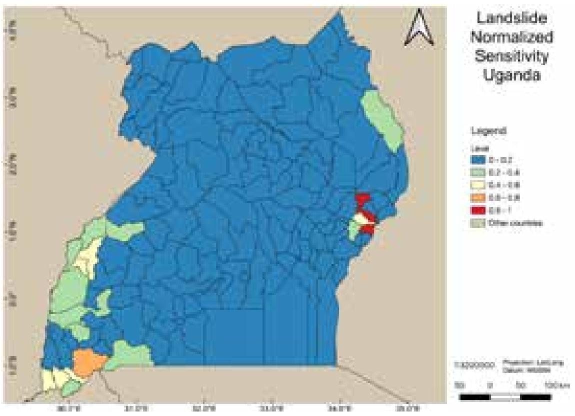
	Indicator
	1.2 Number of people directly and indirectly affected by landslide
	1.3 Dead, injured and missing due to landslide
	1.6 Households dependent on subsistence farming

NOTE: Indicator numbering reflects master list (Volume 3); indicator wording has been lightly edited for clarity and consistency. Shading designates indicator's relevance as prioritized by key stakeholders: high; medium; low.

Hilly areas and areas located along steep slopes are particularly prone to landslides. This applies especially to the districts around Mount Elgon, the Rwenzori Mountain range, and the very tip of south-western Uganda at the border with Rwanda and the Democratic Republic of Congo.

Figure 3.35 shows the combined landslide sensitivity level of each district in Uganda, estimated based on the above indicators, normalized and weighted according to their relevance. The map indicates that not all districts in the aforementioned areas exhibit the same level of sensitivity. While Bulambuli and Bududa are the most sensitive, the districts around the Rwenzori Mountains have low to medium sensitivity. In the area around the Muhabura volcano, Ntungamo alone is characterized by a high sensitivity level.

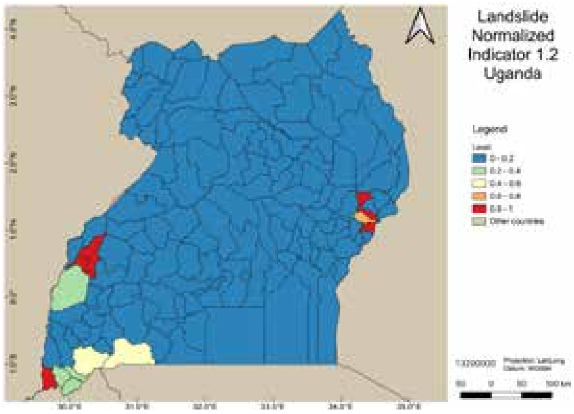
FIGURE 3.35 **Landslide sensitivity**



SOURCE: Data from Climate Change Downscaling Report.

Sensitivity as measured in terms of people being directly or indirectly affected by landslide is highest in the east in Bulambuli and Bududa (very high) and Sironko (high); and in the west in Kabarole and Bunyangabu (very high) and Kisoro (very high). In the south, Ntungamo and Isingiro have a medium level of sensitivity (Figure 3.36).

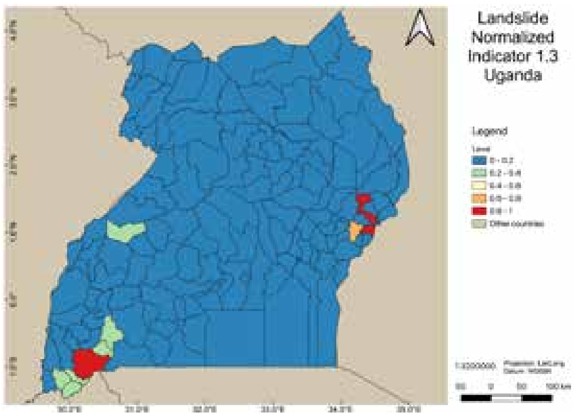
FIGURE 3.36 **Number of people directly and indirectly affected by landslide (Indicator 1.2)**



SOURCE: Data from Climate Change Downscaling Report.

The map reflecting direct harm to people (Figure 3.37) differs from the above in that Ntungamo shows a very high sensitivity, while Isingiro and Kabale show a very low sensitivity. Similarly, around Mount Elgon, Mbale has high sensitivity and Sironko very low—the inverse of their levels with respect to the number of people directly and indirectly affected by landslides.

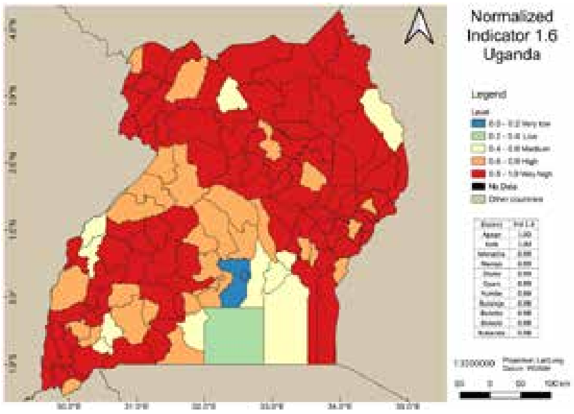
FIGURE 3.37 **Number of dead, injured and missing due to landslide (Indicator 1.3)**



SOURCE: Data from Climate Change Downscaling Report.

Landslide-induced crop damages can significantly affect food security and livelihoods when subsistence farming is practiced. Here again, this occurs less in urban areas, which is why the related sensitivity in and around Kampala is low. However, Figure 3.38 also includes areas that are prone to landslides not due to rainfall but based on their geologic characteristics.

FIGURE 3.38 **Households depending on subsistence farming (Indicator 1.6)**



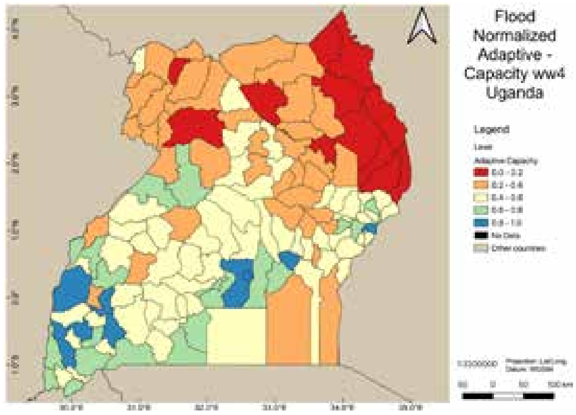
SOURCE: Data from Climate Change Downscaling Report.

3.3.2 Adaptive capacity

For this CRVA, adaptive capacity was calculated using indicators covering the four key performance parameters (governance, knowledge and innovation, equity and social cohesion, and ecosystem integrity), showing the extent to which the population of a specific district would be able to adapt to the adverse effects of climate change. While the adaptive capacity indices for floods and droughts comprise all the same indicators, two of these indicators were perceived as not relevant for landslides—wetland cover and the percentage of households with mosquito nets; these have been taken out of the index for adaptive capacity.

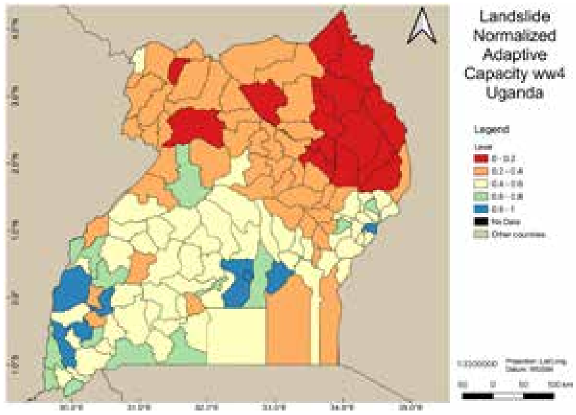
Overall, there is a clear divide in the country when it comes to adaptive capacity (Figure 3.39 and Figure 3.40). Ugandans in the north-east overall have less capacity to adapt to the adverse impacts of climate change, while adaptive capacity in the southern half of the country is overall higher, with some exceptions (e.g. Ntoroko, Kyegegwa, Kalungu, Mayuge and Namayingo).

FIGURE 3.39 **Adaptation capacity: comprehensive index for drought and floods**



SOURCE: Data from Climate Change Downscaling Report.

FIGURE 3.40 **Adaptive capacity: comprehensive index for landslide**



SOURCE: Data from Climate Change Downscaling Report.

EQUITY AND SOCIAL COHESION

The indicators listed in Table 3.7 have been used to define aspects related to equity and social cohesion. All indicators have been normalized on a scale from 0 to 1.

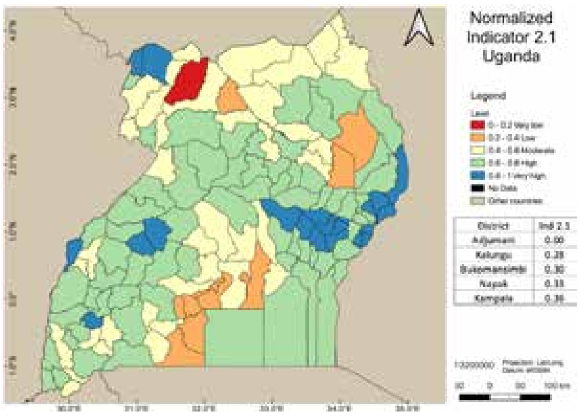
Households headed by women are generally considered more vulnerable; thus, a higher share of women-headed households would mean a reduction in adaptive capacity. Adjumani is the district with the highest number of women-headed households (almost 40 percent), followed by Kalungu, Bukomansimbi, Napak and Kampala (Figure 3.41).

TABLE 3.7 **Indicators used to calculate adaptive capacity: equity and social cohesion**

	Indicator
■ (high)	2.1 Percentage of households headed by women
■ (high)	2.2 Households whose members age 5+ years consume < 2 meals/day
■ (high)	2.3 Households more than 5 km away from any health facility
■ (high)	2.9 Number of functional health facilities by region / district capital per 10,000 people
■ (high)	2.10. Proportion of poor persons by district
■ (high)	2.14 Percentage of households with a permanent roof
■ (medium)	2.16. Percentage of households with mosquito nets
■ (medium)	2.17 Percentage of households with access to piped water
■ (low)	2.18 Percentage of households with a bank account
■ (medium)	2.19 Percentage of households with electric lighting
■ (medium)	2.20 Percentage of households headed by 10- to 17-year-olds

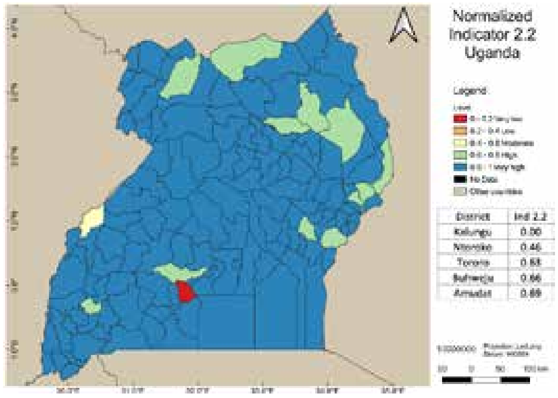
NOTE: Indicator numbering reflects master list (Volume 3); indicator wording has been lightly edited for clarity and consistency. Shading designates indicator's relevance as prioritized by key stakeholders: ■ high; ■ medium; ■ low.

FIGURE 3.41 **Percentage of households headed by women (Indicator 2.1)**



SOURCE: Data from Climate Change Downscaling Report.

FIGURE 3.42 **Households whose members age 5+ years consume < 2 meals/day (Indicator 2.2)**



SOURCE: Data from Climate Change Downscaling Report.

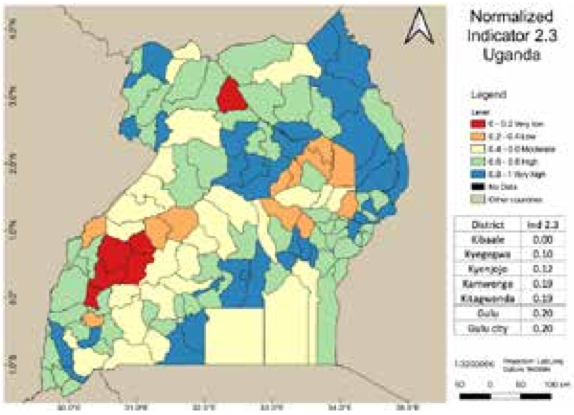
A larger number of people who consume less than two meals a day indicates less adaptive capacity to climate change–related hazards. The district with the highest percentage of such poorly nourished people is Kalungu, followed by Ntoroko, Tororo, Buhweju and Amudat (Figure 3.42).

Households that need to travel farther to reach a health facility are considered more vulnerable, as they would have less possibility of receiving medical treatment in an emergency or in case of an outbreak of vector-borne diseases. Districts with less access to health facilities include Kibaale, Kyegegwa, Kyenjojo, Kamwenge, Kitagwenda, Gulu and Gulu City (Figure 3.43).

The presence of more health facilities indicates a higher level of capacity for medical treatment of climate change–induced diseases and emergencies—thus indicating a higher level of adaptive capacity with respect to access to relevant infrastructure (Figure 3.44).

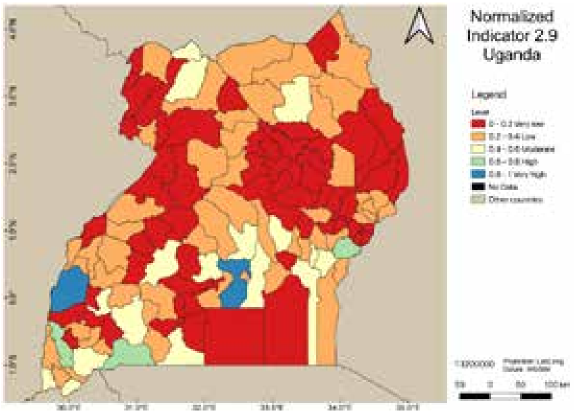
The greater the share of poor people, the lower the adaptive capacity, assuming limited means to respond to the changing climate and higher vulnerability in terms of health condition. The poorest districts are all located in the Karamoja subregion, and include Amudat, Kaabong, Karenga, Kotido, Moroto, Nabilatuk, Nakapiripirit and Napak (Figure 3.45).

FIGURE 3.43 **Households more than 5 km away from any health facility (Indicator 2.3)**



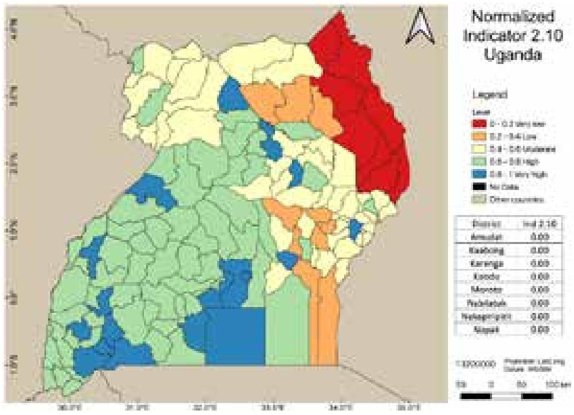
SOURCE: Data from Climate Change Downscaling Report.

FIGURE 3.44 **Number of functional health facilities by region / district capital per 10,000 people (Indicator 2.9)**



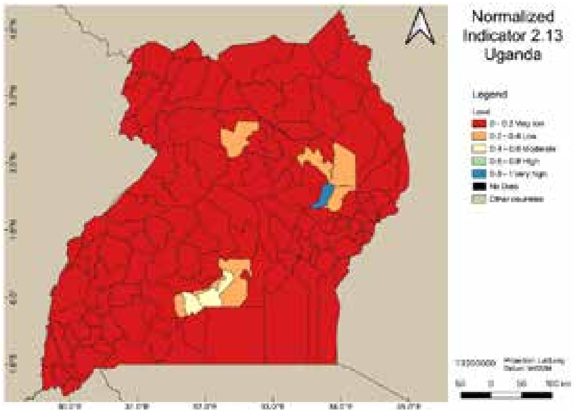
SOURCE: Data from Climate Change Downscaling Report.

FIGURE 3.45 **Proportion of poor people per district (Indicator 2.10)**



SOURCE: Data from Climate Change Downscaling Report.

FIGURE 3.46 **Percentage of households with a permanent roof (Indicator 2.14)**



SOURCE: Data from Climate Change Downscaling Report.

A household with a permanent roof is less exposed to heavy weather events such as strong rain and therefore considered to show higher adaptive capacity to climate change. Overall, the percentage of the population with a permanent roof is relatively low, reducing adaptive capacity in most districts (Figure 3.46).

