UGANDA

Climate Hazard Assessment – Lamwo District

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Climate Hazards in Uganda's Refugee-Hosting Districts.

INTRODUCTION

Uganda hosts one of the largest refugee populations in Africa,[1] many of whom live in climate-sensitive landscapes highly vulnerable to the impacts of climate change due to its reliance on rain-fed agriculture, limited adaptive capacity, and high exposure to extreme weather events such as floods, droughts, and prolonged dry spells.[2] Over recent decades, the country has experienced more frequent and intense climate hazards, undermining livelihoods, food security, health, and infrastructure.[34] Uganda's climate is characterized by a bimodal rainfall pattern; however, this pattern has become increasingly unpredictable, with delayed onset and erratic distribution of rainfall that disrupts agricultural cycles.[5]

Key National Signals

- Temperatures have risen by ~1.0 –1.5°C over the last five decades, increasing heat stress and evapotranspiration.
- More erratic rainfall: delayed onset, mid-season dry spells, intense rainfall events
- Prolonged dry spells and flooding now co-exist as dominant hazards, disrupting agriculture, water access, transport, and shelter

Climate hazards vary across the country, with distinct patterns between the Northern/West Nile and Southwestern regions, highlighting the need for localized analysis. Although both regions are projected to become warmer and wetter by mid-century, the impacts will differ significantly due to variations in baseline conditions, terrain, and livelihood systems.

In the Northern/West Nile region including Yumbe, Koboko, Adjumani, Madi Okollo, Terego, Obongi, and Lamwo, average temperatures are projected to rise from about 25°C to 30°C by mid-century, while annual rainfall increases from roughly 1,138 mm to 1,587 mm. Despite higher rainfall, increased temperatures will accelerate evapotranspiration, leading to greater soil moisture loss and prolonged dry periods during key agricultural seasons. According to the Multi-Sectoral Needs Assessment (MSNA), conducted by **IMPACT Initiatives** in 2024, prolonged dry spells and heavy rains are the hazard types most frequently reported across West Nile and Southwestern regions. With accelerating climate change, they will remain dominant hazards, alongside a growing risk of flash flooding in low-lying and poorly drained areas.[6]

Hazard Type	West Nile	Adjumani	Terego	Koboko	Lamwo	Madi Okollo	Obongi	Yumbe
Drought/ Prolonged dry spells	x	31%	39%	40%	46%	31%	36%	46%
Heavy Rains	x	38%	40%	42%	24%	33%	35%	38%
Extreme Temp. Events	x	19%	13%	12%	18%	26%	13%	7%
Flood	x	13%	8%	6%	12%	10%	15%	9%

Table 1: Climate hazards reported in the 2024 MSNA, Northern/West Nile Region

In Southwestern Uganda districts, Isingiro, Kamwenge, Kyegegwa, Kiryandongo, and Kikuube, historical temperatures average about **20.3°C** but are projected to rise to around **26°C** by mid-century, marking significant warming. Annual rainfall is also expected to increase from about **842 mm** to roughly **1,372 mm**.

Hazard Type	Southwest	Kiryandongo	Isingiro	Kamwenge	Kikuube	Kyegegwa
Drought/ Prolonged dry spells	x	49%	74%	45%	48%	58%
Heavy Rains	x	30%	17%	28%	25%	25%
Extreme Temp. Events	x	16%	6%	23%	18%	13%
Flood	x	6%	3%	4%	9%	3%

Table 2: Climate hazards reported in the 2024 MSNA, Southwestern Region

Across both regions, warmer and wetter conditions do not reduce climate risk. Instead, they increase overlapping hazards, with seasonal droughts, floods, and heat stress occurring in the same districts and seasons. These pressures are especially acute in refugee-hosting areas where land, water, and services are already limited. District-level Climate Hazard Assessments translate national and regional climate trends into local evidence, highlighting key hazards, seasonal risks, and exposures to support targeted planning and resilience for host and refugee communities.

Climate Hazard Assessment – Lamwo District

CONTEXT & RATIONALE

Lamwo District is located in the Acholi Sub-region of northern Uganda, bordering the **Republic of South Sudan** to the north, **Amuru District** to the northwest, **Gulu District** to the southwest, **Kitgum District** to the east and southeast, and **Pader District** to the south. The district lies approximately 472 km north of **Kampala** and its administrative headquarters are located in Lamwo Town Council. Lamwo covers an estimated area of about **5,588 km²**, most of which is arable land, supporting predominantly rural livelihoods based on subsistence agriculture, livestock keeping, and natural resource use.[7] The district experiences a **tropical climate with a bimodal rainfall pattern**, with rains typically beginning in late March or early April and continuing until November, with peaks around April and August. These rainfall fluctuations are driven by broader climate variability affecting Uganda, including changes in the Inter-Tropical Convergence Zone (ITCZ) and shifts associated with climate cycles such as El Niño/La Niña.[8] Lamwo District faces increasing climate variability and environmental degradation that compound existing development challenges. The district faces fluctuating rainfall, prolonged dry spells, and declining soil fertility, which undermine agricultural productivity and food security

Climate projections under the Moderate Socio-economic Path (SSP2-4.5 scenario), which represents a middle of the road development trajectory with moderate emissions and limited climate mitigation, suggests that Lamwo district will become warmer and moderately wetter by mid-century, with mean annual temperatures rising from **24.1°C to 26.47°C** and annual rainfall increasing from **1,143 mm to about 1,363 mm**.[1] Despite this increase in rainfall, intensifying heat stress is expected to pose greater risks to rural households and displaced populations.[9]

Lamwo District hosts over **97,000** refugees living in Palabek Refugee Settlement primarily from the neighboring conflict-affected countries from South Sudan.[10] This analysis therefore seeks to generate evidence-based insights into historical and projected climate trends to inform climate-resilient humanitarian and development programming in Lamwo District.

By identifying hazard susceptibility, exposure patterns, and future climate hazards, this series of district-level analyses aims to support relevant government authorities and humanitarian/development partners in developing targeted interventions, strengthening disaster preparedness and enhancing resilience in Uganda's refugee-hosting districts.