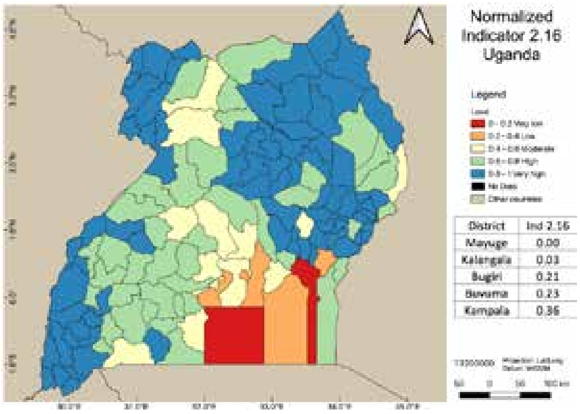
Households with mosquito nets can protect themselves better from a potentially climate change–induced increase of vector-spreading infectious diseases. Most vulnerable districts in that regard are Mayuge, Kalangala, Bugiri, Buvuma and Kampala (Figure 3.47)

Households with access to piped water are more likely to have access to clean water in case of severe climate events, as well as being less likely to fall ill. Only Kampala, Wakiso and Jinja have a significant share of households with access to piped water (Figure 3.48).

A household with a bank account is assumed to have greater financial security to respond to climate change–induced damages and is therefore considered as having a higher adaptive capacity. The largest share of bank accounts can be found in Kampala, Wakiso, Gulu, Ibanda, Bushenyi, Sheema and Mbarara (Figure 3.49).

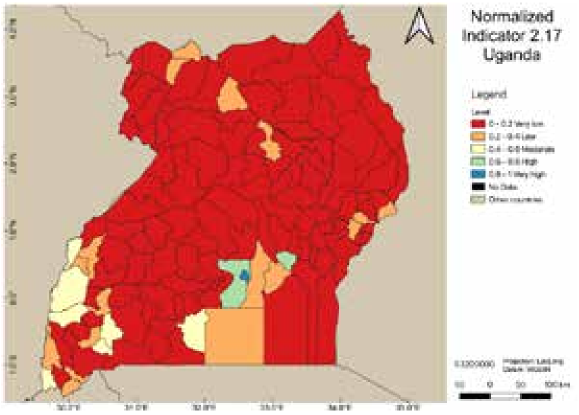
The percentage of households with electric lighting indicator is used as a proxy for access to electricity in general. Households with access to electricity are considered to have a higher adaptive capacity; this is because electricity allows, for

FIGURE 3.47 **Percentage of households with mosquito nets (Indicator 2.16)**



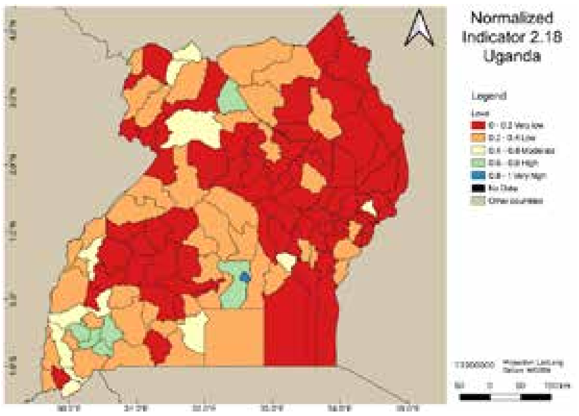
SOURCE: Data from Climate Change Downscaling Report.

FIGURE 3.48 **Percentage of households with access to piped water (Indicator 2.17)**



SOURCE: Data from Climate Change Downscaling Report.

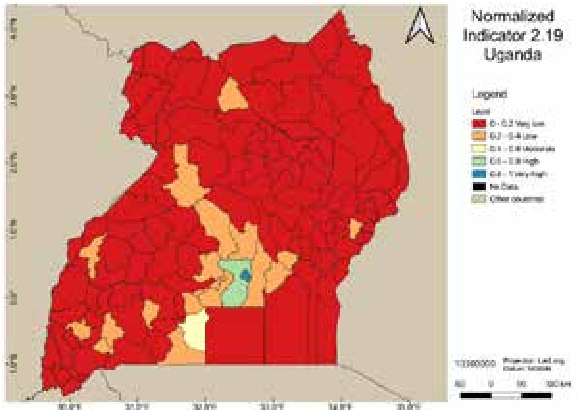
FIGURE 3.49 **Percentage of households with a bank account (Indicator 2.18)**



SOURCE: Data from Climate Change Downscaling Report.

example, better access to electronic communication devices and therefore better access to relevant information. The highest share of households with access to electricity is in Kampala and Wakiso, followed by Masaka (Figure 3.50).

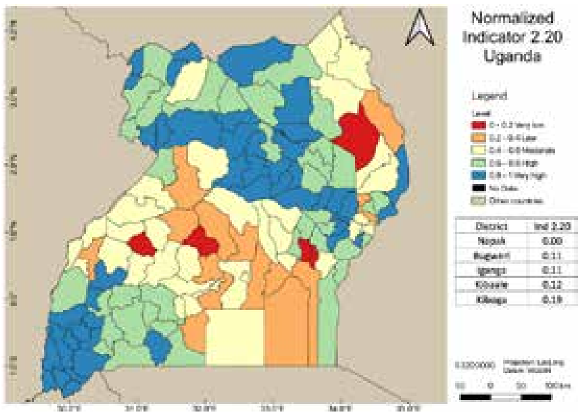
FIGURE 3.50 **Percentage of households with electric lighting (Indicator 2.19)**



SOURCE: Data from Climate Change Downscaling Report.

Households headed by children are generally considered more vulnerable than others; thus, a larger share of children-headed households would mean a lower adaptive capacity. Districts with the highest percentage of children-headed households include Napak, Bugweri, Iganga, Kibaale and Kiboga (Figure 3.51).

FIGURE 3.51 **Percentage of households headed by 10- to 17-year-olds (Indicator 2.20)**



SOURCE: Data from Climate Change Downscaling Report.

ECOSYSTEM INTEGRITY

The indicators listed in Table 3.8 have been used to define aspects related to ecosystem integrity.

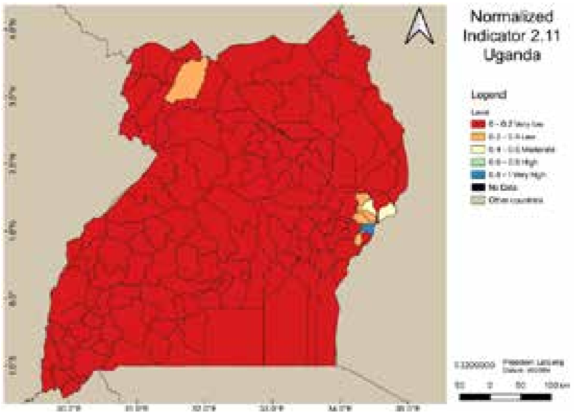
TABLE 3.8 Indicators used to calculate adaptive capacity: ecosystem integrity

	Indicator
■	2.11 Forest cover (% of land area)
■	2.13 Wetland cover (% of total area)

NOTE: Indicator numbering reflects master list (Volume 3); indicator wording has been lightly edited for clarity and consistency. Shading designates indicator's relevance as prioritized by key stakeholders: ■ high; ■ medium; ■ low.

Districts with larger forest area are more able to sustain and improve the functionality of ecosystems and productivity. While 9 percent of the land area of Uganda is covered by forests, this is mainly woodlands (MWE, 2016). Roughly only 5 percent is covered by either tropical moist forest or forest (Figure 3.52).

FIGURE 3.52 Forest cover (% of land area) (Indicator 2.11)



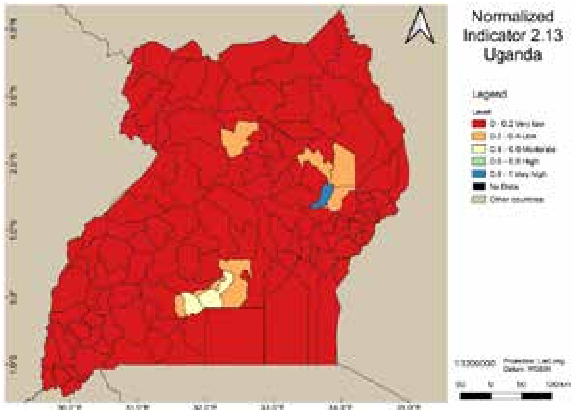
SOURCE: Data from Climate Change Downscaling Report.

Wetlands in general and inland wetlands in particular are relevant to Uganda, in that they are known to help buffer some of the climate change hazards and therefore increase adaptive capacity. Eleven percent of the country is covered by wetlands (MWE, 2013) (Figure 3.53).

GOVERNANCE

The indicators listed in Table 3.9 have been used to define aspects related to governance.

FIGURE 3.53 Wetland cover (% of total area) (Indicator 2.13)



SOURCE: Data from Climate Change Downscaling Report.

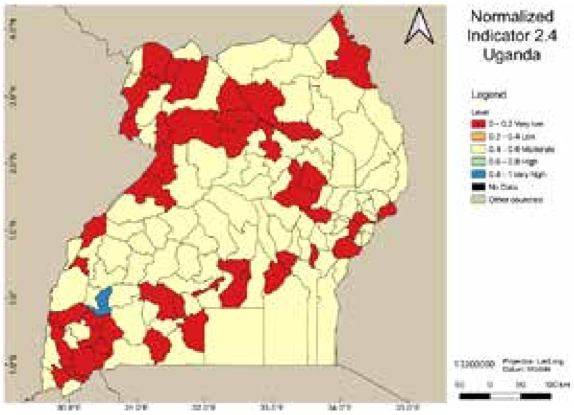
TABLE 3.9 Indicators used to calculate adaptive capacity: governance

	Indicator
■	2.4 Share of total budget for stakeholder environmental training and sensitization
■	2.5 Local governments implementing climate change interventions in their district development plans
■	2.6 Safeguards for service delivery of investments effectively handled; evidence that environmental, social and climate change interventions have been integrated into local government development plans and annual work plans and budgets complied with

NOTE: Indicator numbering reflects master list (Volume 3); indicator wording has been lightly edited for clarity and consistency. Shading designates indicator's relevance as prioritized by key stakeholders: ■ high; ■ medium; ■ low.

A higher share of budget dedicated to stakeholder environmental training and sensitization serves as a proxy for indicating the level of stakeholders' awareness of climate change. Based on data from Ugandan governmental sources, one district (Ibanda) currently dedicates a sizeable percentage of its budget to these kind of activities (Figure 3.54). All other districts either dedicate relatively little or no funding to awareness raising and training regarding climate change.

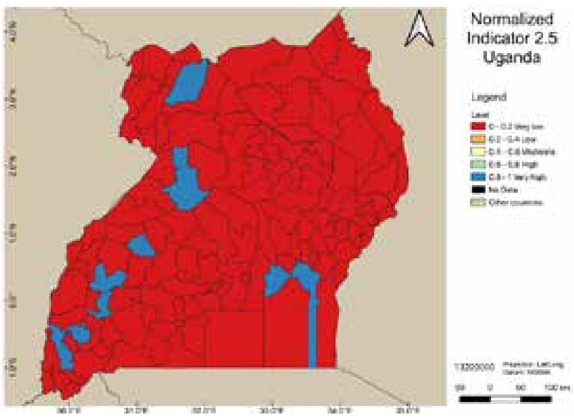
FIGURE 3.54 **Share of total budget for stakeholder environmental training and sensitization (Indicator 2.4)**



SOURCE: Data from Climate Change Downscaling Report.

District governments with stand-alone projects involving climate change interventions are better prepared than other districts, and thus show higher adaptive capacity towards climate change. This indicator has been analysed using a yes/no scale, meaning that districts shaded in blue in Figure 3.55 integrate climate change interventions into their district development plans.

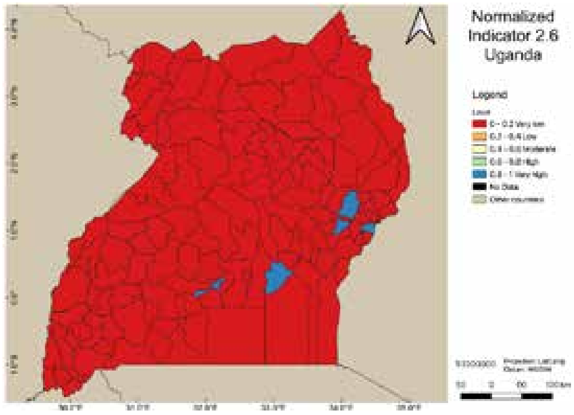
FIGURE 3.55 **Local governments implementing climate change interventions in their district development plans (Indicator 2.5)**



SOURCE: Data from Climate Change Downscaling Report.

Climate change interventions being included in local government development plans indicate a certain degree of preparedness to climate change at the local government level. As can be seen in Figure 3.55, only a handful of districts (Butambala, Buikwe, Budaka, Buyende and Bududa) currently include climate change interventions in their local government development plans (Figure 3.56).

FIGURE 3.56 **Safeguards for service delivery of investments effectively handled; evidence that environmental, social and climate change interventions have been integrated into local government development plans and annual work plans and budgets complied with (Indicator 2.6)**



SOURCE: Data from Climate Change Downscaling Report.

KNOWLEDGE AND INNOVATION

The indicator originally chosen to capture knowledge and innovation was the availability of Uganda National Meteorology Authority (UNMA) weather stations throughout the country. However, no data were available for this. Availability of and access to mobile phones and radio can indirectly be considered an aspect of knowledge and innovation, as they provide access to information on climate-related events as well as on the prevention of vector-borne diseases and exposure to climate hazards. People thus forewarned and informed are presumably able to adapt to climate change more readily. These indicators are listed in Table 3.10.

People with mobiles phones can react more quickly in case of emergencies and inform themselves / be informed more instantaneously, indicating higher adaptive capacity. The share of people with mobile phones is highest in Kampala and the surrounding districts (Figure 3.57). Access to mobile phones is relatively limited in the entire

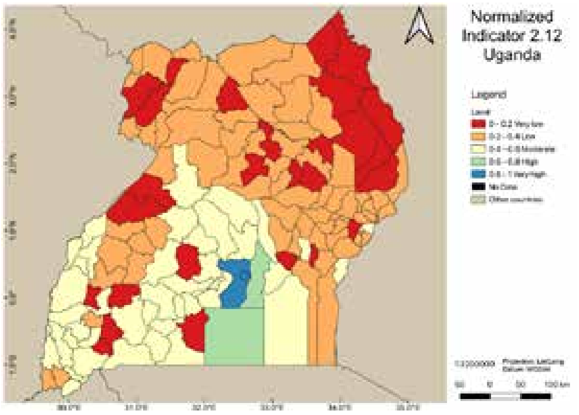
TABLE 3.10 **Indicators used to calculate adaptive capacity: knowledge and innovation**

	Indicator
■ (medium)	2.12 Share of people who own mobile phones
■ (medium)	2.15 Percentage of households with a radio

NOTE: Indicator numbering reflects master list (Volume 3); indicator wording has been lightly edited for clarity and consistency. Shading designates indicator's relevance as prioritized by key stakeholders: ■ high; ■ medium; ■ low.

Northern Region, as well as most of the Western Region of the country.

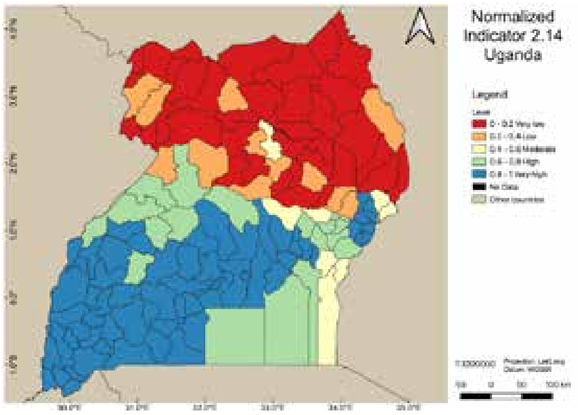
FIGURE 3.57 **Share of people who own mobile phones (Indicator 2.12)**



SOURCE: Data from Climate Change Downscaling Report.

Households with a radio can be informed more quickly about potential climate threats and related measures, indicating higher adaptive capacity. Overall, there is a clear division of access in the country, with southern Uganda having overall good access to radios, compared with the northern half of the country (Figure 3.58).

FIGURE 3.58 **Percentage of households with a radio (Indicator 2.15)**



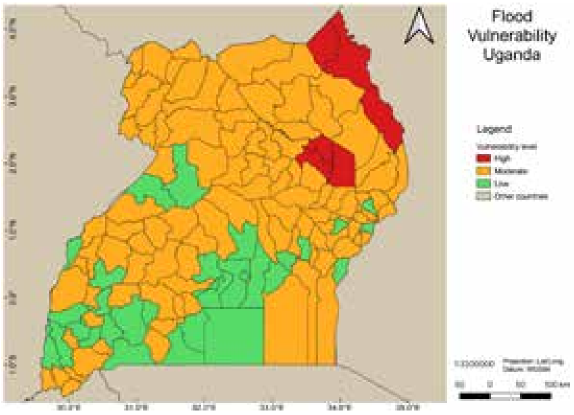
SOURCE: Data from Climate Change Downscaling Report.