Key Messages

- Lamwo District currently receives ~**1,143 mm** of annual rainfall, projected to rise moderately to ~ **1,363 mm** by mid-century under the SSP2-4.5 scenario. However, greater seasonal variability, prolonged dry spells and higher evapotranspiration are expected to intensify water stress especially in densely populated Palabek refugee settlement.
- Temperatures are projected to increase by **2.5 -2.6ºC** during the warmest month and driest quarters. This is likely to lead to more frequent **extreme heat conditions**, increasing **heat stress and seasonal drought risk**, which in turn can negatively affect **crop yields, livestock health, and water availability**.
- Seasonal drought remains a dominant hazard, with the Standard Precipitation Index (SPI) and Vegetation Condition Index (VCI), which capture rainfall deficits and vegetation stress respectively, showing severe dryness across **Paloga, Agoro and Madi Opei Sub counties,** leading to vegetation stress, reduced crop yields, and limited pasture and water availability.
- **Palabek (Kal, Ogili and Gem), Paloga and Lokung are more susceptible to water logging and flash floods** due to low elevation, downstream position and low forest cover. Their gently sloping terrain easily accumulates runoff during peak rainfall periods, resulting in repeated damage to shelters,

[1] SSP2-4.5 refers to a *moderate climate change scenario* that combines the "Middle-of-the-Road" Shared Socio-economic Pathway (SSP2) with a radiative forcing level of 4.5 W/m² by 2100. It assumes continued socio-economic development along current trends, moderate population growth, and limited but ongoing climate mitigation, resulting in continued warming and increasing climate variability.

Location and Topography

Lamwo District is in the Acholi Sub-region of Northern Uganda, bordering South Sudan to the north, Kitgum District to the east, Pader District to the south, and Amuru District and Gulu District to the southwest. The district's headquarters are in Lamwo Town Council, approximately 472 km north of Kampala and about 66 km northwest of Kitgum, along the Gulu-Kitgum-Lamwo road corridor.[11]

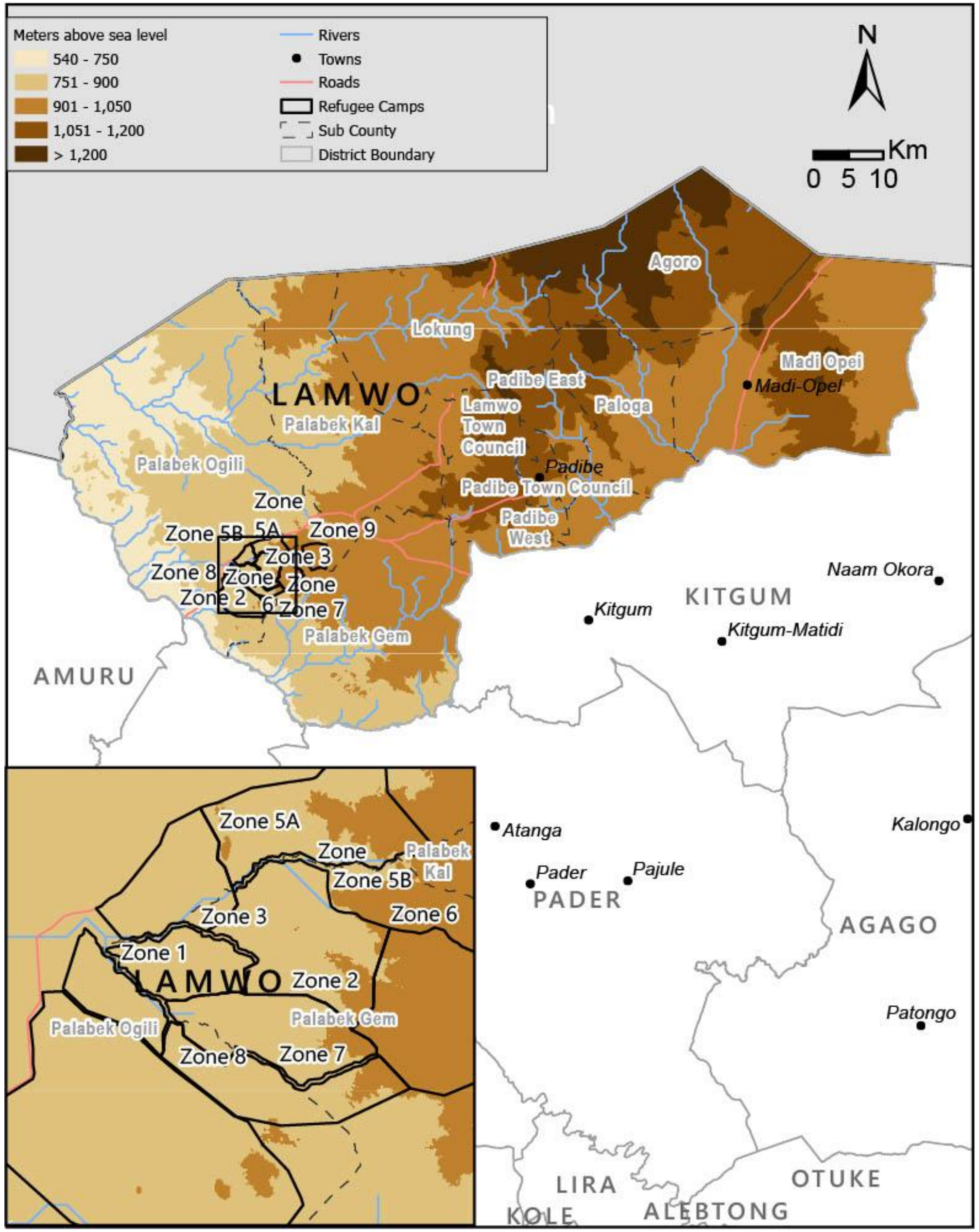
The district covers an estimated 5,588 km^2, making it one of the largest districts in northern Uganda. Much of the land is rural and suitable for subsistence agriculture, grazing, and natural vegetation, supporting the predominantly agrarian livelihoods of local communities.[12]

The district's topography is largely characterized by low landscape with relatively uniform topography marked by few sharp contrasts like Agoro hills, Latolim hill, and Lamwo hill among others. Elevation generally ranges between 900 and 1,300 meters above sea level, with slightly higher altitudes in the hill ranges and lower elevations in valley bottoms and seasonal wetlands.[13]'

Drainage in the district consists mainly of seasonal streams and small rivers that form part of the Aswa River basin, flowing southward toward the White Nile system. These seasonal watercourses influence settlement patterns, agricultural activities, and local water availability, while low-lying areas are occasionally prone to waterlogging and localized flooding during periods of heavy rainfall. Natural vegetation is dominated by savannah grasslands, scattered woodland, and shrubland typical of the Acholi landscape, with denser vegetation occurring along riverbanks and hill slopes.[14]

Demographics and Population Distribution

According to the 2024 National Population and Housing Census, Lamwo District has a population of over **213,000 people**, reflecting a steady growth from the 2014 census figure of **134,000 people.**[15] The district's population is predominately **Acholi ethnic group**. **Christianity is** the dominant religion practiced in the district, alongside a smaller Muslim population reflecting the broader demographic patterns of Acholi subregion in Northern Uganda. The population remains largely rural, with most households dependent on **rain-fed agriculture, livestock keeping, and small-scale trade as the primary livelihood source**. Key trading and administrative centers, such



Map 1: Map showing the Location and Elevation of Lamwo District

as Lamwo Town Council and Palabek Town Council serve as important local economic and service hubs.[16]

Lamwo District also hosts a large refugee population mainly from South Sudan in Palabek Refugee Settlement with an estimated **97,000** refugees as of February 2026. living under Uganda's integrated settlement model where refugees and host communities share access to land and basic services.[17]

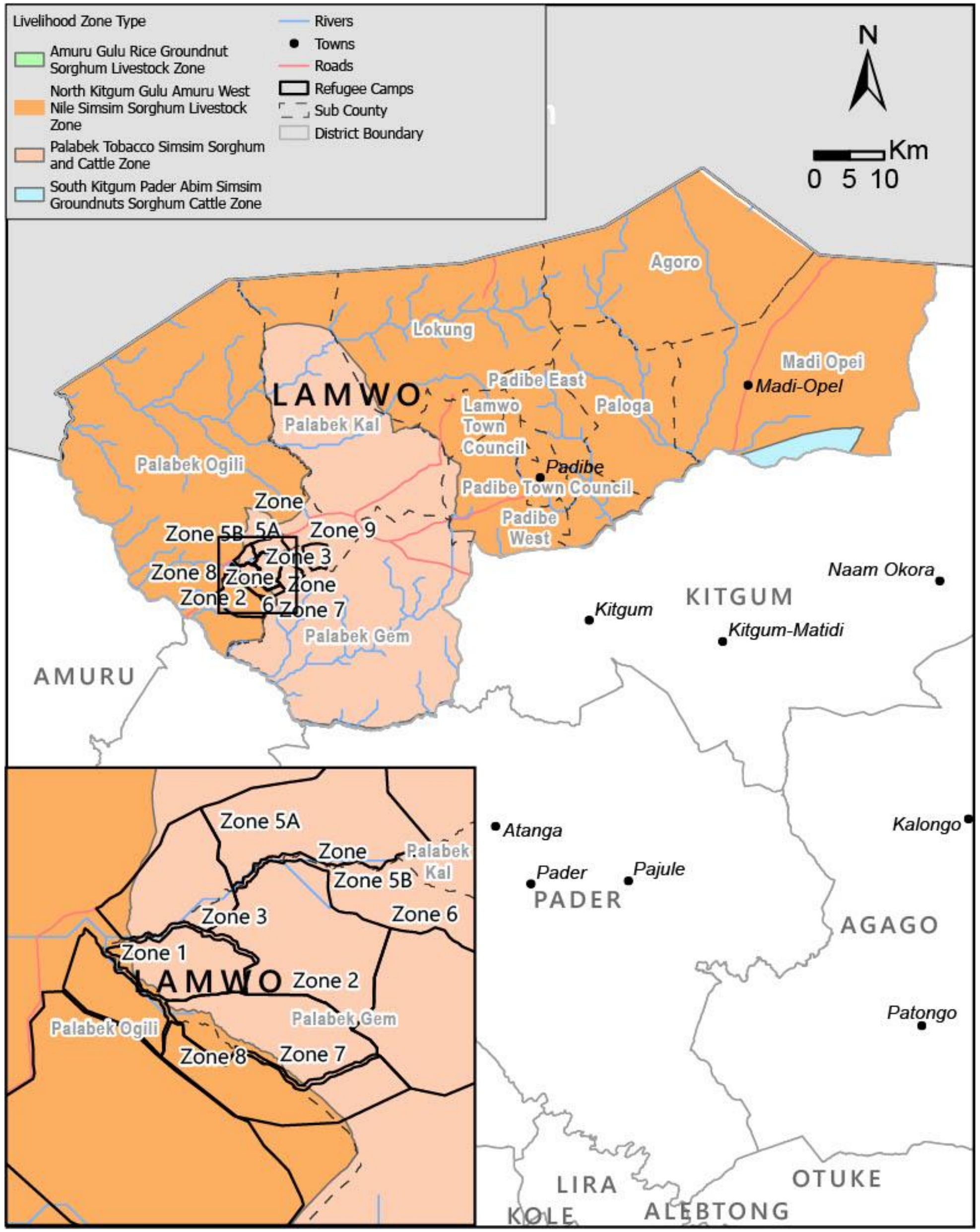
The presence of refugees, combined with **continued natural population growth**, increases pressure on **land resources, water supply, social services, and infrastructure**. As noted in refugee response planning frameworks for northern Uganda, these demographic dynamics influence **service delivery capacity, environmental resource use, and land availability** across Lamwo District.[18]

Livelihoods

Lamwo District lies in four major livelihood zones: (1) *North Kitgum Gulu Amuru West Nile Simsim Sorghum Livestock Zone,* (2) *Amuru Gulu Rice Groundnut Sorghum Livestock Zone,* (3) *Palabek Tobacco Simsim Sorghum and Cattle Zone, and* (4) *South Kitgum Pader Abim Simsim Groundnuts Sorghum Cattle Zone.*

The *North Kitgum-Gulu-Amuru-West Nile Simsim, Sorghum, and Livestock Zone* are characterized by semi-arid savannah farming systems where households rely on sorghum, sesame (simsim), and livestock as their main sources of food and income. nothingThe households depend on sorghum for food security, sesame (simsim) for cash income, and livestock (cattle, goats, poultry) for resilience. As a high plateau this zone may experience faster runoff to lower elevation. Thus, it may be the first to experience seasonal drought during dry spell.