3.3.3 Vulnerability index

Vulnerability can be considered the combination of sensitivity and adaptive capacity. As with the other hazards, vulnerability maps have been generated for flood (Figure 3.59), drought (Figure 3.60) and landslide (Figure 3.61). These vulnerability maps are an important precursor to calculating overall risk based on a matrix approach that considers high, medium and low vulnerability in comparison to exposure and subsequently with the hazards (see Figure 2.3).

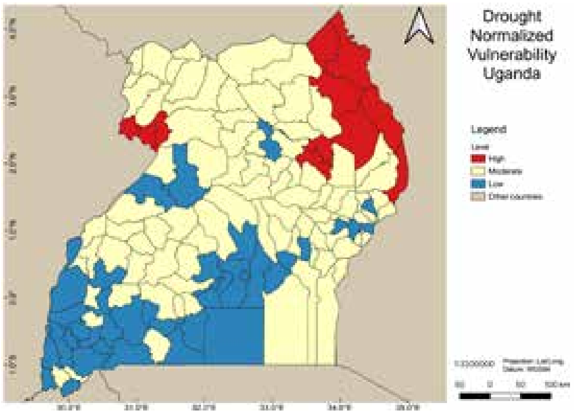
Vulnerability maps have therefore been generated for a three-scale approach considering high, medium and low vulnerability of the different districts. Note that vulnerability has been constructed using adaptive capacity, which is the same for all three hazards, as well as the hazard-specific sensitivity maps. Vulnerability to climate-induced changes is therefore overall higher in those areas where adaptive capacity is low, although sensitivity to a specific climate risk might not be significant.

FIGURE 3.59 **Vulnerability: sensitivity to floods**



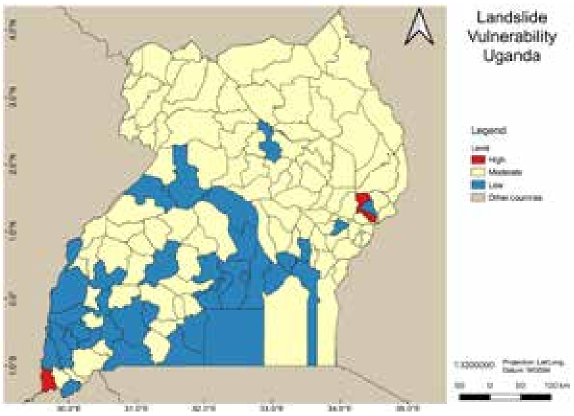
SOURCE: Data from Climate Change Downscaling Report.

FIGURE 3.60 **Vulnerability: sensitivity to droughts**



SOURCE: Data from Climate Change Downscaling Report.

FIGURE 3.61 **Vulnerability: sensitivity to landslides**



SOURCE: Data from Climate Change Downscaling Report.

3.4 RISK

The maps in this section show the risk level for each district with respect to the three climate hazards of flood, drought and landslides for the historical period (1990–2020); the following section shows risk for future scenarios. The risk level reflects the potential for adverse consequences (impacts) related to each of these climate hazards to occur. Risk in this context is conceptualized as the interaction between vulnerability conditions and the exposed elements to hazardous climate-related processes and events (see Section 2.4). The risk levels established and presented in the following maps take into account:

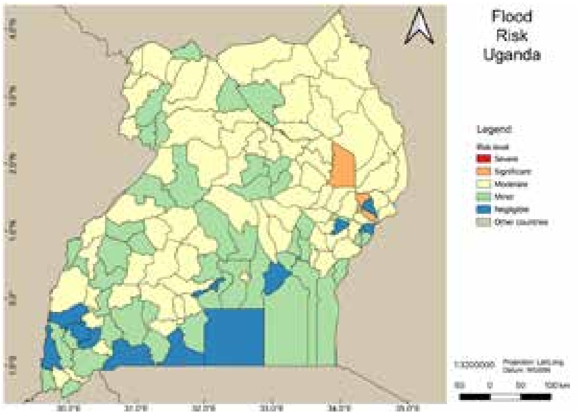
- The potential of a hazard to occur in each district;
- The presence of people, livelihoods, or economic, social or cultural assets in the respective district (represented by the indicators listed in Table 2.1);
- The degree to which the population, non-human organisms and related systems in that district are affected if a hazard occurs (along the indicators listed in Table 2.2);
- The ability of the district to adapt or respond to potential damages in consideration of parameters reflecting governance, knowledge and innovation, equity and social cohesion, and ecosystem integrity (see Table 2.3 for the full list of indicators).

The difference between the risk maps presented here and the hazard maps presented earlier is that the hazard maps reflect the likelihood of a potentially hazardous climatic or climate-related event (flood, drought, landslide) occurring; the risk maps show the likelihood of damage resulting from such occurrence. The risk levels range from negligible (small potential of occurrence) to severe (very high potential of occurrence) and are colour-coded for each district (from blue for negligible to red for severe). The higher the risk level, the more important it is to identify and implement suitable responses and adaptation measures.

3.4.1 Flood

The historical flood risk analysis did not position any district under the severe category; most districts show a moderate or minor risk (Figure 3.62). Two districts, Katakwi and Bulambuli, attained the highest risk level category of significant.

FIGURE 3.62 **Uganda's historical flood risk**



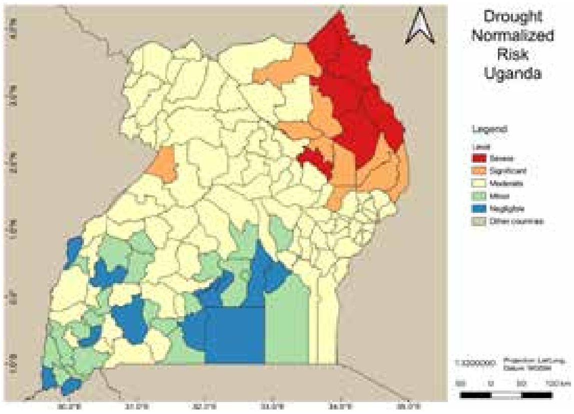
SOURCE: Data from Climate Change Downscaling Report.

Only a few districts have a negligible flood risk level, including Kanungu, Rubirizi, Mitooma, Sheema, Butambala, Buikwe, Kapchorwa, Bududa and Budaka. Although Bulambuli and Katakwi have very high exposure to floods, their existing levels of adaptive capacity (which can be strengthened significantly) make for a risk level that is significant but not severe.

3.4.2 Drought

The historical drought risk analysis positions districts in Uganda's north-east in the severe category (Figure 3.63). This includes Karenga, Kaabong, Moroto, Kotido, Napak and Amuria. The adjacent districts of Kitgum, Abim, Otuke, Katakwi, Kumi, Nakapiripirit and Amudat have a significant drought risk, as does Buliisa. Most districts appear under the moderate or minor category of risk; just a few have a negligible level. The districts that are most exposed and sensitive to drought are also those with less adaptive capacity, which makes the historical drought risk level in the north-east severe.

FIGURE 3.63 **Uganda's historical drought risk**

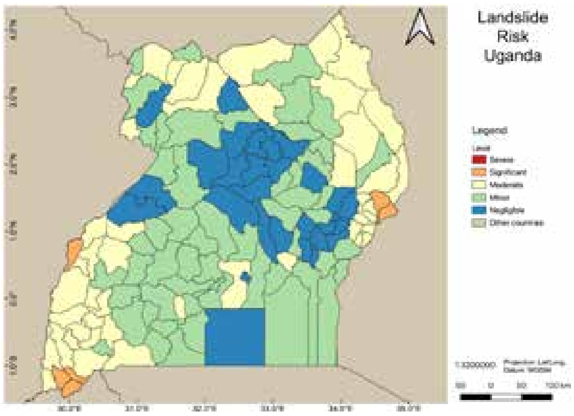


SOURCE: Data from Climate Change Downscaling Report.

3.4.3 Landslide

The historical rainfall-induced landslide risk analysis identifies Kween and Bukwo around Mount Elgon; Bundibugyo in the Rwenzori Mountains; and Rubanda, Kabale and Rukiga as being significantly at risk (Figure 3.64). In contrast, none of Uganda's districts is subject to a severe risk of rainfall-induced landslides, despite the high hazard levels within these areas. This reflects the districts' sensitivity and adaptive capacity levels. Other districts in the areas most prone to rain-induced landslides show a medium level of risk; most of the districts in central Uganda show either a minor or negligible risk level.

FIGURE 3.64 **Uganda's historical landslide risk**



SOURCE: Data from Climate Change Downscaling Report.

3.5 FUTURE PROJECTIONS

Risk levels have been projected for the RCP 4.5 and RCP 8.5 scenarios, showing the development of risk levels separated by flood, drought and landslide. For all three hazards, the historical risk level has been compared to the risk levels under RCP 4.5 and RCP 8.5 for three projected time periods.

3.5.1 Flood

In no future time period under either the RCP 4.5 or 8.5 scenario does any district in Uganda fall in the severe risk category for flood (Figure 3.65). However, there are significant increases in the level of risk all across the country, and a wide range of districts increase their risk category to significant from moderate over time. This is especially notable in the West Nile subregion, as well as in central Uganda. In contrast, the risk category for the district of Bulambuli decreases to moderate.

While there are some differences between the RCP 4.5 and RCP 8.5 scenarios, overall risk is projected to be very similar for the two scenarios, with the districts with significant flood risk extending towards Kayunga and Kamuli for the 2050–2059 projections under the RCP 8.5 scenario.

3.5.2 Drought

No districts fall into the severe risk category for drought under the RCP 4.5 and RCP 8.5 projections (Figure 3.66). However, overall drought risk increases significantly, and a large part of the country can be considered to be under significant drought risk in the future. Uganda's entire northern half and parts of western Uganda including Isingiro, Ntungamo, Rukungiri and Mitooma face a significant drought risk in the future. It is of concern that many districts, especially in central Uganda, face a significant flood risk concurrent with facing a significant drought risk due to changes in climate and more extreme weather events. Under the RCP 8.5 scenario, Mityana and Mubende reach the status of significant risk at an earlier stage than under the RCP 4.5 scenario.

3.5.3 Landslide

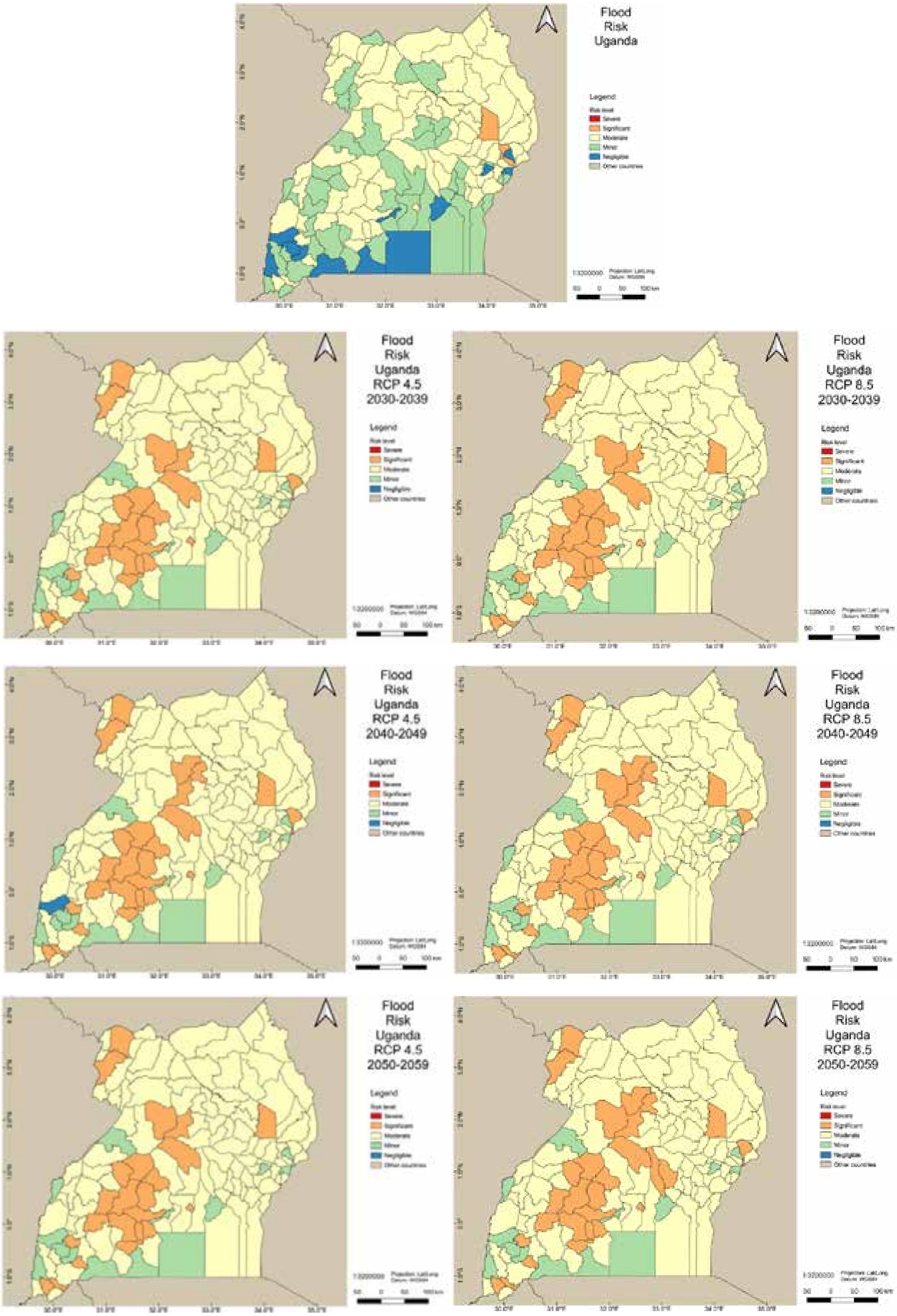
No district falls into the severe risk category under either the RCP 4.5 or RCP 8.5 scenario (Figure 3.67). However, the overall risk for landslides triggered by rainfall does increase for most of the country, and no district is categorized any longer as having a negligible risk level. Several districts see their risk level increase from moderate to significant; this is not just in the three primary areas of vulnerability around Mount Elgon, the Rwenzori Mountains, and Muhabura, but also in the country's north-east (Kaabong) and south-west (Buhweju).

3.6 DEVELOPMENT OF ADAPTATION OPTIONS

Developing adaptation options based on existing hazards and risk profiles is crucial in order to minimize future climate risks. Adaptation to climate change has been a priority for the Government of Uganda throughout the last several years. In this context, a comprehensive process for updating the NDC was undertaken. Additionally, several ministries and other entities have developed regional as well as sectoral adaptation strategies and plans, including the National Adaptation Plan for the Agricultural Sector (MAAIF, 2018). Complementing these efforts, LoCAL has provided an extensive investment menu (Annex E) for local adaptation investments, especially in infrastructure, to local governments.

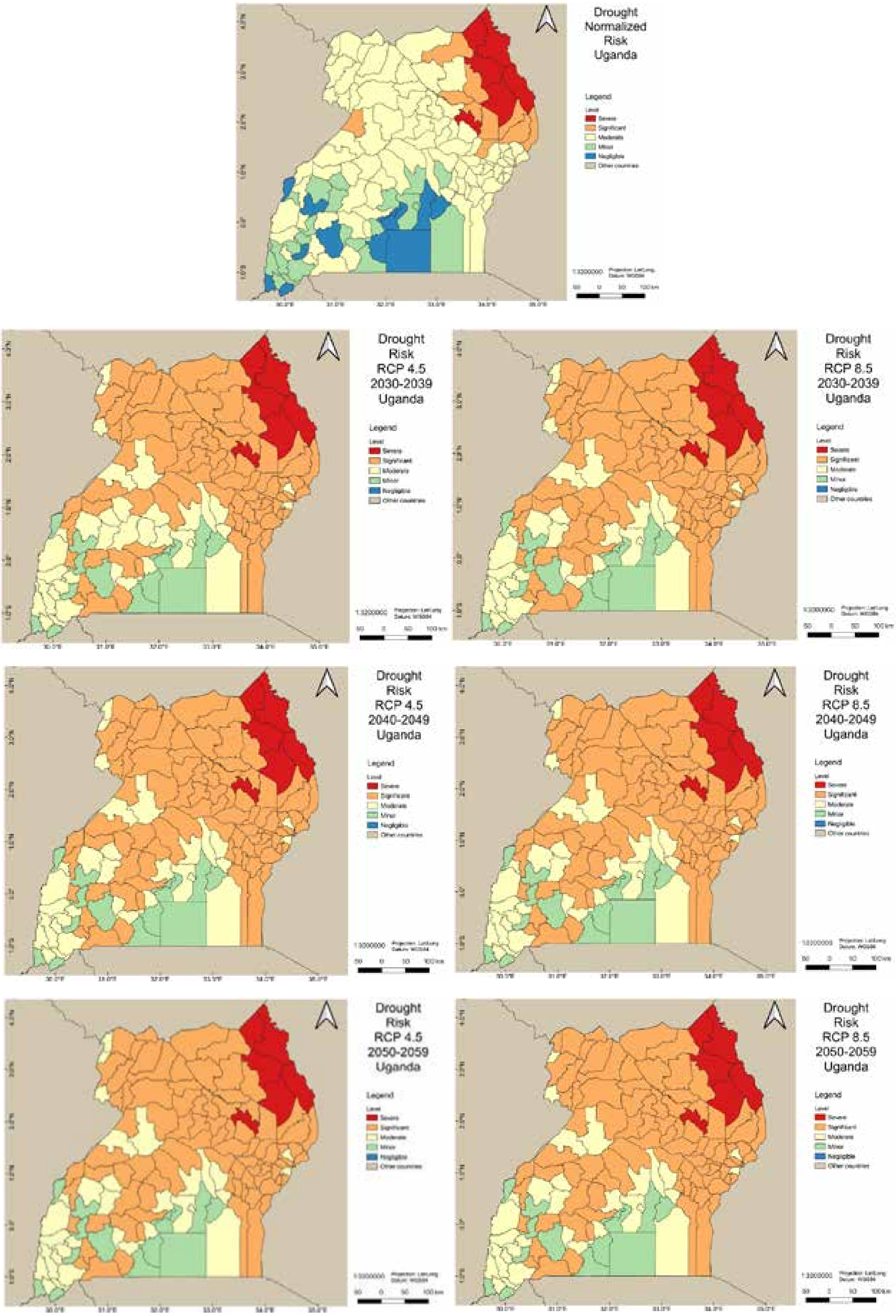
Many of these documents and plans contain concrete adaptation options that have been widely discussed and approved by a variety of national and subnational stakeholders. For this report, the consultants have analysed existing

FIGURE 3.65 **Uganda's flood risk: historical and projected under the RCP 4.5 and 8.5 scenarios for 2030–2039, 2040–2049 and 2050–2059**



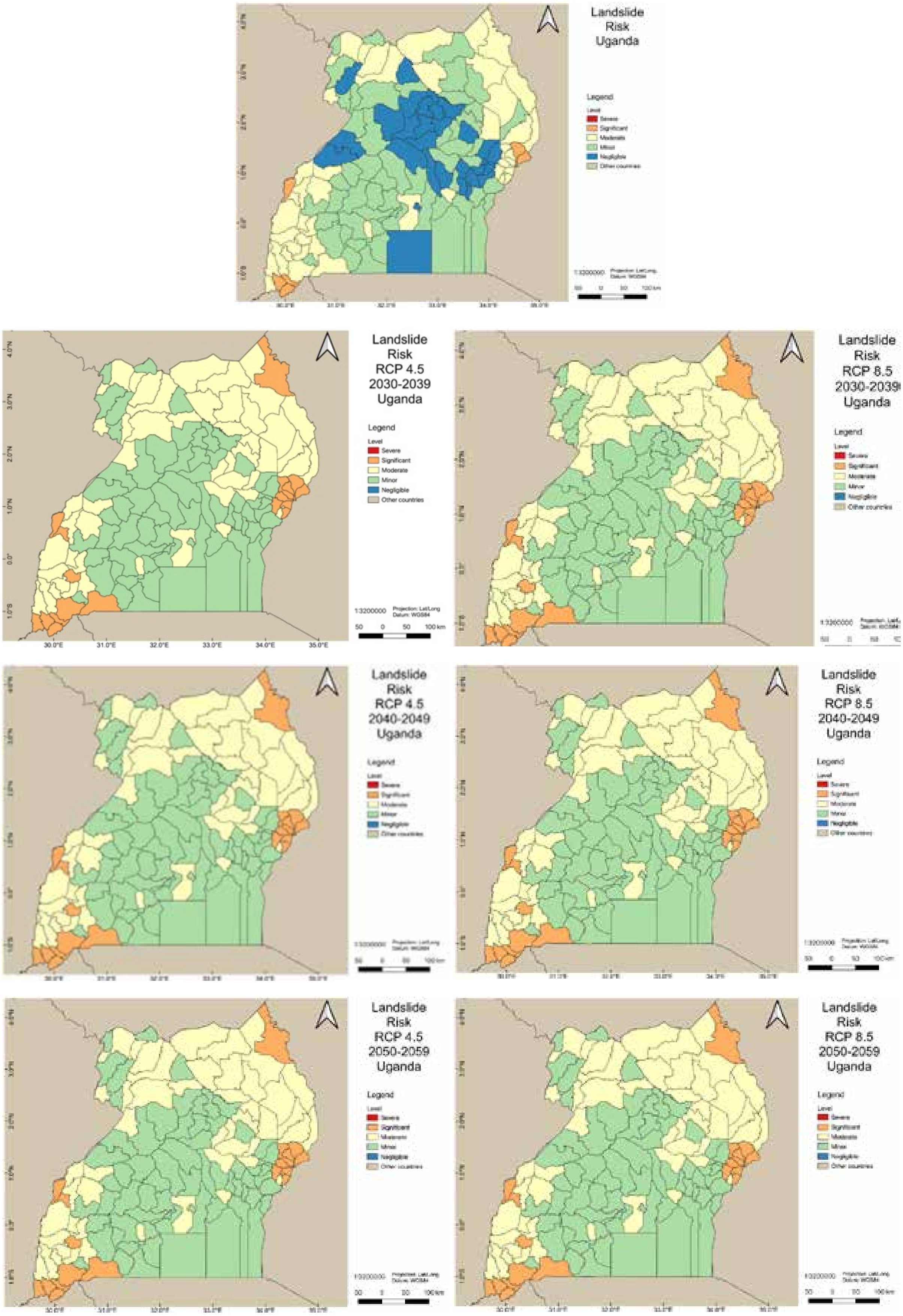
SOURCE: Data from Climate Change Downscaling Report.

FIGURE 3.66 **Uganda's drought risk: historical and projected under the RCP 4.5 and 8.5 scenarios for 2030–2039, 2040–2049 and 2050–2059**



SOURCE: Data from Climate Change Downscaling Report.

FIGURE 3.67 Uganda's landslide risk: historical and projected under the RCP 4.5 and 8.5 scenarios for 2030–2039, 2040–2049 and 2050–2059



SOURCE: Data from Climate Change Downscaling Report.

adaptation strategies and plans and have selected those measures that are relevant for the district level—either because the measures would be implemented by district governments themselves or because implementation takes place at the local level.

Adaptation options have been cross-checked with the sectors most relevant and important to the Ugandan economy and livelihoods at the regional level. In four regional stakeholder consultations in the Northern, Eastern, Central and Western Regions, these adaptation options have been discussed with representatives from local and national government and further refined and adapted. The discussions revealed that, although the individual situation regarding adaptation varies from district to district, priority sectors for adaptation are similar across the region; these priority sectors include governance, infrastructure, water and sanitation, agriculture, forestry, and fisheries. For an overview of relevant adaptation sectors by region, as well as the results of the regional stakeholder consultations, see Annex D.

The following subsections provide an overview of the adaptation options for each of these sectors; the measures are summarized in Tables 3.11–3.17.

3.6.1 Governance

Governance is critical in climate change adaptation, as it provides the structures and processes needed for implementation. Throughout the regional consultations, the need for effective capacity building of local institutions was emphasized across the regions; stakeholders also noted the need to include actors not directly working with environmental or climate change topics, such as fiscal officers. Sound land use planning that avoids increasing pressure on already fragile ecosystems, such as wetlands and river banks, is an important driver to ensure that ecosystems are able to cope with changing climate and that possible extreme events can be mitigated more easily.

Actors at the national level need to invest in providing districts and local governments with the infrastructure needed to enable adaptation to a changing climate. Throughout the workshops, UNMA emphasized its interest and willingness to prioritize investment in regional weather data and forecasts; this would enable local governments to make more accurate decisions and forewarn their population when extreme weather is expected.

Another important focus area is to increase communities' capacity to understand the relevance of investments for climate change adaptation, as well as enable them to manage the necessary investments. Only if local communities feel ownership of adaptation will measures and investments be sustainable. Table 3.11 summarizes these and other potential measures to strengthen climate resilience through governance.

3.6.2 Infrastructure

To provide the necessary support to community livelihoods in both rural and urban contexts, climate-resilient infrastructure must be in place. This includes, on the one hand, climate-proofing existing infrastructure such as roads, tracks, bridges, hospitals, water storage etc. On the other hand, newly built infrastructure should be able to resist—or even prevent—climate hazards and minimize related risks, including, for instance, water treatment, erosion and flood protection.

In the context of flood risks, investments will be needed in erosion protection—for example, through planting vegetation around infrastructure, levelling embankments, roads, and structures, river training and protection, creating or retrofitting drainage structures, and strengthening pavements.

Where there is an increased risk for landslides, stabilizing slopes will be an important measure. Stakeholder consultations highlighted that, where possible, nature-based solutions should

TABLE 3.11 **Summary of proposed adaptation measures: governance**

Measure	Source	Hazard addressed	Comments
Increase local institutions' capacities (including capacity building, assessments, strategies, plans)	LoCAL-Uganda investment menu (Annex E)	All	Also include fiscal officers and others who are not directly responsible for climate change
Increase local community capacity and resilience through campaigns, participatory approaches to adaptation measures, studies and capacity building		All	Information currently does not reach the community level, and awareness is crucial at that level both for climate change as well as for the relevance and maintenance of infrastructure for climate change adaptation (e.g. dams)
Improve land use planning and registration to protect local communities and reduce land degradation	Proposed during regional stakeholder workshops	All	With a specific focus on urban settings, especially for areas where poor communities live, as well as for disaster-prone areas
Develop and disseminate local weather forecasts and other weather-related data		All	UNMA confirmed that it is planning to work on regional and local weather forecast services
Improve early warning system		All	

be prioritized. For example, slope stabilization could be achieved through tree plantations. Other measures to reduce landslide risk include conducting alignment studies, geotechnical and environmental studies, local road network (access) studies and plans. Equally important is upgrading existing buildings; this should especially address low-income housing, as noted during stakeholder consultations.

For both floods and landslides, planning is important, taking into account, for example, that significant construction on hilly landscapes can lead to increased water downpour from roofs and thereby contribute to flooding in the lowlands. Along these lines, investment should be made into the definition of procedures, standards and capacities, including strengthening community capacity for routine maintenance; as well as into management plans, for instance, for flood risk management and emergencies. Table 3.12 summarizes these and other potential measures to strengthen the sector's climate resilience.

3.6.3 Water and sanitation

Measures in water and sanitation are mainly aimed at guaranteeing the security of supply, normally and in case of extreme weather events. Water treatment to ensure safe drinking water, measures to ensure an existing waste management structure at the community level and a working sanitation infrastructure are critical to increasing the adaptive capacity of local communities. In the case of drought, ensuring that water is collected and stored and does not disappear through runoff—currently a major risk in the Karamoja subregion—is an important set of measures to be implemented. Nature-based solutions that protect and enhance the natural protection services of existing ecosystems, such as through afforestation or the protection of catchment areas, are another important set of measures that need to be adapted to the district level. Stakeholders emphasized the relevance of appropriate financing schemes, as well as the integration of other partners, such as through the development of public-private partnerships. Table 3.13 summarizes these and other potential measures to strengthen the sector's climate resilience.

TABLE 3.12 **Summary of proposed adaptation measures: infrastructure**

Measure	Source	Hazard addressed	Comments
Climate resilience of new infrastructure (water treatment/harvesting and source protection, waste, erosion protection, flood protection)		All	Application of water recharge, retention and reuse will help reduce overflow and protect soils against erosion
Climate-proofing of existing infrastructure (roads, tracks, bridges, water storage, drainage)		All	
Bioengineering (vegetation plantation) for erosion protection around infrastructure		Flood	Emphasis on soil and water conservation technologies
Flood-protection infrastructure, increased size/level of embankments and structures		Flood	
Slope stabilization measures		Landslide	Emphasis on nature-based solutions, such as trees; soil and water conservation technologies
River/stream bank protection works and river training works		Flood	Emphasis on buffer zoning and restoration of degraded areas
Climate-proofing of road/track through adequate designs and specifications		Flood, landslide	
Alignment studies, geotechnical and environmental studies, local road network (access) studies and plans		Flood, landslide	
Increased level of roads, additional drainage structures, increased size of side drains, strengthened pavements		Flood	
Improvement to pavement design standards and upgrading of existing road pavements (to deal with temperature increases, water runoff and surface erosion, prolonged spells of cold weather at higher altitudes—snow/ice)	LoCAL-Uganda investment menu (Annex E)	Flood, heat	
Additional costs for climate-proofing of already planned roads/tracks		Flood, landslide	
Upgrading of existing buildings to climate-proof standards		Flood, landslide	Should include low-income housing as well
Increased size, level and/or span of bridges		Flood	
Increased size of drainage channels		Flood	
Strengthened roofs (storms/hail), higher elevation, protection measures against flooding and increased drainage for buildings (schools, health facilities, other service centres)		Flooding and landslide	Should also include planning, taking into account that increased construction on hilly landscapes can lead to increased water downpour from roofs and flooding in lowlands
Strengthened or additional river/channel bank protection works		Flood	Emphasis on buffer zoning and restoration of degraded areas
Rehabilitation of damage to infrastructure caused by climate change–related events (storms, high-intensity rainfall, floods)		Flood	
Road maintenance procedures and capacities, including strengthened community capacity for routine maintenance		Flood	
Preparation of drainage and flood risk management plans for flood-prone cities and regions		Flood	

TABLE 3.13 **Summary of proposed adaptation measures: water and sanitation**

Measure	Source	Hazard addressed	Comments
Water treatment facilities to ensure safe drinking water	LoCAL-Uganda investment menu (Annex E)	Flood, drought	Potential for public-private partnerships in management conservation of water resources
Water harvesting facilities		Drought	Very relevant, but costs need to be taken into account; many districts would not be able to afford investing in this technology
Community waste management and sanitation infrastructure		Flood	
Water intakes, sedimentation basins and storage tanks for drinking water schemes and irrigation		Drought	Emphasis on water recharge, retention and reuse
Water source protection measures, e.g. catchment areas, forest conservation and reforestation, water source area fencing		Flood, drought	Potential for public-private partnerships in management conservation of water resources
Increased size or additional number of water storage basins		Drought	Emphasis on water recharge, retention and reuse
Increased length of water supply systems (access to water source)		Drought	In districts where flood and landslide risks are prevalent, systems should also be rendered resilient to these hazards
Mini-solar-powered water supply systems	GCF Concept Note (MWE, 2017)	Drought	
Fencing/marking of buffer zones, planting appropriate grass and tree species, creating diversion channels for storm water management	MWE catchment / water source protection plans	Drought	
Multi-purpose solar-powered water systems	GCF Concept Note (MWE, 2017)	Drought	
Mapping of water points, remote monitoring systems to avoid depletion		Drought	
District-level climate-resilient water and sanitation planning framework		Drought	
Restoration of degraded water catchment areas through tree planting and agroforestry	GCF Concept Note (MWE, 2017)	Drought	
Community sensitization and advocacy on water efficiency in cities and urban areas	NDC (MWE, 2022)	Drought	
Manage water resource systems, including wetlands, particularly in cities, so floods are prevented and existing resources conserved (through the establishment of an integrated water resources management system)		Flood, drought	
Develop safely managed sanitation solutions		Flood	Prioritized for high flood risk districts

(continued)

TABLE 3.13 **Summary of proposed adaptation measures: water and sanitation** *(continued)*

Measure	Source	Hazard addressed	Comments
Construct climate-smart sanitation facilities in prioritized rural, peri-urban communities, and in institutions to increase coverage	NDC (MWE, 2022)	Flood	
Community sensitization and advocacy on water efficiency in cities and urban areas		Drought	
Ecosystem-based watershed management and rainwater harvesting		Drought	
Promote soil conservation and management at catchment level		Landslide	
Operation and maintenance of newly implemented water management technologies	Proposed during regional stakeholder workshops	All	

NOTE: GCF = Green Climate Fund; MWE = Ministry of Water and Environment.

3.6.4 Agriculture and livestock

Agriculture is one of the priority sectors for achieving Uganda's development targets as highlighted in National Vision 2040 (MAAIF, 2019). It is also the sector on which most livelihoods in Uganda depend—and is strongly affected by the changing climate. The NDC, the National Adaptation Plan for the Agricultural Sector (MAAIF, 2018), as well as studies such as USAID's Uganda Climate Change Vulnerability Assessment Report (USAID, 2013) reflect this relevance. A wide range of different projects are currently focusing on the promotion of climate-smart agriculture in different regions of the country.