The *Amuru-Gulu Rice, Groundnut, Sorghum, and Livestock Zone* in northern Uganda is a mixed farming livelihood area, where households rely on rice, groundnuts, sorghum, and cattle/goats for both food and income. In this zone, rice, which is highly sensitive to rainfall variability, may be experiencing heat stress during dry spells. To build resilience, households practice mixed cropping and intercropping, maintain cattle and goats for milk and income, and use wetland irrigation schemes to stabilize rice production during dry spells, while savings groups and small trade provide financial buffers against climate and market shocks.[19]



Map 2: Map showing Livelihood Zones in Lamwo District

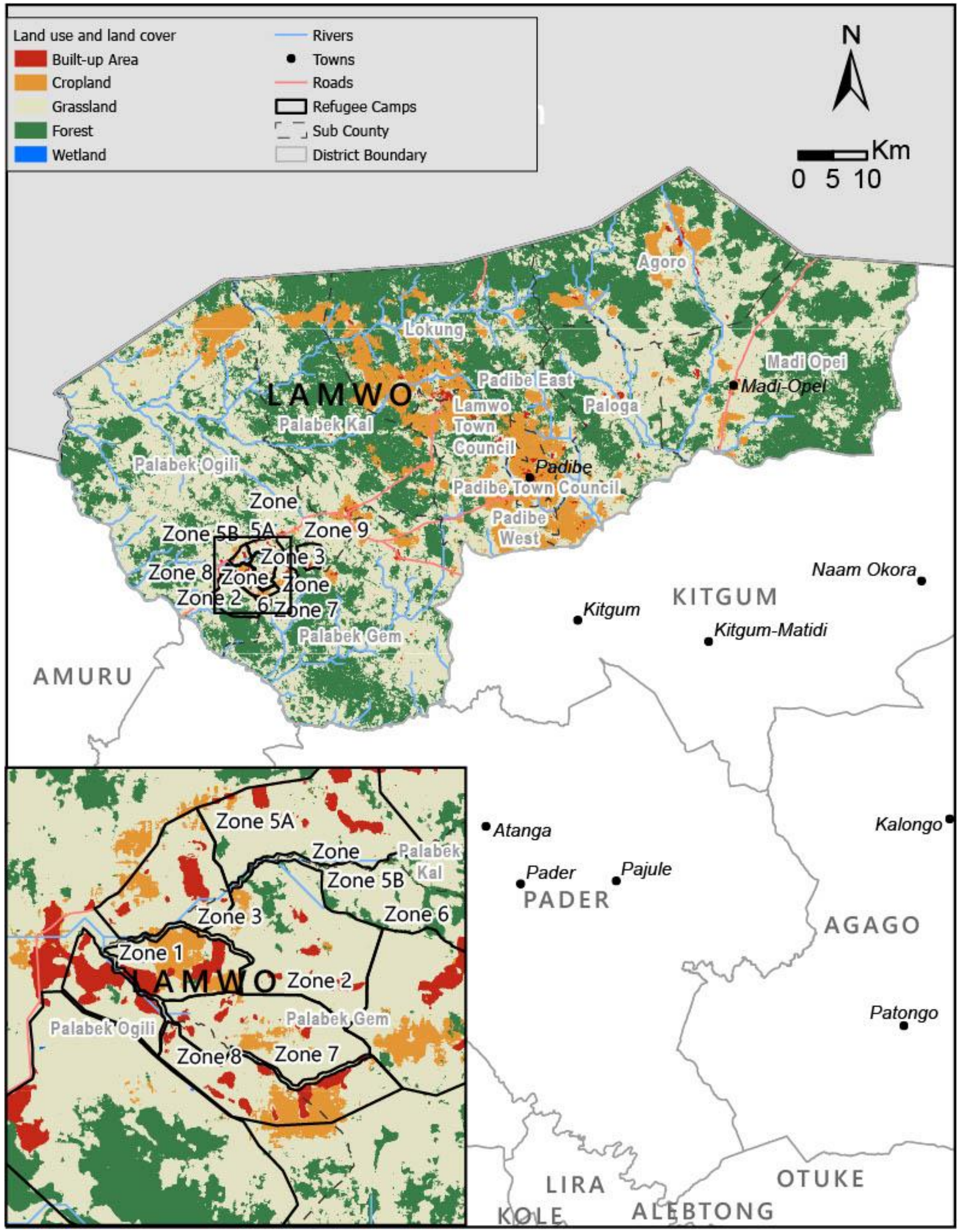
Environment, Land Use and Land Cover

Lamwo District lies within the **Acholi savannah landscape of Northern Uganda**, where natural ecosystems play an important role in supporting rural livelihoods. The district is endowed with **savannah grasslands, forests, wetlands, hills, beautiful mountains scenery, rocks, potential minerals sites and fertile soils,** which support **rain-fed agriculture, livestock grazing, domestic water supply, and energy needs** such as fuelwood collection. Natural features such as the **Agoro Hills** and surrounding woodland areas also contribute to biodiversity and local ecosystem services.[20] However, these ecosystems have experienced significant degradation, both quantitatively and qualitatively, because of the rapid population increase, where wetlands and forests have been turned into farmlands resulting in loss of biodiversity, deforestation, charcoal production, and water scarcity.[21]

Population growth has also contributed to rising pressure on natural resources. The district's population increased from **about 134,000 people in 2014 to over 213,000 people in 2024**, increasing demand for **agricultural land, fuelwood, and construction materials**.[22] In addition, Lamwo hosts **Palabek Refugee Settlement**, which accommodates tens of thousands of refugees, mainly from South Sudan. The presence of refugees alongside host communities has increased demand for **land, water, fuelwood, and other environmental resources**, contributing to **land fragmentation, pressure on forests, and environmental stress** in parts of the district.[23]

As shown in *Map 3*, Lamwo District's landscape is predominantly composed of grassland, which covers approximately 48.2% of the total land area. Extensive grassland supports key livelihood activities such as livestock grazing and seasonal cultivation.