The threat from hazards such as flood, drought and landslide appears to be greater than that of a decrease in yields; nevertheless, locally adapted measures are necessary to meet both threats (MWE, 2015). During the regional stakeholder consultations, members of local government emphasized measures related to improved water management for agricultural use and livestock. This includes the implementation of small-scale irrigation systems, as well as the promotion of water harvesting. Investment in seed banks, as well as the promotion of climate-smart farming practices and the strengthening of extension services are other important measures to be implemented to promote an agricultural sector adapted to a changing climate. Table 3.14 captures the diverse types of measures proposed in various documents and by stakeholders.

3.6.5 Forestry

Forests play a crucial role in stabilizing the climate and buffering the impacts of climate change. Apart from their mitigation function, they regulate ecosystems, protect biodiversity and support community livelihoods. To strengthen forestry and forests, stakeholders proposed strengthening forest extension services and supporting agroforestry farming systems. To better cope with floods and droughts, districts and areas prone to these could select and cultivate tree species that are adapted or indigenous to the region. Sound planning plays a crucial role in climate-resilient forestry; thus the integration of climate change issues into forest sectoral planning and implementation should be ensured. Further, national parks and game reserves should be maintained, as they are key to forest ecosystem protection. Table 3.15 summarizes these and other potential measures to strengthen the sector's climate resilience.

3.6.6 Fisheries

Climate change poses risks for the fisheries sector, notably in terms of floods and droughts as

TABLE 3.14 **Summary of proposed adaptation measures: agriculture and livestock**

Measure	Source	Hazard addressed	Comments
Promote climate change adaptation strategy implementation that enhances resilient, productive and sustainable agricultural systems	LoCAL-Uganda investment menu (Annex E)	All (especially drought)	
Promote value addition, improve food storage and management systems to ensure food security at all times as a factor of resilience		All (especially drought)	
Climate-proof storage facilities for agricultural produce		Flood	
Increase size of or add length to irrigation channels		Drought	
Invest in heat-resistant varieties of maize and beans that meet local preferences; improve soil moisture management	USAID, 2013	Drought	
For coffee and matooke, invest in shading and other temperature-reducing management techniques, as is soil moisture management to offset expected increases in evapotranspiration		Drought	
Maintain reserves of seeds and plants that are disease- and pest-free at district research centres to improve recovery after disease outbreaks; develop management strategies that reduce pest and disease risk		Drought, flood	• Sweet potato (Luwero, Isingiro and districts with similar agroecology); sorghum (Gulu, Lira and districts with similar agroecology); cassava (Lira, Gulu, Mbale, Kasese and districts with similar agroecology); rice (Gulu, Lira and districts with similar agroecology) • Proposal during regional workshops to use schools, universities or religious institutions to set up seed banks
Facilitate construction of water harvesting structures at household and community levels	MAAIF, 2018	Drought, flood	Emphasized as crucial throughout the workshops
Develop appropriate efficient small-scale irrigation technologies and packages		Drought, flood	Emphasized as crucial throughout the workshops; focus on cost-sharing arrangements, take into account that farmers and districts are not able to finance these schemes
Implement rainwater harvesting and agricultural water management schemes		Drought, flood	Emphasized as crucial throughout the workshops
Improve storage facilities and establish public-private partnerships for management of long-term food/grain storage and supply	NDC (MWE, 2022)	Drought, flood	
Increase timely access to quality agricultural inputs and their efficient use, including inorganic fertilizers		Drought	

(continued)

TABLE 3.14 **Summary of proposed adaptation measures: agriculture and livestock** *(continued)*

Measure	Source	Hazard addressed	Comments
Conduct studies on irrigation potential and identify sites in various river floodplains and underground water sources for micro-irrigation systems	NDC (MWE, 2022)	Drought	
Promote and encourage highly adaptive and productive livestock breeds		Drought	Emphasized as crucial throughout the workshops
Promote pest and disease surveillance		Drought	
Promote and encourage highly adaptive and productive crop varieties and cultivars in drought-prone, flood-prone and rain-fed crop farming systems		Drought	
Scale up awareness and access to climate-resilient crop varieties by farmers and communities in different agroecological zones		Drought	
Promote and encourage conservation agriculture and ecologically compatible cropping systems to increase resilience to the impacts of climate change		Drought	
Promote and scale up conservation agriculture practices such as agroforestry and sustainable land management		Drought	
Support innovative paddy rice production techniques to increase productivity, better manage water resources and reduce greenhouse gas emissions		Drought	
Promote diversification and integration of agricultural enterprises at all levels to spread climate risks		Drought	
Promote integrated crop-livestock systems to enhance community resilience to changing climate		Drought	
Establish early warning information to enhance resilience		Drought	
Integrate strong operation and maintenance components when promoting new water harvesting or irrigation strategies	Proposed during regional stakeholder workshops	Drought	
Empower farmer groups; build social capital and provision of stable markets and agricultural insurance to increase resilience		All	

NOTE: MWE = Ministry of Water and Environment.

TABLE 3.15 **Summary of proposed adaptation measures: forestry**

Measure	Source	Hazard addressed
Promote use of trees in demarcation of protected areas such as national parks and game reserves	NDC (MWE, 2022)	All
Integrate climate change issues into forest sectoral planning and implementation		Drought
Select tree species that are adapted to the region	Proposed during regional stakeholder workshops	Drought, flood
Support agroforestry farming systems and use of indigenous crop seeds		Drought, flood
Strengthen forest extension services		All

well as increasing temperatures. While floods can stimulate fish productivity (increase habitat), they can also cause species' abundance to decline—depending on many variables such as fish age, morphology, physiology, habitat requirements etc. (Carlson et al., 2016). Drought and heat are likely to have effects on water habitat quality in terms of higher water temperatures, decreasing oxygen levels and increasing toxicity of pollutants (Ficke, Myrick and Hansen, 2007).

Fisheries in Uganda represent an important sector for livelihoods, economic development and export, with about 450,000 tonnes of fish produced every year (NaFIRRI, 2013). Protecting this sector from climate risks through investment in adaptation measures should be a priority. A potential measure that particularly addresses floods lies in the promotion of zonation and protection of fish breeding grounds along shorelines. During stakeholder consultations, it was also suggested to promote aquaculture as an additional livelihood. And Uganda's NDC suggests putting in place economic incentives to diversify livelihood options and reduce dependence on climate-sensitive fisheries resources and to strengthen monitoring capacity and the capability of preventing overfishing and unauthorized exploitation of waterbodies. Table 3.16 summarizes these and other potential measures to strengthen the sector's climate resilience.

3.6.7 Energy

Uganda's energy sector is largely based on biomass, which is fuelling about 90 percent of the population's primary energy consumption, especially in the form of firewood and charcoal (MEMD, 2014). Already, the biomass supply does not meet demand, causing an increase in the price of charcoal, and will not be sufficient in the future—even without climate change (Twinomuhangi, Kato and Sebbit, 2021). In light of increasing temperatures and droughts (see Volume 2), and the resulting pressure on the country's forest cover and biodiversity, the biomass supply is particularly vulnerable to climate change and will become even more critical.

In contrast, the vast majority of Uganda's electricity is generated through hydropower with

TABLE 3.16 **Summary of proposed adaptation measures: fisheries**

Measure	Source	Hazard addressed	Comments
Promote zonation and protection of fish breeding grounds along shoreline	NDC (MWE, 2022)	Flood	Emphasis on protection of buffer zones and promotion of fish farming
Strengthen operation and maintenance of existing infrastructure		Drought	
Put in place economic incentives to diversify livelihood options and reduce dependence on climate-sensitive fisheries resources		All	
Strengthen monitoring capacity and the capability to prevent overfishing and unauthorized exploitation of waterbodies		All	
Promote aquaculture as an additional livelihood	Proposed during regional stakeholder workshops	Flood	Wetlands water abstraction for irrigation does not need to compromise wetlands' use; hence, livelihoods options such as fish farming can be promoted to alleviate pressure on wetlands

over 80 percent installed capacity.[4] This energy source may be less affected by climate change, given the slight increase in precipitation and wet days expected until 2060 (see Volume 2). However, as these changes as well as exposure to droughts are region-dependent, there is a risk of reduced water availability in certain areas. Furthermore, increasing temperatures are expected to trigger an increased demand in electricity, especially for cooling purposes, and to contribute to reduced efficiencies in the electricity supply infrastructure—including electricity generation, transmission and distribution (MWE, 2022).

Table 3.17 summarizes potential measures as outlined in the updated NDC to strengthen the sector's climate resilience. These measures are in line with LoCAL's prioritized areas for future investments in the energy sector—namely the promotion of sustainable energy access and utilization as a means of sustainable development in the face of uncertainties related to climate change.

[4] Source: Uganda Electricity Regulatory Authority website, Uganda's Electricity Sector Overview.

TABLE 3.17 **Summary of proposed adaptation measures: energy**

Measure	Source	Hazard addressed
Increase efficiency in the use of biomass in the traditional energy sector and significantly reduce dependence on traditional biomass	NDC (MWE, 2022)	Drought
Promote use of alternative/renewable energy sources (other than hydropower) and promote energy-efficient technologies to reduce electricity demand		Drought
Ensure the best use of hydropower through careful management of water resources		Drought
Climate-proof investments in the electricity power sector		Flood, landslide
Increase access to clean cooking technologies		Drought
Develop and enforce minimum energy performance standards and regulations for energy efficiency		Drought
Implement incentives to promote uptake of energy-efficient technologies		Drought
Support the building code's promotion of energy efficiency in buildings		Drought
Promote the establishment of energy service companies (ESCOs)		Drought

4 conclusions

The CRVA for Uganda at the district level shows that climate change under either the RCP 4.5 or RCP 8.5 scenario increases the risk for floods, droughts and landslide. There appears to be no significant difference for the risk levels between the two scenarios. Although regions and districts are not affected uniformly across the country, some districts will need to take adaptation action against multiple hazards (e.g. many of the districts in Central Uganda face a significant flood risk as well as a significant drought risk).

The district level provides a good basis to define adaptation measures going forward. To be able to start implementation, however, further fine-tuning of the proposed measures through a more in-depth local consultation process will be necessary. This approach will help in further adapting the measures to the specific circumstances at the community and local ecosystem level. The Ministry of Water and Environment is planning such consultations and will use the present report as a basis. Also, the investment officers working with UNCDF will further fine-tune and prepare localized investment strategies before moving ahead with any concrete investment planning.

The results of the CRVA provide a good overview of the relevant hazards and risks at the district level in Uganda. It should be noted, however, that the drought and landslide hazards showed a better correlation with extreme climate indices than did the flood hazard; therefore, the former are more accurate than the latter. To analyse flood events, a watershed perspective may be needed to account for factors related to the water cycle; these can be better assessed with a Geographic Information System (GIS) and hydrological analysis software such as the Soil and Water Assessment Tool (SWAT).

Implementation of adaptation plans at the local level should be accompanied by extensive capacity building and awareness raising of local district governments. Because adaptation is cross-cutting, it will not be sufficient for only environmental and natural resource officers to be aware of the issue; rather, actors such as those responsible for fiscal training must have a basic knowledge of the needs and opportunities entailed with investment in adaptation. In this context, it is also crucial to align responsibilities and coordination mechanisms across the different local government bodies, both horizontally and vertically. It was stressed during the regional consultation workshops that a lack of coordination in government is a key impediment to efficient and effective climate change action.

To increase data reliability, as well as overcome existing limitations regarding data availability and knowledge of climate change at the subnational level, the following actions are recommended:

- The UBOS census has proven to be a very valuable data source, specifically in measuring adaptive capacity. However, based on the experience of the consultants as well as specific stakeholder recommendations during the national stakeholder consultations, it is recommended that additional data relevant to measuring adaptive capacity be integrated into UBOS data collection.
- UNMA is currently working to make regional and local forecasts and weather data available to the districts. An open data policy to further distribute any data related to existing weather stations, as well as forecasts to local governments, will be extremely valuable—not only for making future CRVAs even more specific and accurate, but also to increase planning security and reaction times by local governments. UNMA's work should be supplemented with efforts aimed at guaranteeing smooth operation of weather stations, and capacity building of lead government institutions covering topics such as weather equipment and climate data analysis.
- Centralizing existing data from different stakeholders is critical in planning for future climate risks and increasing adaptive capacity. Research has shown that much information relevant is available; however, it is currently scattered throughout different organizations and ministries, and access to these data is difficult. Clear structures and mandates for information sharing with the relevant ministries (i.e. the Ministry of Local Government and the Ministry of Water and Environment) would enhance data reliability and make it easier for those responsible for adaptation planning to define the most appropriate measures for each community.
- To mainstream climate change adaptation at the subnational level, governments and training institutes should look to incorporate climate change as a topic in existing training programmes for different related professions. A more detailed training course and capacity building would be required for those taking the lead at the local government level (e.g. natural resource and environment officers), including those already in service. This effort should supplement existing climate change courses offered, mainly at the post-graduate level (such as those offered at Makerere University).

Uganda's districts

NORTHERN REGION

Abim
Adjumani
Agago
Alebtong
Amolatar
Amudat
Amuru
Apac
Arua
Dokolo
Gulu
Kaabong
Kitgum
Koboko
Kole
Kotido
Lamwo
Lira
Maracha
Moroto
Moyo
Nakapiripirit
Napak
Nebbi
Nwoya
Omoro
Otuke
Oyam
Pader
Pakwach
Yumbe
Zombo

EASTERN REGION

Amuria
Budaka
Bududa
Bugiri
Bukedea
Bukwo
Bulambuli
Busia
Butaleja
Butebo
Buyende
Iganga
Jinja
Kaberamaido
Kaliro
Kamuli
Kapchorwa
Katakwi
Kibuku
Kumi
Kween
Luuka
Manafwa
Mayuge
Mbale
Namayingo
Namisindwa
Namutumba
Ngora
Pallisa
Serere
Sironko
Soroti
Tororo

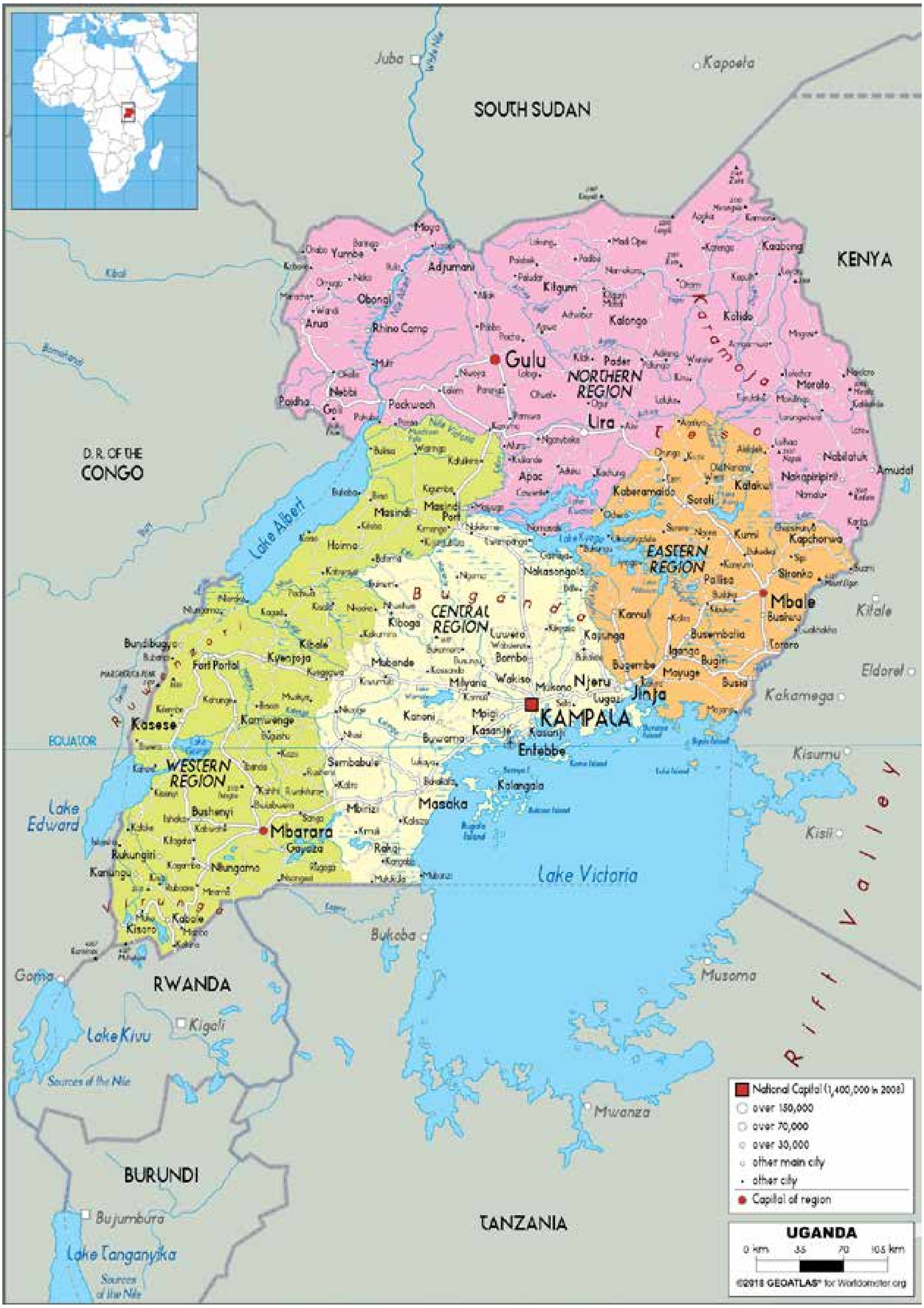
WESTERN REGION

Buhweju
Buliisa
Bundibugyo
Bunyangabu
Bushenyi
Hoima
Ibanda
Isingiro
Kabale
Kabarole
Kagadi
Kakumiro
Kamwenge
Kanungu
Kasese
Kibaale
Kiruhura
Kiryandongo
Kisoro
Kyegegwa
Kyenjojo
Masindi
Mbarara
Mitooma
Ntoroko
Ntungamo
Rubanda
Rubirizi
Rukiga
Rukungiri
Sheema

CENTRAL REGION

Buikwe
Bukomansimbi
Butambala
Buvuma
Gomba
Kalangala
Kalungu
Kampala
Kayunga
Kiboga
Kyankwanzi
Kyotera
Luwero
Lwengo
Lyantonde
Masaka
Mityana
Mpigi
Mubende
Mukono
Nakaseke
Nakasongola
Rakai
Sembabule
Wakiso

FIGURE A.1 **Political map of Uganda**



SOURCE: Worldometers.info.

NOTE: The district and regional divisions in this map do not correlate to those used in the report, as they are from different sources and cover different time periods. The map is included for reference only.

FIGURE A.2 **Physical map of Uganda**

SOURCE: Worldometers.info.

NOTE: The district and regional divisions in this map do not correlate to those used in the report, as they are from different sources and cover different time periods. The map is included for reference only.

methods

The indicators derived from Uganda's National Risk and Vulnerability Atlas were georeferenced to extract their corresponding values to be analysed in tables.

All indicators were normalized using the min/max method shown in the following equation:

$$x' = \frac{x - \min(x)}{\max(x) - \min(x)}$$

Maps were built to show each normalized indicator to better assess its impact at the district level. All maps were categorized using the following categories.

- **Exposure.** Exposure was calculated using the indicators and weights shown in Table B.1; weights were assigned based on the results obtained from the national stakeholder workshop (Annex C).
- **Sensitivity.** Sensitivity was calculated using the indicators and weights shown in Table B.2; weights were assigned based on the results obtained from the national stakeholder workshop (Annex C).
- **Adaptive capacity.** Adaptive capacity was calculated using the indicators and weights shown in Table B.3; weights were assigned based on the results obtained from the national stakeholder workshop (Annex C).
- **Vulnerability.** Vulnerability was estimated by averaging the inverse values of adaptive capacity and the sensitivity values for each district.

A statistical analysis was undertaken to assess three hazards in Uganda: flood, drought and landslide. The analysis focused on identifying which extreme climate indices were correlated with hazardous events in the country. The

TABLE B.1 **Weights assigned to each indicator to estimate flood, drought and landslide exposure**

Indicator	Weight		
	Flood	Drought	Landslide
3.1 Population density	0.19	0.27	0.25
3.2 Physical exposure to flood	0.19	n.a.	n.a.
3.3 Physical exposure to landslides induced by rainfall	n.a.	n.a.	0.25
3.4 Physical exposure of agricultural systems to drought (high and medium risk)	n.a.	0.27	n.a.
3.5 Number of floods and droughts	0.19	0.27	n.a.
3.6 Road network vulnerable to flood hazard	0.19	n.a.	n.a.
3.7 Road network vulnerable to landslide hazard	n.a.	n.a.	0.17
3.8 Hazard exposure of population to flood	0.13	n.a.	n.a.
3.9 Hazard exposure of population to landslides	n.a.	n.a.	0.17
3.10 Hazard exposure of population to drought	n.a.	0.18	n.a.
3.11 Hazard exposure of residential buildings to flood	0.13	n.a.	n.a.
3.12 Hazard exposure of residential buildings to landslides	n.a.	n.a.	n.a.

NOTE: n.a. = not applicable. Indicators are numbered by assessment category as follows: 1.x = sensitivity; 2.x = adaptive capacity; 3.x = exposure. Indicator wording has been lightly edited for clarity and consistency.

TABLE B.2 **Weights assigned to each indicator to estimate flood, drought and landslide sensitivity**

Indicator	Weight		
	Flood	Drought	Landslide
1.1 Number of houses destroyed or damaged by disaster	0.18	n.a.	n.a.
1.2 Number of people directly and indirectly affected by type of disaster	0.18	0.41	0.41
1.3 Dead, injured and missing due to natural hazards	0.18	0.41	0.41
1.4 Damage to crops	0.18	n.a.	n.a.
1.5 Cattle loss due to disaster	0.18	n.a.	n.a.
1.6 Households dependent on subsistence farming	0.08	0.18	0.18

NOTE: n.a. = not applicable. Indicators are numbered by assessment category as follows: 1.x = sensitivity; 2.x = adaptive capacity; 3.x = exposure. Indicator wording has been lightly edited for clarity and consistency.

TABLE B.3 **Weights assigned to each indicator to estimate flood, drought and landslide adaptive capacity**

Indicator	Weight		
	Flood	Drought	Landslide
2.1 Percentage of households headed by women	0.06	0.06	0.07
2.2 Households whose members age 5+ years consume < 2 meals/day	0.06	0.06	0.07
2.3 Households more than 5 km away from any health facility	0.06	0.06	0.07
2.4 Share of total budget for stakeholder environmental training and sensitization	0.06	0.06	0.07
2.5 Local governments implementing climate change interventions in their district development plans	0.06	0.06	0.07
2.6 Safeguards for service delivery of investments effectively handled; evidence that environmental, social and climate change interventions have been integrated into local government development plans and annual work plans and budgets complied with	0.06	0.06	0.07
2.7 Number / density / geographic coverage of UNMA weather and climate observation stations	0.00	0.00	n.a.
2.8 Districts with infectious disease institute	0.00	0.00	n.a.
2.9 Number of functional health facilities by region / district capital per 10,000 people	0.06	0.06	0.07
2.10 Proportion of poor persons by district	0.06	0.06	0.07
2.11 Forest cover (% of land area)	0.06	0.06	0.07
2.12 Share of people who own mobile phones	0.04	0.04	0.05
2.13 Wetland cover (% of total area)	0.06	0.06	n.a.
2.14 Percentage of households with a permanent roof	0.06	0.06	0.07
2.15 Percentage of households with a radio	0.04	0.04	0.05
2.16 Percentage of households with mosquito nets	0.04	0.04	n.a.
2.17 Percentage of households with access to piped water	0.04	0.04	0.05
2.18 Percentage of households with a bank account	0.03	0.03	0.03
2.19 Percentage of households with electric lighting	0.04	0.04	0.05
2.20 Percentage of households headed by 10- to 17-year-olds	0.04	0.04	0.05

NOTE: n.a. = not applicable. UNMA = Uganda National Meteorology Authority. Indicators are numbered by assessment category as follows: 1.x = sensitivity; 2.x = adaptive capacity; 3.x = exposure. Indicator wording has been lightly edited for clarity and consistency.

Pearson correlation coefficient was estimated using extreme climate indices; the DesInventar database; and the National Risk and Vulnerability Atlas (OPM, 2019). A separate analysis was undertaken for each hazard.

- **Flood.** The statistical analysis showed a poor correlation between extreme climate indices and flood events derived from the DesInventar database (ranging between –0.20 and 0.03), and extreme climate indices and the National Risk and Vulnerability Atlas's integrated flood hazard zonation map of Uganda (ranging between –0.28 and 0.10). The best-correlated extreme climate indices were selected: percentage of rainy days, percentage of days with precipitation above the 95th percentile, percentage of days with precipitation above the 90th percentile and the maximum spell of rainy days. An average of the normalized values of the selected extreme climate indices was calculated to estimate the country's flood hazard. The resulting map was analysed with an expert to ensure the estimated food hazard was adequate.
- **Drought.** The statistical analysis showed a good correlation between extreme climate indices and flood events derived from DesInventar database (ranging between –0.18 and 0.40), and extreme climate indices and the National Risk and Vulnerability Atlas (ranging between –0.59 and 0.62). The best-correlated extreme climate indices were selected: maximum temperature spell, maximum value of maximum temperature and percentage of dry days. An average of the normalized values of the selected extreme climate indices was calculated to estimate the drought hazard for Uganda. The resulting map was analysed with an expert to ensure the estimated drought hazard was adequate. Despite the good correlation values between the selected extreme climate indices and in situ data (DesInventar database and National Risk and Vulnerability Atlas, the map failed to show drought hazard at the district level. A comprehensive approach was undertaken by averaging the normalized data of the selected extreme climate indices, the DesInventar drought events and the National Risk and Vulnerability Atlas's integrated drought hazard zonation map of Uganda.
- **Landslide.** The statistical analysis showed a poor correlation between extreme climate indices and landslide events derived from the DesInventar database (only two landslide events were reported in the database), and extreme climate indices and the National Risk and Vulnerability Atlas's landslide susceptibility induced by rainfall map of Uganda (ranging between –0.23 and 0.25). The best-correlated extreme climate indices were selected: maximum spell of rainy days, mean precipitation and maximum precipitation. Those districts most prone to landslides were also selected, as follows:

  - Bududa
  - Buhweju
  - Bukwo
  - Bulambuli
  - Buliisa
  - Bundibugyo
  - Bunyangabu
  - Bushenyi
  - Hoima
  - Ibanda
  - Isingiro
  - Kabale
  - Kabarole
  - Kaabong
  - Kagadi
  - Kanungu
  - Kapchorwa
  - Kasese
  - Katakwi
  - Kisoro
  - Kween
  - Kyenjojo
  - Manafwa
  - Mbale
  - Mbarara
  - Mitooma
  - Moroto
  - Nakapiripirit
  - Namisindwa
  - Napak
  - Ntoroko
  - Ntungamo
  - Rubanda
  - Rubirizi
  - Rukiga
  - Rukungiri
  - Sironko

  The landslide hazard was calculated for the above districts by averaging the normalized selected extreme climate indices. The resulting map was analysed with a local expert to ensure the adequacy of the estimated flood hazard.

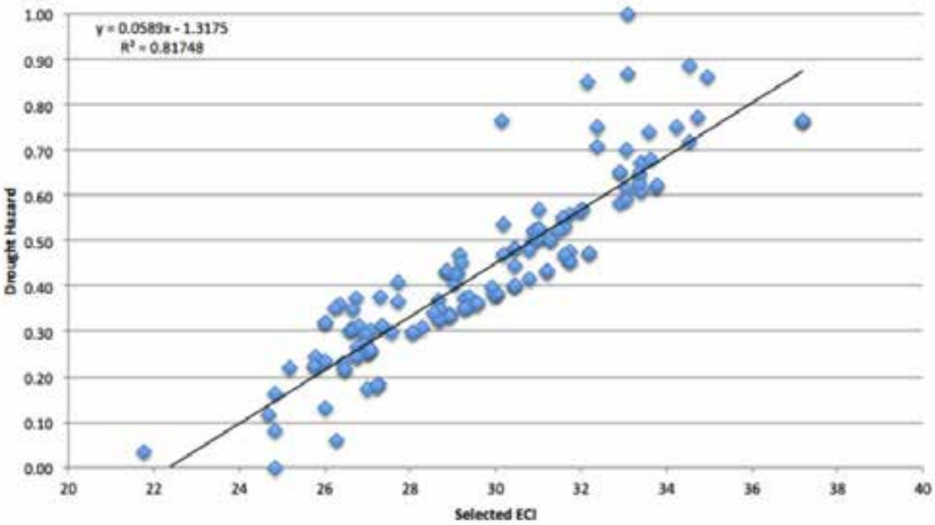
Exposure and vulnerability could not be projected into the future due to insufficient data periodicity and poor correlation with available ancillary projected data. Hence, the historical values for exposure and vulnerability were used for the projected future scenarios.

Flood, drought and landslide hazards were projected into the future using the extreme climate indices calculated for the representative concentration pathway (RCP) 4.5 and 8.5 scenarios for the 2030–2039, 2040–2049 and 2050–2059 periods. Three different approaches were followed based on the historical hazard analysis:

- **Flood.** The selected extreme climate indices normalized data for the RCP 4.5 and 8.5 scenarios were averaged to estimate the flood hazard for the future.
- **Drought.** A linear regression analysis was conducted to project the comprehensive hazard component for drought. The coefficient of determination for this equation was 0.82. The plot and equation are shown in Figure B.1. The selected extreme climate indices discussed above were used to estimate the RCP 4.5 and 8.5 future hazard scenarios with the equation derived from the regression analysis.
- **Landslide.** The selected extreme climate indices normalized data for the RCP 4.5 and 8.5 scenarios were averaged to estimate the flood hazard for the future, but only for those districts with a high susceptibility to landslides.

The projected hazards (flood, drought and landslide) were used to calculate the risk future projections.

FIGURE B.1 **Plot of regression analysis between extreme climate indices (x) and comprehensive drought hazard (y)**



results of national stakeholder consultation

Minutes of the Climate Risk and Vulnerability Analysis, Uganda: Stakeholder Workshop Virtual Meeting held September 2, 2021, 9:00–11:30 CET (lightly edited for consistency and clarity)

C.1 BACKGROUND

The Government of Uganda is developing the LoCAL-Uganda mechanism with the support of UNCDF. A climate risk and vulnerability assessment (CRVA) will provide important evidence and a scientific analysis of climate risks and vulnerability. A consultant consortium of GlobalCAD and Mancala Consultores was assigned to conduct this CRVA. The objective is to identify and map climate risk, exposure and vulnerability hotspots at the local (district) level and prioritize climate change adaptation actions and investments based on a quantified, science-based analysis. The results of the work will feed into the process of updating the nationally determined contribution and defining the main adaptation targets and actions in synergy with boosting and accelerating Sustainable Development Goal achievement. The two main and consecutive elements of the CRVA are (i) climate change downscaling (completed), and (ii) risk and vulnerability assessment (in progress).

C.2 OBJECTIVES OF THE WORKSHOP

Having completed and validated the climate change downscaling, proceeding with the risk and vulnerability assessment requires the input of key stakeholders with regard to the scope of the analysis. Ensuring that the experience and perspective of relevant stakeholders in Uganda are taken into account is crucial to the relevance and accuracy of the CRVA. Against this backdrop, the objectives of this workshop were the following:

3. Provide a quick summary of the main results of the climate change downscaling
4. Validate the choice of the relevant climate change–related hazards as well as the proposed process for establishing the hazard index
5. Validate and prioritize the indicators reflecting vulnerability (sensitivity and adaptive capacity) and exposure

C.3 WORKSHOP HIGHLIGHTS

Opening remarks

The meeting began with a brief welcome from Joel Mundua of UNCDF, who requested Florence Akello of the Ministry of Local Government to officially open the meeting. In her remarks, Ms. Akello thanked all the stakeholders for their participation in the workshop. She also provided background information on both the LoCAL-Uganda mechanism implemented by the Government of Uganda with UNCDF support and on the CRVA, which will provide important evidence and a scientific analysis of Uganda's climate risks and vulnerability. The objective of the CRVA is to identify and map climate risk, exposure and vulnerability hotspots at the district level and prioritize climate change adaptation actions and investments.

Presentation of climate change downscaling report for Uganda and Q&A

The results of the climate change downscaling were presented in detail in a dedicated stakeholder workshop on 26 July 2021. The consultants briefly provided a summary of the most important downscaling results at this workshop to ensure all participants had the same background information and opportunity to raise any concerns. The presentation was followed by a short question and answer (Q&A) session to clarify open questions.

Presentation and discussion of proposed process for establishing hazard indices

The purpose of this presentation was to ensure the process of establishing the hazard indices is in line with stakeholders' knowledge, experience and expectations.

- It was agreed that a hazard index for each of the three hazards (flood, landslide and drought) will be established individually, rather than having a single index combining the three hazards.
- The stakeholders also agreed that a normalized hazard profile will be established based on an unweighted combination of (i) the georeferenced hazard profile derived from Uganda's latest National Risk and Vulnerability Atlas and (ii) historical data derived from the DesInventar database—taking into account all hazard events since 1960 for which losses and damages were reported.

  Furthermore, there was consensus that the final hazard profile will take into account the relevant downscaling results.

Presentation and discussion of the indicators selected for the vulnerability and exposure profiles for each of Uganda's districts

The consultants presented the draft indicators along the three categories of exposure, sensitivity and adaptive capacity (the latter two reflecting the vulnerability profile) with the aim of:

- Obtaining agreement with the stakeholders on the selected indicators, i.e. identify further indicators that should be included and those that should be excluded;
- Identifying which indicators should receive greater and lower weight to reflect their relative relevance.