Forestlands (41.9 %) stretch across the district, playing a vital role in providing fuelwood, timber, and construction poles. They also contribute to soil fertility and erosion control, making it essential for both ecological stability and household energy needs. They support key livelihood activities, such as livestock grazing and building materials. From 2021 to 2024, Lamwo lost the equivalent of 1% forest cover compared to year 2000. This loss in forest cover was caused by illegal logging for timber harvesting, charcoal burning, agriculture area expansion and firewood collection.[24]



Map 3: Map showing Land Use and Land Cover in Lamwo District. Source: ESRI land cover map.

Cropland, which makes up 9.2% of the district's total area, remains crucial for subsistence farming, with crops such as tobacco, sorghum, maize, cassava and groundnuts forming the backbone of household food security and income generation. **Built-up areas make up 0.8% of the district's land cover and include settlements, trading centres, and refugee zones. These areas also host critical infrastructure,** including schools, health centres, and road networks.

Although wetlands and open water bodies cover less than 0.1% of Lamwo District, they are vital for water supply, brick making, dry season farming, and livestock watering. Wetlands are both productive agricultural zones and critical ecological buffers that can sustain communities during climate stress. Upland agricultural lands are at times vulnerable to rainfall variability. Wetlands support fishing and small-scale rice cultivation. Wetlands are threatened by encroachment for agriculture and settlement that may pollute them with domestic and agricultural waste.

CLIMATE CONTEXT

This section presents an analysis of Lamwo District's climate using key indicators. Rainfall and temperatures are examined from both historical records and future climate projections to understand long-term trends and emerging risks and hazards associated with them. The aim is to provide a clear picture of how climate patterns have evolved over time and how they are expected to change in the coming decades, informing both vulnerability profiling and resilience planning.

Rainfall

Lamwo District experiences a **rainfall regime that is concentrated in the middle months of the year**, with a clear wet season extending from **March through November** and a pronounced dry period from **December to February**. *Figure 1* shows that rainfall begins to increase from **March**, rising steadily through **April and May**, and reaching its highest totals between **July and August**, with August typically being the wettest month while the driest months of **January and February** often receive only minimal rain (often less than 15 mm in January).[25]

This seasonal pattern reflects **distinct wet and dry periods**, with most of annual rainfall occurring in the mid-year months. These mid-year rains support **rain-fed agriculture, pasture growth, and replenishment of seasonal water sources**. However, rainfall within the wet season can fluctuate considerably from one month to another, creating **intra-seasonal variability that affects agricultural planning**, particularly planting and harvesting decisions. The onset of rain may also vary, with occasionally **delayed early-season rains or short dry spells during the growing season**.

Year-to-year variation is evident across the **2022-2024** period, with differences in both rainfall amounts and timing when compared to the historical average. As shown in Figure 1, recent observations highlight variability around the long-term mean:

For example:

- **2022:** Rainfall was generally **below the long-term average during the early and mid-rainy season**, particularly in **April, June, and July**. However, **August and November recorded relatively higher rainfall**, while **January-February and December remained dry**, consistent with historical seasonal patterns.

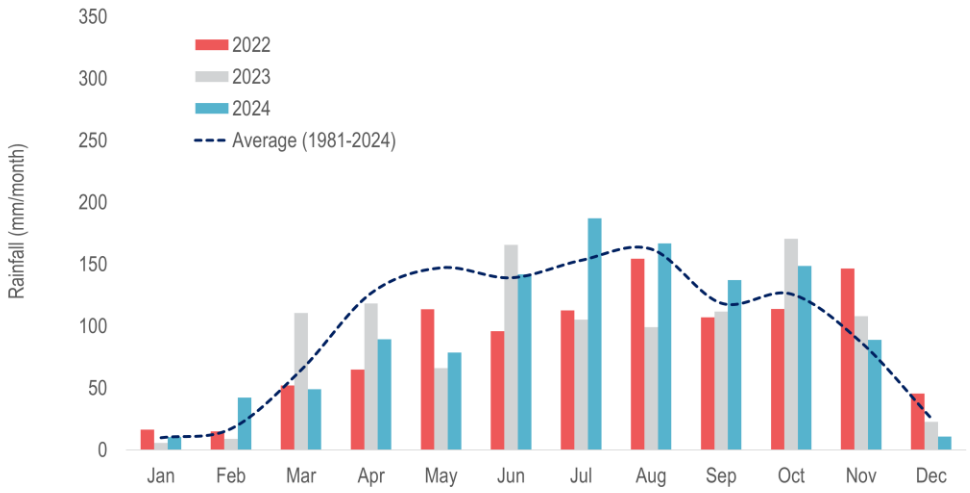


Figure 1: Graph showing Long-term Average Rainfall (2022-2024) in Lamwo District.

- **2023:** Rainfall showed **mixed deviations from the long-term average**. **March, June, October and November recorded above-average rainfall**, while **April, May, July, August, September and December were closer to or below the historical average**, indicating uneven rainfall distribution during the rainy season.

- **2024**: Rainfall showed **stronger variability compared to the long-term average**. The **early rainy season (March-May) was relatively weak**, but rainfall increased significantly from **June to October**, with **July and August recording notably above-average rainfall**. Toward the end of the year, **November remained moderately wet**, while **December recorded very low rainfall**, marking the start of the dry season.

Overall, the graph highlights **increasing rainfall variability**, characterized by **weaker early-season rains and intensified mid-season peaks**, particularly evident in **2024**.

These fluctuations are influenced by climate variability phenomena such as the El Niño Southern Oscillation (ENSO), which can alter the onset, duration, and intensity of seasonal rains. Historically, the El Niño Southern Oscillation (ENSO) typically occurred in an irregular cycle of two to seven years with the individual El Nino persisting for 9 to 12 months. In recent decades, greater variability in ENSO timing, intensity and impacts has contributed to less predictable rainfall patterns across the Northern sub region.

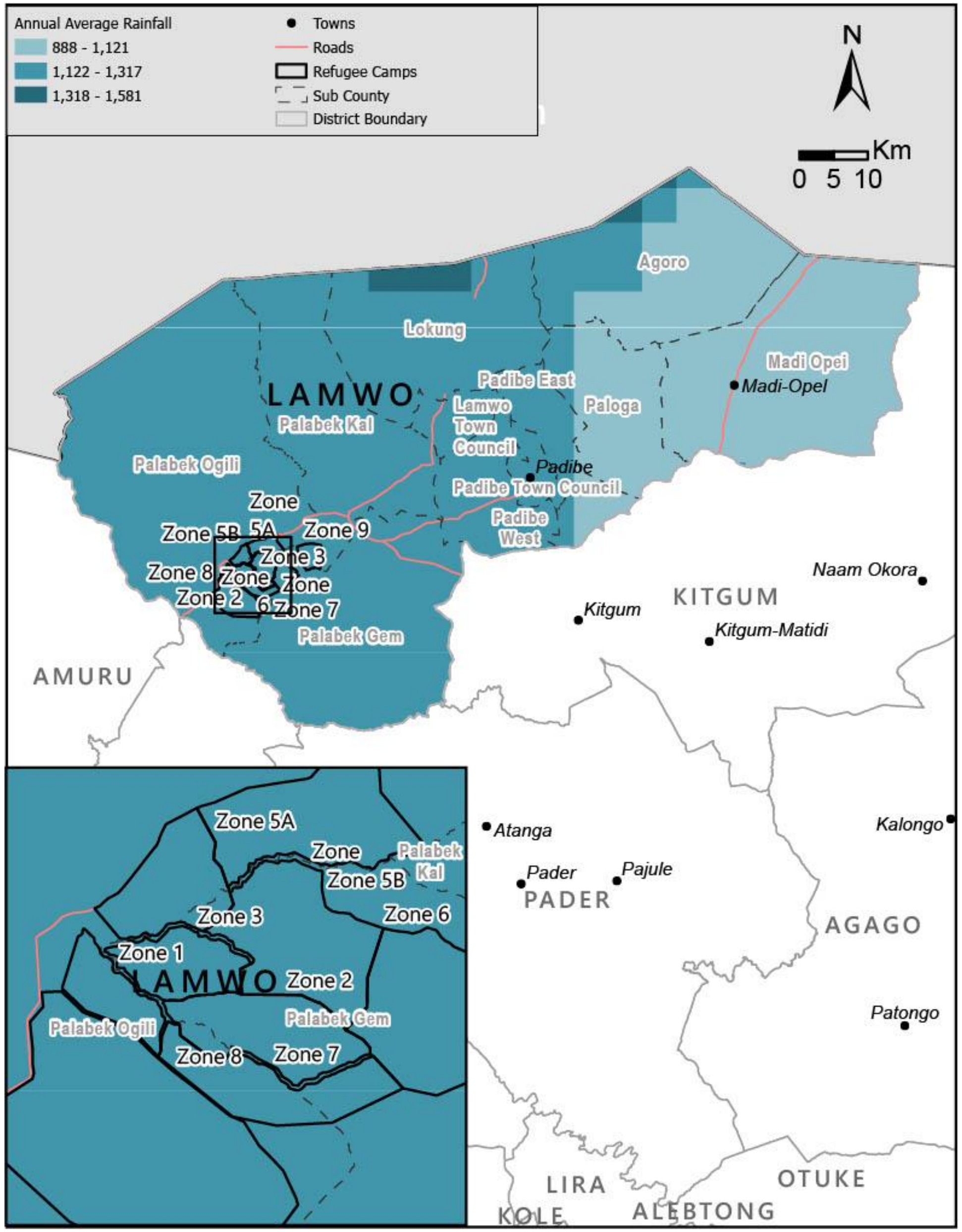
As a result, Lamwo District is increasingly exposed to both flooding and dry spells though flooding is more pronounced.[26] Prolonged dry spells, especially during the December-February period, reduce soil moisture, strain water sources, and affect crop establishment at the start of the first season. Conversely, intense rainfall events during the August-October peak can trigger flash floods that damage crops, homes, roads and social infrastructure.

Overall, increasing variability in rainfall patterns, characterized by erratic onset of rains, intermittent dry spells, and localized flooding,combined with Lamwo District's heavy reliance on rain-fed agriculture, heightens climate risks for both host and refugee communities. These conditions place growing pressure on water resources, crop production, and pasture availability, underscoring the need for context-specific climate adaptation and resilience strategies to support water security, food systems, and sustainable livelihoods across the district.

Map 4 displays the spatial distribution of average annual rainfall across Lamwo District for the period 1981-2024, derived from long-term CHIRPS precipitation data. The district falls mainly within the **888 mm – 1,122mm** and **1,122 -1,317 mm** annual rainfall zones, indicating **moderate rainfall conditions** suitable for rain-fed agriculture across most parts of the district.

The **central parts** of Lamwo district, including **Lamwo Town Council, Padibe East, Padibe Town Council, and Padibe West Sub counties**, are predominantly within the **1,122-1,317 mm** rainfall zone, reflecting relatively wetter conditions. In contrast, the **eastern parts**, including **Palabek Ogili, Palabek Kal and Palabek refugee settlement, also fall within 1,122-1,317 mm** zone. The **western and northwestern areas**, particularly around **Agoro**, **Madi Opei and Paloga Sub counties** fall within the **888-1,121 mm** range, suggesting relatively drier conditions compared to the rest of the district.

Local farmers in Lamwo report that **rainfall patterns** have become **increasingly unpredictable and erratic, with delayed onset of rains, short rainfall periods followed by prolonged dry spells, and shifting seasonal timing**. For example, farmers in Agoro Sub-county have raised concerns about heavy rains causing flooding



Map 4: Map showing Average Annual Rainfall (1981-2024) of Lamwo District.

and waterlogging in the Agoro Irrigation Scheme, threatening crops, such as rice, maize, and vegetables.[27] Similarly, reports from Northern Uganda indicate that prolonged dry spells in Lamwo and neighboring districts have disrupted planting seasons, with farmers experiencing uncertainty over when to plant and increased crop failure risks.[28]

These changing weather patterns are consistent with broader national observations of increasing climate variability in Uganda, where alternating dry conditions and intense rains have been linked to reduced agricultural productivity and heightened vulnerability for rain-fed households. Such variability complicates farmers' ability to schedule planting and crop management and contributes to water scarcity during extended dry spells.[29]

Overall, Lamwo District's climate is characterized by moderate rainfall with increasing variability, which directly affects agriculture, livestock systems, water availability, and livelihoods. The growing unpredictability of rainfall onset, prolonged dry spells, and periodic heavy rainfall events reflects broader regional trends in Northern Uganda and underscores the need for climate-resilient agricultural practices, improved water management, and strengthened community adaptation strategies.