The consultants followed a three-step process for each of the categories:

1. Presentation of indicators selected and brief feedback round
2. Weighting of relative relevance by the participants using Zoom's polling function
3. Brief discussion of polling results

RESULTS: EXPOSURE

The participants considered all seven exposure indicators presented as relevant. The poll for the weighting was joined by 27 participants (63 percent of all workshop participants). Table C.1 reflects the absolute number and share in percentage of the poll participants who voted for a higher (+) or lower (–) weight for each exposure indicator.

RESULTS: SENSITIVITY

The participants considered all six sensitivity indicators presented as relevant. The poll for the weighting was joined by 23 participants (55 percent of all workshop participants). Table C.2 reflects the absolute number and share in percentage of the poll participants who voted for a

TABLE C.1 **Ranking of exposure indicators**

Indicator	Higher weight (+)		Lower weight (–)		Neutral	
	No.	%	No.	%	No.	%
1. Population density	16	59	8	30	3	11
2. Physical exposure to flood	22	81	1	4	4	15
3. Physical exposure to landslides	15	56	1	4	11	41
4. Physical exposure of agri-systems to droughts	16	59	3	11	8	30
5. Number of floods and droughts	13	48	5	19	9	33
6. Road network vulnerable to floods	11	41	7	26	9	33
7. Road network vulnerable to landslides	8	30	8	30	11	41

NOTE: Indicator wording has been lightly edited for clarity and consistency.

higher (+) or lower (–) weight of each sensitivity indicator.

RESULTS: ADAPTIVE CAPACITY

Due to the larger number of indicators and limitations in Zoom's polling function, two polls were conducted for adaptive capacity, beginning with the indicators reflecting the equity and social cohesion key performance parameter, and followed by polling for the indicators reflecting the other key performance parameters (governance, knowledge and innovation, ecosystem integrity).

Of the 17 proposed adaptive capacity indicators, 16 were approved by the participants, while the indicator "Infectious disease institute availability per district" was considered irrelevant and therefore not to be taken into account. The poll for the weighting of equity and social cohesion indicators was joined by 21 participants (50 percent of all workshop participants); the poll referring to the other indicators was joined by 24 participants (56 percent). Tables C.3 and C.4 reflect the absolute numbers and shares in percentage of the poll participants who voted for a higher (+) or lower (–) weight for each adaptive capacity indicator.

OTHER INDICATORS

The participants suggested additional indicators to take into account, including, for instance, loss of land cover, physical exposure of infrastructure to floods, location of infrastructure such as housing to sensitive areas like wetland, type of house, topography, land ownership, areas prone to lightning, and migration.

While many of the suggested indicators are highly relevant and could provide added value to the analysis, most cannot be taken into account due to a lack of data (not available/no access) or the level of granularity (not available at the district level). Wherever possible, additional indicators will be considered.

In the exposure category (for which it might be possible to derive the needed data as an approximation from the atlas), the indicators added are:

- Exposure of population to flood hazard
- Exposure of population to landslide hazard
- Exposure of population to droughts
- Exposure of residential buildings to flood
- Exposure of residential buildings to landslides

For adaptive capacity, the following indicators have been added:

- Percentage of households with electric lighting
- Percentage of households headed by children

TABLE C.2 **Ranking of sensitivity indicators**

Indicator	Higher weight (+)		Lower weight (–)		Neutral	
	No.	%	No.	%	No.	%
1. No. of houses destroyed or damaged	16	70	4	17	3	13
2. No. of people directly or indirectly affected	19	83	1	4	3	13
3. Dead, injured and missing	14	61	5	22	4	17
4. Damages in crops	16	70	1	4	6	26
5. Lost cattle	9	39	6	26	8	35
6. Households dependent on subsistence farming	5	22	14	61	4	17

NOTE: Indicator wording has been lightly edited for clarity and consistency.

TABLE C.3 **Ranking of adaptive capacity indicators reflecting equity and social cohesion**

Indicator	Higher weight (+)		Lower weight (–)		Neutral	
	No.	%	No.	%	No.	%
1. Households headed by women	15	71	2	10	4	19
2. Households with < 2 meals/day	14	67	3	14	4	19
3. Households > 5 km to health facility	11	52	5	24	5	24
4. Number of health facilities/10,000 people	11	52	5	24	5	24
5. % poor person/ district	15	71	3	14	3	14
6. % people with mobile phone	2	10	8	38	11	52
7. % households with permanent roof	10	48	2	10	9	43
8. % households with radio	4	19	7	33	10	48
9. % households with mosquito net	6	29	6	29	9	43
10. % households with bank account	2	10	11	52	8	38

NOTE: Indicator wording has been lightly edited for clarity and consistency.

TABLE C.4 **Ranking of adaptive capacity indicators reflecting other key performance parameters**

Indicator	Higher weight (+)		Lower weight (–)		Neutral	
	No.	%	No.	%	No.	%
1. % budget stakeholder sensitization	16	67	3	13	5	21
2. Local governments implementing climate change interventions	20	83	1	4	3	13
3. Evidence environmental, social and climate change interventions have been integrated into local government development planning	21	88	0	0	3	13
4. Forest cover	14	58	4	17	6	25
5. Wetland cover	13	54	5	21	6	25
6. UNMA weather stations	14	58	4	17	6	25
7. Infectious disease institute	0	0	24	100	0	0

NOTE: UNMA = Uganda National Meteorology Authority. Indicator wording has been lightly edited for clarity and consistency.

It was suggested that a number of the other indicators as proposed during the meeting should be taken up as part of the next household survey to be undertaken by the Uganda Bureau of Statistics. The list of additional suggested indicators in that regard will be added to the CRVA report.

Next steps and closure

Closing the event, it was agreed that:

- Any additional indicator any of the participants wishes to include will be forwarded to the consultants, including the relevant data (source).
- The Uganda National Meteorology Authority will provide the consultants with a list of all weather stations operating in Uganda, by district.
- The consultants will update the indicator list and develop the hazard, vulnerability and exposure profiles, based on which a first draft report of the CRVA will be developed and shared with the stakeholders for their consultation and critical feedback.

results of regional stakeholder consultation

Minutes of the Climate Risk and Vulnerability Analysis, Uganda: Regional Consultations held 29 November–2 December 2021, 3:00–5:00 pm; CET (lightly edited for consistency and clarity)

D.1 BACKGROUND

The Government of Uganda is developing the LoCAL-Uganda mechanism with the support of UNCDF. A climate risk and vulnerability assessment (CRVA) will provide important evidence and a scientific analysis of climate risks and vulnerability, as well as adaptation options at the local level. A consultant consortium of GlobalCAD and Mancala Consultores was assigned to conduct this CRVA. The objective is to identify and map climate risk, exposure and vulnerability hotspots at the local (district) level and prioritize climate change adaptation actions and investments based on a quantified, science-based analysis. The results will feed into UNCDF LoCAL efforts in mainstreaming adaptation within local governments. The two main and consecutive elements of the CRVA are (i) climate change downscaling, and (ii) risk and vulnerability assessment, including adaptation options.

As the results of the CRVA are displayed on the district level and differ substantially depending on the climatic, geographical and socioeconomic situation in the different regions of the country, the workshops have been undertaken individually for each of the main regions (Northern, Eastern, Central, Western) of Uganda. The workshops were led by the Ministry of Local Government, as well as the Ministry of Water and Environment.

D.2 OBJECTIVES OF THE WORKSHOP

The completed CRVA needs to be validated by local government stakeholders, and their input sought regarding possible adaptation options relevant for the district level. Against this backdrop, the objectives of these workshops were the following:

4. Provide a quick summary of the main results of the climate change downscaling, as well as of the CRVA (region-specific)
5. Validate the results of the CRVA (region-specific)
6. Discuss adaptation options in key sectors for each of the regions

D.3 WORKSHOP HIGHLIGHTS

Opening remarks

All workshops began with a brief welcome from Florence Akello of the Ministry of Local Government, who requested Scovia Akot of the Ministry of Water and Environment to officially open the meeting. In her remarks, Ms. Akot thanked all the stakeholders for their participation in the workshop. She also provided background information on the need for defining relevant and locally tailored adaptation options at not only the district level but the community level as well. She encouraged lively participation by the districts in identifying adaptation options that are most useful and realistic at the local level.

Presentation of climate change downscaling report for Uganda and Q&A

The consultants provided a brief summary of the most important results of the climate change downscaling report with a specific regional focus as background information for understanding the extreme climate indices and representative concentration pathway (RCP) scenarios used in the CRVA. The presentation was followed by a short question and answer (Q&A) session to clarify open questions.

Presentation and discussion of the main results of the CRVA

This presentation covered the CRVA methodology, key concepts and results (for exposure, sensitivity, adaptive capacity and risk) regarding the three different hazards (flooding, landslide and drought). The presentation focused on the regional level, showing the CRVA profiles for the different districts in the relevant region.

- It was clarified that while there are other relevant hazards—such as lightning, hailstorms etc.—that have a significant impact at the district level, the analysis focused only on floods, droughts and landslides, as insufficient data are available to clearly relate any other hazards to extreme climate indices or to analyse specific exposure and vulnerability.
- Clarifications were provided for a number of districts regarding regular occurrences of specific hazards and additional fine-tuning of results and data analysis to be done in advance of the final report. For instance, information will be included on recent drought in Kasese districts, where rainy seasons have lately been shorter than usual and crop losses have occurred. In Kasese, the Nyamwamba River would typically cause flooding, but the municipality itself has been dry—a phenomenon common to various districts and affecting the survival of trees grown in reforestation efforts. Similarly, it was mentioned that it would be good to include the Kafu River in Western Uganda among the areas with a risk of flooding (affecting Luwero, Nakaseke, Nakasongola, Kyankwanzi, Hoima and Masindi).
- It was clarified that, although it is important to specify instances such as the above wherever possible, the analysis is based on long-term trends and events. Thus, not all flooding and drought events would be considered a significant risk that will increase due to the changing climate.
- It was noted that the research was done during a period where Uganda's administrative reorganization was still ongoing. Consequently, the newest districts might not be included in the overall analysis.

Presentation and discussion of adaptation options by sector and hazard

The consultants presented a draft list of adaptation options, tailored to each region by taking into account the most prevalent productive sectors (mostly agriculture, fishery and forestry), as well as the relevant hazards. Not all adaptation measures are suitable for each hazard, and not all regions are affected by all hazards.

Adaptation options were chosen based on existing official documents such as the LoCAL investment menu (Annex E), Uganda's updated draft nationally determined contribution, the National Adaptation Plan for the Agricultural Sector (MAAIF, 2018), USAID's Uganda Climate Change Vulnerability Assessment Report (USAID, 2013) etc. Only those relevant for the district level (either to be implemented by districts themselves or where districts play a specific role in implementation) were included.

The adaptation options were chosen in each region for the following sectors and hazards.

- **Northern:** Adaptation measures selected for the Northern Region are those relevant for flood and drought in the agriculture, fisheries, infrastructure resilience, water and sanitation, and governance sectors.

- **Eastern:** Adaptation measures selected for the Eastern Region are those relevant for flood, drought and landslide in the agriculture and livestock, fisheries, infrastructure resilience, water and sanitation, and governance sectors.
- **Central:** Adaptation measures selected for the Central Region are those relevant for flood, drought and landslide in the agriculture, forestry, fisheries, infrastructure resilience, governance, and water and sanitation sectors.
- **Western:** Adaptation measures selected for the Western Region are those relevant for flood, drought and landslide in the agriculture, forestry, fisheries, infrastructure resilience, governance, and water and sanitation sectors.

Table D.1 presents the main results and discussion points emerging from the regional workshops.

Next steps and closure

Closing the workshops, it was agreed that

- The meeting report as well as a long list of adaptation options would be provided to all participants for further distribution and additional feedback.
- The consultants would adapt the final CRVA report based on the comments received throughout the different workshops.
- A final report would be shared for comments at the end of December.

TABLE D.1 **Summary of needs and considerations related to the CRVA by sector and region**

Sector	Need/consideration
Northern Region	
Governance	• Additional awareness raising needed at the lowest local levels to ensure all people understand the problem at hand: what does climate change mean, and why is adaptation necessary • Information currently does not reach communities, and they are not aware of what is at stake • Additional focus should be on scaling up activities being undertaken on a pilot basis
Energy	Local production and trade of charcoal is an important issue; sufficient energy supply needs to be ensured at all times, including in times of emergency
Private sector engagement	• Although this engagement Is seen as critical, information on how to collaborate with the private sector is lacking, and the private sector does not know about existing opportunities; one suitable option might be a facilitation or exchange platform • Private sector is also seen as a key actor to help raise awareness
Water and sanitation	Investment needed in water conservation technologies that help to divert and retain access to water
Eastern Region	
Governance	Raise awareness with local communities so as to avoid misuse of existing infrastructure; need to better explain importance, e.g. of dams, for communities (specifically for Karamoja)
Agriculture	• Need to promote improved livestock breeds that are more tolerant to climate change • Need for small-scale irrigation systems as well as improved water management technology; focus needs to be on water infrastructure development that allows water harvesting to support livestock as well as irrigation (Karamoja subregion)
Water and sanitation	• Lack of water, as well as of operation and maintenance, and protection of current water infrastructure is a major issue • For Loko and Lokere, catchment management plans that detail needed measures were developed and will be shared; these plans will be an important source of information for the districts • Overall, in Karamoja, the major problem is heavy rains that are quickly running off; water harvesting could solve this problem, but districts to the south have to deal with the runoff
Central Region	
Governance	• Need for dissemination of weather forecast information as an adaptation measure; the information disseminated helps the population—especially farmers—prepare for different hazards • To increase adaptive capacity, poverty at the household level needs to be addressed; irrigation solutions would help solve problems with regard to food security • Dumping of material, waste management and open dumping make landscapes as well as infrastructure more vulnerable; a sound waste management system that would contain the waste, also in case of emergencies, is necessary • Need to strengthen early warning systems • Land registration for rural areas is also key to stop degradation
Infrastructure	• Physical development and land use planning are key to reduce vulnerability of communities; this is especially necessary in urban settings • Need to adapt houses and buildings to the risk of strong winds and storms • Need to find adaptation solutions for buildings adapted to low-income housing as well
Agriculture	• For irrigation schemes in case of droughts, cost sharing is necessary, but local government is not able to provide the funding • Empower farmer groups; build social capital and provide stable markets and agricultural insurance • Promote drought-resistant species

(continued)

TABLE D.1 **Summary of needs and considerations related to the CRVA by sector and region** *(continued)*

Sector	Need/consideration
Agriculture *(continued)*	• Promote renewable energy-saving options • Improve and ensure more climate-resilient post-harvest handling of crops • Most of the soil upland is depleted and needs an intervention to address it; increasing soil productivity will reduce natural resource degradation • A sound seed system for farmers should be developed; promoting agroecology • Establish arboreta/botanical gardens in schools, religious institutions and cultural institutions to act as seed banks
Fishery	• Aquaculture in wetlands would be a lucrative option, but most wetlands have been severely encroached • Promote catchment management through afforestation
Forestry	• Strengthen forest extension services • Promote agroforestry and the use of indigenous crop seeds • Promote catchment management through afforestation
Ecosystem	Restore wetlands
Western Region	
Governance	• Need for dissemination of timely weather forecast information as an adaptation measure; this information helps the population—especially farmers—prepare for different hazards; the Uganda National Meteorology Authority (UNMA) confirmed that it intends to provide this in the future • Capacity building at the district level is necessary for functionality of governance structures and to be able to mainstream climate change • District development plans are not responsive to climate change adaptation; this should be promoted more comprehensively • Fiscal planning officers do not know about climate change, but are responsible for the budget; capacity building needs to focus on all relevant departments • Profiling is needed (for disaster-prone areas) to ensure planning is done correctly
Infrastructure	• Population growth and settlement in fragile areas / hilly terrains generate increased water from rooftops that causes flooding downstream in Kasese • Need for planting trees in fragile areas / hilly slopes and river banks • Soils are poor in Kasese with murram; they cannot hold water for long, resulting in bare hills • Design buildings (schools etc.) as well as roads so they are able to cope with climate changes and related hazards
Agriculture	• Need for agriculture management where soil and water conservation techniques are integrated • Need for proper rangeland management where vegetation is cleared for farmland • Expanding agriculture into forest frontiers, e.g. in Masindi where sugar cane has been promoted at the expense of forests, is leading to environmental degradation
Fishery	Wetlands water abstraction for irrigation does not need to compromise wetlands use; hence livelihood options such as fish farming can be promoted to alleviate pressure on wetlands
Forestry	Need to select tree species adapted to the region and support agroforestry farming systems
Water and sanitation	• Rainwater harvesting techniques are good, but the challenge of upfront costs requires a private sector intervention since communities cannot afford the technology • There is potential for public-private partnerships in the management/conservation of water resources • Low-lying water-stressed districts such as Yumbe face difficulties in defining and implementing the most appropriate technologies, which requires addressing the issue of recharging the existing waterbodies to make them more resilient; if new technology is introduced, operation and maintenance are the most important challenges