Temperature

Over the past four decades, Lamwo District has experienced a gradual increase in average temperatures, reflecting a sustained warming trend. As illustrated in *Figure 2,* the temperature record from 1981 to 2023 shows a gradual rise in annual mean temperatures, with the most pronounced increases occurring in the most recent years. In recent years, average temperatures have frequently reached above **25°C,** with 2023 recording the highest value in the series, indicating temperatures that are clearly above earlier historical levels.

This pattern suggests that **warming has become more pronounced in the last decade**, with temperatures fluctuating from year to year but generally following an upward trajectory. Earlier years in the **1980s and early 1990s** were relatively cooler, mostly ranging between **about 23.5°C and 24.2°C**, while later years increasingly exceed **24.5°C**, demonstrating a gradual shift toward warmer conditions.

The long-term temperature trend can be summarized as follows:

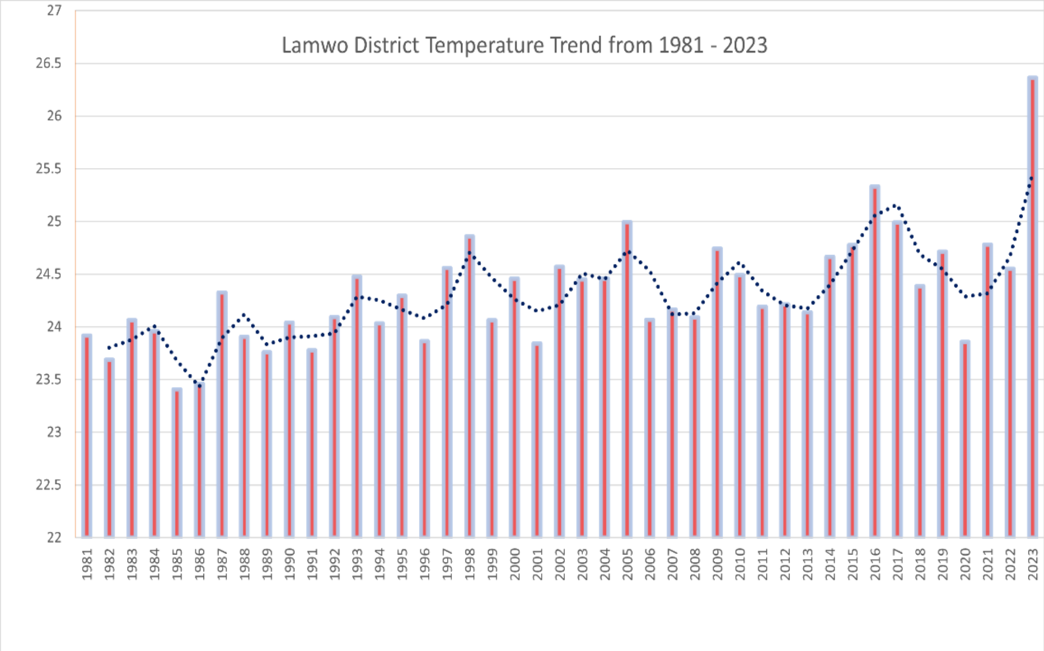


Figure 2: Graph showing the Long-term Temperature Trend (1981-2023)

- **1980s-mid 1990s**: Average annual temperatures in **Lamwo District** remained relatively stable, generally fluctuating around **23.5°C - 24.2°C**, with limited year-to-year variability and no strong warming signal. This period reflects comparatively stable climatic conditions, with temperatures closely aligned with the long-term mean.

- **Late 1990s-2014:** A gradual warming trend begins to emerge, with average annual temperatures increasingly approaching and occasionally exceeding **24.5°C** in several years. Although inter-annual variability persists, this period marks a transition from earlier stability, indicating the beginning of longer-term temperature increases in the district.

- **2015 onwards**: A **clearer and more sustained warming trend becomes evident**. Many years after 2015 record **temperatures close to or above 25.0°C**, with notable peaks around **2016 - 2017** and again in **2023**, which appears as the warmest year in the record. While there is some moderation in the late 2010s, temperatures rise again in the early 2020s, highlighting both **higher average temperatures and increased inter-annual variability**. This pattern reflects growing climate stress in the district.

Overall, the temperature record for **Lamwo District** highlights a **consistent upward trend over the past four decades**, indicating increasing climate pressure. Rising temperatures are likely to **increase evapotranspiration, accelerate soil moisture loss, and intensify heat stress**, with potential impacts on **rain-fed agriculture, water availability, livestock productivity, and human health**, particularly for rural and refugee-hosting communities in the district.

Seasonally, Lamwo District experiences its **warmest conditions during the December-March dry season**, when clear skies and high solar radiation push temperatures above the long-term average. Temperatures generally decline from **April through July**, reaching their lowest levels during the mid-year months, before gradually increasing again from **September to December**. This seasonal pattern reflects the interaction between temperature and rainfall cycles, where **cooler conditions typically coincide with the peak rainy months**, while hotter conditions occur during the **dry periods at the beginning and end of the year**.

The long-term monthly temperature average (1981-2024), shown by the dashed line in *Figure 3*, indicates a clear temperature peak at the beginning of the year (January-March) followed by a steady decline toward July which is the coolest month. Temperatures begin to rise again from August through December, creating a secondary warming phase toward the end of the year. Compared to rainfall patterns, **temperature variability within the rainy season remains relatively limited**, with moderately cooler conditions prevailing during months with higher rainfall.