LoCAL investment menu

TABLE E.1 **Investment menu for investments and interventions**

NDP III programme	NDP III subprogramme	Eligible investments[1]	NDC adaptation pillar[2]
1. Human capital development	Pre-primary and primary education	• CC proofing/strengthening of classroom construction and rehabilitation (incl. fencing, safety, rain water harvesting, hand washing facilities, COVID-19 screening facilities, lightening arrestors, solar installations etc.) • CC proofing of construction and rehabilitation of Latrine Construction (incl. rehabilitation and emptying); changing rooms for girls • CC proofing of construction and rehabilitation of relevant teacher house construction and rehabilitation • Developing and enhancing CC data availability and dissemination • Cooking sheds with improved institutional cook stoves	10: Mainstreaming CC adaptation in education
	Secondary education	• CC proofing of secondary school construction and rehabilitation (incl. latrine construction, changing rooms for girls, fencing, safety, rainwater harvesting, hand washing facilities COVID19 screening facilities, PPE disposal facilities, lightening arrestors, solar installations etc.) • CC proofing of administration block rehabilitation and Teacher house construction • CC proofing of laboratory and science room construction • Developing and enhancing CC data availability, data and technology to review CC trends etc., and dissemination • Cooking sheds with improved institutional cook stoves	
	District hospital and primary health care	• CC proofing of staff house construction and rehabilitation • CC proofing of OPD and other ward construction, and rehabilitation • CC proofing of standard pit latrine construction (incl. rehabilitation and emptying) • CC proofing of technologically appropriate hand washing facility installation • CC proofing of maternity ward construction and rehabilitation including placenta pits and energy efficient incinerators; OPD and other ward construction and rehabilitation, theatre construction and rehabilitation including lightening arrestors, solar installations • Cooking sheds with improved institutional cook stoves. • CC proofing of medical waste disposal facilities	10: Mainstreaming CC adaptation in health

NDP III programme	NDP III subprogramme	Eligible investments[1]	NDC adaptation pillar[2]

2. Agro industrialization	Agricultural extension services and district production services	• Diffusion of appropriate, efficient technologies that address climate trends of benefit for agriculture
		• Enhancement of structures & CC proofing of:
		  ◦ Valley dam construction
		  ◦ Micro-scale irrigation
		  ◦ Cattle dip construction
		  ◦ Slaughter slab construction
		  ◦ Livestock market construction
		  ◦ Plant clinic/mini laboratory construction
		  ◦ Crop marketing facilities
		  ◦ Demonstration farms for training of communities in agriculture crop diversification on resilient farming, demonstration field for resilient crops, and introduction of climate adaptive crop varieties suited to adverse conditions brought about CC, pasture improve
		  ◦ Support to improved animal breeds and health service to protect animals against disease and heat, vaccinations programs, artificial insemination etc.
		  ◦ Monitoring systems for crop, livestock diseases and pests affected by CC
		  ◦ Improvement and climate proofing of livestock infrastructures, cattle dips and market systems
		  ◦ Measures to protect agriculture land and agriculture projects (storage facilities) from flooding, erosion and wave surges
		  ◦ Construction of sustainable land management structures (SLMs) e.g. terraces, contours etc.
		  ◦ Solar driers
		  ◦ Construction of fish ponds, hatcheries and aquaponics systems
		  ◦ Fish handling facilities including energy saving smoking kilns
		  ◦ Promotion of conditions for bee keeping (protection of trees, honey for food and income, pollination to maintain the ecosystem for sustainable livelihoods)
			1: Supporting resilient agricultural production and value chains

3. Community mobilization and mindset	Community mobilization and empowerment	• Community plans and support to sustainability management of natural resources, protection of natural habitats, including monitoring arrangements • Community CC adaptation plans to protect environment	4: Supporting community engagement for restoration, conservation and safeguarding of forests, catchment areas, riverbeds, wetlands, and urban environments

NDP III programme	NDP III subprogramme	Eligible investments[1]	NDC adaptation pillar[2]
4. Private sector development	Commercial services	• CC proofing of the construction, remodelling and rehabilitation of markets. • Enhancement and CC proofing of agriculture products storage facilities • CC proofing of construction, remodelling and rehabilitation of bus stands, lorry parks and other economic infrastructure • CC proofing of demonstration areas for private business and one-stop shops for interaction between business and private sector • CC proofing of tourism promotional services	7: Developing eco-tourism to restore and protect ecosystems through enhance value
5. CC, natural resources, environment and water management	Natural resource management	• Land management services (surveying, valuations, titling and freehold/lease management and customary certificate of ownership) • Integration of CC changes considerations in the physical development planning • Tree planting and greenery of public places and institutions (e.g. schools, health facilities, roads etc.), including erosion protection around infrastructure, riverbanks etc. • River bank, forest and wetland restoration (including enhancement/ up-grading of degraded water catchment areas) • Increases in water storage facilities and strengthening of these • Walls against flooding from heavy rain • Drainage system for mountain lakes which might overflow their banks because of heavy rain and/ glacier melts • Disseminate land/resource maps to support traditional land/natural resources management practice/local land management practices with farming and grazing areas in response to CC, Reviewing and enforcing land use master plans/ land use plans, Exploring and promoting sustainable land management technologies and support investments in these • Investment in renewable energy technologies in public institutions and demonstration centres, which has adaptation objectives. • Bio-energy technologies e.g. bio-gas, briquettes	4: Supporting community engagement for restoration, conservation and safeguarding of forests, catchment areas, riverbeds, wetlands, and urban environments 6: Reducing dependence on charcoal and firewood for energy to protect forest ecosystems

	Rural water supply and sanitation	Based on review of impact from CC strengthen existing structure for resilience building or ensure better coverage strategically to address:
		• Enhancement and climate proofing of:
		  ◦ Existing natural water sources and catchment areas
		  ◦ Rehabilitation and repairs to rural water sources
		  ◦ Construction of public latrines in RGCs
		  ◦ Spring protection
		  ◦ Borehole drilling and rehabilitation
		  ◦ Construction of piped water system
		  ◦ Construction of dams
		• Investments to ensure water harvesting and storage and supply, e.g. rainwater harvesting and improved local water retention through ponds and improved irrigation practices.
			3: Supporting climate resilient, safe, sustainable and equitable water supply and sanitation systems and increasing water supply and capacity and assurance/ reliability of supply

NDP III programme	NDP III subprogramme	Eligible investments[1]	NDC adaptation pillar[2]

6. Integrated transport infrastructure and services	District urban and community access roads and district engineering services	• CC proofing of construction of public building including major upgrading and investments (e.g. to ensure they are resilient against threats from CC etc.)
		• Major upgrading, CC proofing investments in:[3]
		  ◦ Community access roads
		  ◦ District and community access roads
		  ◦ Bridges for district and urban roads including stone-arch bridges
		  ◦ Additional culverts stones,
		  ◦ Construction and rehabilitation of rural and urban drainage infrastructure to cope with additional impact from CC
		  ◦ Construction and rehabilitation of solid waste collection and disposal facilities impacted by CC
		  ◦ Tree planning/vegetation along the road for shoulder and slope stabilization and erosion protection
			8: Strengthening the regulations, standards and incentives for resilient construction practices in buildings and other infrastructures to support resilient urban planning

7. Regional development	District and urban administration	• Climate change proofing in the construction or rehabilitation and furnishing of government offices • Drainage systems around larger public building and infrastructure to address increasing impact from CC	

NOTE: CC = climate change; NDP = National Development Plan.

[1] Subject to compliance to climate adaptation requirements (climate specific, climate smart, climate strategic).

[2] Nationally determined contribution (NDC) pillars that are under local government mandate.

[3] Note for roads, the importance is to strengthen the roads to cope with the impact from CC, e.g. through increasing the height of the road embankment in parts where the road can be affected by flooding, etc.

TABLE E.2 **Investment menu for investment service costs**

Budget code	Activities – Positive	LoCAL indicative activities
Monitoring, supervision and appraisal of capital works	• Project identification and appraisal (desk and field), including review of the impacts from climate change, and screening/classification • Contract management and execution activities • Routine monitoring • Databases and systems	• Conducting climate risk and vulnerability assessment Identification of investments to address climate risks whilst targeting vulnerable groups • Screening of investments and provision of adaptation rationales • Training in use of the ACCAF and tools to mainstream CC in the entire project cycle • Disaster risk reduction and preparedness plan Environmental, social and climate impact assessments Preparation of environmental and social management plans, and CC strategies and adaptation plans Mainstreaming of climate change in plans, budgets, contracts, and monitoring. • Technical supervision costs to ensure CC targeting
Feasibility studies for capital works	• Preparation of engineering designs and cost estimation, including design work on review of additional costs from impact from climate change and climate proofing of infrastructure • Location studies for geotechnical, environmental, review of e.g. flood levels to ensure safety of existing buildings and studies of more resilient development in sectors impacted • Preparation of bidding documents including preparation of BoQs	• Development of technical designs that responds to climate change adaptation • Development of cost estimates that are responsive to the technical designs that put into consideration climate change adaptation measures • Development of project profiles for prioritized LoCAL investments as per guidelines • Incremental procurement costs for LoCAL investments and interventions (advertisement, evaluations and contracts committee costs) • Costs /benefits of CC relevant investments, and review of climate co-benefits

NOTE: CC = climate change.

TABLE E.3 **Investment menu for monitoring activities**

Budget code	Activities – Positive	LoCAL indicative activities
Monitoring and evaluation	Monitoring and evaluation activities	Joint monitoring (political leadership and technical staff) to check compliance to: • Adaptation plans • Environmental social management plans • Schedule and scope of work of civil works

TABLE E.4 **Investment menu for institutional strengthening and capacity building**

Categories	Activities/examples of expenditure	LoCAL indicative activities
Staff training (on the job) Workshops and seminars	• In-house short-term training, skills development (not more than a month) • Benchmarking on best practices	• Support to develop performance enhancement plans in climate change related areas of performance • Training in climate change related issues, forecasts, impact, vulnerability assessments, targeting of projects etc. • Community training in climate change related areas, including e.g. water harvesting, water supply operations etc.
Small office equipment	• Office equipment • Retooling	Files and databases to store and make analysis of climate change relevant data
ICT equipment	ICT equipment, including databases on e.g. climate changes, vulnerabilities, early warning systems, etc.	• IT equipment and databases to store and make analysis of CC relevant data • Tools to do climate risks and vulnerability assessments
Consultancy services – short term	E.g. support to strengthen the planning process and mainstreaming of cross-cutting issues, e.g. climate adaptation, especially if LGs have performed poorly in the LG PA	• Support in conducted climate vulnerability and risk assessment • Support to mainstream climate change in planning, costing, budgeting, procurement etc.
Coordination and reporting	Use of ACCAF tool, and linkages with other physical and financial reporting templates and tools	• Minor maintenance LoCAL vehicle • Travel costs for reporting and consultations
Awareness-raising activities on climate change adaptation issues	Public awareness raising on climate change	• Education: Development and execution of awareness raising programs on climate change issues, climate change and environmental sustainability, community programs for increased resilience • Health: Awareness raising of communities and outreach staff on impacts of climate change on disease transmission, and occurrence and epidemic preparedness and response. • Agriculture: training of communities in crop diversification and resilience farming, demonstration facilities etc. • Dissemination of climate and market information to livestock keepers • Community campaigns to inform and understand and identify climate change impacts, vulnerability, risks, adaptation measures and to strengthen community resilience • Community engagement for LoCAL investments and intervention beneficiaries and project-affected persons • Wetland wise use model: training on wise methods of sustainable wetland management

NOTE: CC = climate change; ICT = information and communication technology; LG = local government.

glossary

All concepts used in this report are based on the IPCC's Fifth Assessment Report, unless otherwise indicated. For further explanations of technical concepts, please see the IPCC Glossary.

Adaptive capacity. "The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities or to respond to consequences" (IPCC, 2022, p. 2899).

Ecosystem integrity. One of the four key performance parameters used in this study. The United Nations Convention to Combat Desertification defines land degradation neutrality as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services to enhance food security remain stable, or increase, within specified temporal and spatial scales and ecosystems." Halting and reversing land degradation involves restoring degraded ecosystems and sustainably managing resources through a commitment to neutrality in land degradation in order to preserve food and freshwater production, protect against the dangers of climate change, and sustain future demand without further degrading the finite resource base of regions and localities.

Equity and social cohesion. One of the four key performance parameters used in this study. Inequalities are one of the main coefficients of vulnerability and the primary challenge for sustainable development based on risk reduction and adaptation. Social cohesion, through the eradication of inequalities, is the key strategy to change conditions and look to prevent, reduce and reverse vulnerability by increasing adaptive capacity and resilience. Similarly, the eradication of social and gender inequality can increase the capacity of women, groups in conditions of poverty, indigenous groups and other groups in conditions of social exclusion to strengthen the resilience and sustainability of their livelihoods and the quality of their living environment.

Exposure. The "presence of people; livelihoods; species or ecosystems; environmental functions, services and resources; infrastructure; or economic, social or cultural assets in places and settings that could be adversely affected" (IPCC, 2022, p. 5).

Governance. One of the four key performance parameters used in this study. As used here, governance refers to climate governance, which is defined by the IPCC as the "[p]urposeful mechanisms and measures aimed at steering social systems towards preventing, mitigating, or adapting to the risks posed by climate change" (IPCC, 2018, citing Jagers and Stripple, 2003). Both the Paris Agreement and the IPCC's Fifth Assessment Report indicate that enhancing governance is about clarifying the process of who does what, how and when, to address the climate threat through risk reduction based on sustainable development and adaptation.

Hazard. The "potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources" (IPCC, 2022, p. 5).

Key performance parameter. Criterion against which the effectiveness of certain actions is measured in relation to expected results. The key performance parameters defined in this study to serve as a basis for indicator selection are governance, knowledge and innovation, equity and social cohesion, and ecosystem integrity.

Knowledge and innovation. One of the four key performance parameters used in this study. Recognizing the importance of expanding knowledge through research, development and innovation is a key factor in modifying practices in organizations, the economy, society, and the use of land and natural resources, which are reflected in the correction of the processes of degradation of the climate system and its impact on society and the most vulnerable. Understanding this is crucial for adaptation.

Risk. Risk is conceptualized as the interaction between vulnerability conditions and the exposed physical elements to hazardous climate-related processes and events.

Risk index. A two-step process was used to calculate the risk index: (i) the exposure and vulnerability levels were combined, resulting in exposure-vulnerability categories in an index form; and (ii) those results were combined with existing hazard levels to obtain the final risk index.

Sensitivity. "The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of flooding)" (IPCC, 2022, p. 2922). In the context of this report, sensitivity refers to adverse effects only.

Vulnerability. The "propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt" (IPCC, 2022, p. 5). It is calculated combining sensitivity and adaptive capacity.

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The impact of climate change is acutely experienced at the local level—where we work, go to school and live our lives. In the world's most climate-vulnerable nations, adaptation is critical and, all too often, under-resourced. The United Nations Capital Development Fund (UNCDF) designed the **Local Climate Adaptive Living Facility (LoCAL)** in 2011 as a way to channel finance to local government authorities and their communities to cover the additional costs of mitigating and adapting to the impacts of climate change—thereby minimizing and addressing potential loss and damage. Managed by UNCDF, the Facility supports LoCAL country-owned mechanisms for climate finance delivery that have realized adaptation solutions for more than 16 million people around the world. More than 30 countries across Africa, Asia, the Caribbean and the Pacific have engaged with LoCAL to deliver resilience-building solutions for climate-vulnerable populations. The LoCAL approach provides the basis for international standard ISO 14093:2022, which contributes to Sustainable Development Goals 1, 11 and 13.

The **United Nations Capital Development Fund (UNCDF)** is the United Nations' flagship catalytic financing entity for the world's 46 Least Developed Countries (LDCs). With its unique capital mandate and focus on the LDCs, UNCDF works to invest and catalyse capital to support these countries in achieving the sustainable growth and inclusiveness envisioned by the 2030 Agenda for Sustainable Development and the Doha Programme of Action for the least developed countries, 2022–2031.

UNCDF builds partnerships with other UN organizations, as well as private and public sector actors, to achieve greater impact in development; specifically by unlocking additional resources and strengthening financing mechanisms and systems contributing to transformation pathways, focusing on such development themes as green economy, digitalization, urbanization, inclusive economies, gender equality and women's economic empowerment.

A hybrid development finance institution and development agency, UNCDF uses a combination of capital instruments (deployment, financial & business advisory and catalysation) and development instruments (technical assistance, capacity development, policy advice, advocacy, thought leadership, and market analysis and scoping) which are applied across five priority areas (inclusive digital economies, local transformative finance, women's economic empowerment, climate, energy & biodiversity finance, and sustainable food systems finance).

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