Recent observations (2022-2024) highlight persistent warming relative to the long-term average, particularly during the early months of the year and toward the end of the year:

The recent monthly temperature trend (2022-2024) can be summarized as follows:

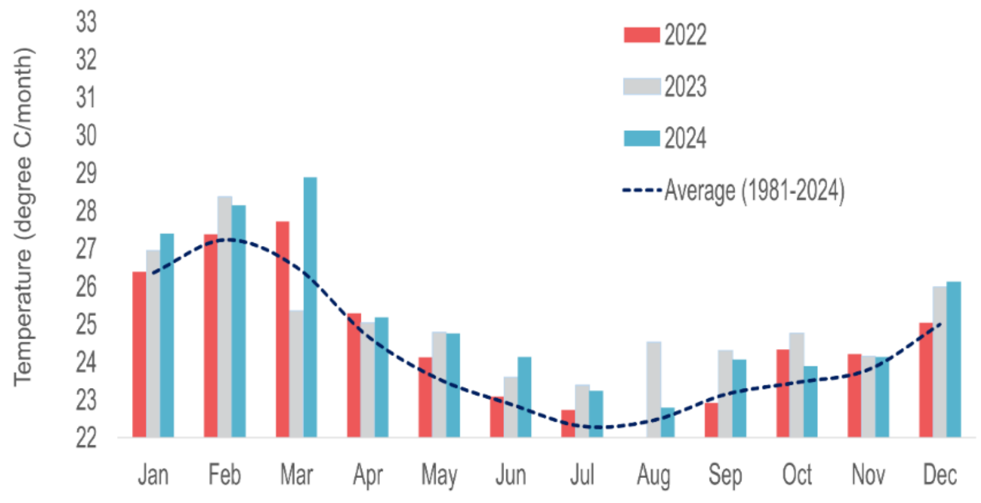


Figure 3: Graph showing average annual temperature (2022-2024) of Lamwo District.

- **2022:** Temperatures were **generally close to the long-term average** across most months. During the **first cropping season (April-May)**, temperatures were slightly **above the historical average**, suggesting relatively warm conditions during crop establishment. However, the **second season (August–September)** recorded **slightly cooler temperatures**, particularly in **August**, before temperatures rose again toward **October and December.**

- **2023:** Temperatures showed **moderate positive deviations from the long-term average** during several months. The **first season (April-May)** recorded **warmer than average conditions**, while **August and October** were also above the historical mean. These conditions suggest **generally warmer seasonal conditions throughout much of the year**.

- **2024:** Temperatures showed the **most consistent warmth relative to the long-term average**. The **early months (January-March)** recorded **notably higher temperatures**, with March standing out as particularly warm. During the **first cropping season (April–June)** temperatures remained slightly above average, while the **second season (August–September)** also recorded **above-average temperatures**, indicating sustained warmth across much of the year.

Overall, the graph indicates a **pattern of increasingly frequent above-average temperatures**, particularly in **2023 and 2024**. These warmer conditions during **key agricultural periods** may contribute to **higher evapotranspiration, increased soil moisture loss, and greater heat stress**, potentially affecting **crop growth, water availability, and agricultural productivity** in Lamwo District.

Above-normal temperatures negatively affect crops at all stages-reducing

- germination by accelerating metabolism, leading to depletion of energy reserves, impairing starch breakdown and causing poor root development before seedlings establish.
- flowering by hindering pollination, fertilization, and impairing chlorophyll function, thus lowering carbohydrate supply and leading flowers to drop prematurely.
- seed development by reducing carbohydrate and oil accumulation in seeds, resulting in smaller seeds and thus lowering the seed germination potential of harvested seeds

Overall, the observed seasonal and intra-seasonal temperature patterns in Lamwo District point to increasing heat exposure during key agricultural periods, reinforcing concerns around rising climate-related stress on crops, water resources, and broader livelihood systems.

CLIMATE CHANGE PROJECTIONS

In this study, bioclimatic variables from WorldClim v2.1, which provide historical high resolution- baseline climate data, such as temperature and precipitation patterns, were compared with future climate projections generated by the UKESM1-0-LL Earth system model under the SSP2 - 4.5 scenario, which is considered a "middle-of-the road-" pathway. Under this scenario, socioeconomic development and moderate mitigation policies lead to stabilizing greenhouse gas emissions. This comparison allows researchers to assess how key climatic factors like seasonal rainfall, temperature extremes, and drought indices are expected to shift in coming decades, highlighting potential impacts on ecosystems, agriculture, and water resources under a moderately warming future.

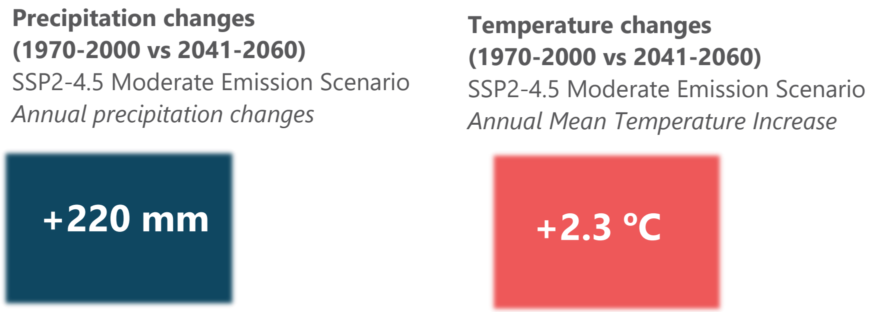


Figure 3: Annual precipitation and temperature changes in Lamwo District

Temperature

The mean annual temperature is projected to rise from **24.1°C** in the historical baseline to **26.4°C** by 2041-2060. Both minimum and maximum temperatures show substantial increases. The strongest warming **(up to 2.35-2.39°C)** is expected in the sub-counties of **Palabek Ogili, Lokung and Agoro**. Sub-counties such as **Palabek Gem, Padibe West, Padibe Town Council and Padibe East** are expected to experience slightly smaller increases **(~2.26°C)** but still exceed the districtwide warming trend.

Mean temperatures in the **warmest month** are projected to increase by approximately **+2.5°C**, while temperatures during the **driest quarter** are expected to rise by about **+2.6°C**. Together, these changes indicate **stronger warming during already hot and dry periods of the year**. This is likely to intensify **dry-season stress** by accelerating **evapotranspiration**, increasing **soil moisture loss**, and raising **water demand for crops, livestock, and domestic use**

Similarly, mean temperatures in the **coldest month** are projected to increase by approximately **+2.4°C**, while the **wettest quarter** is expected to experience a rise of about **+2.1°C.** This suggests that even the traditionally cooler months will become noticeably warmer, reducing the level of seasonal cooling typically experienced during that period. The increase during the wettest quarter may also enhance evapotranspiration during peak rainfall months, which could partly offset rainfall benefits and increase crop water requirements, even during periods that are generally wetter.

Overall, these projections point to year-round warming, with amplified heat during both dry and wet seasons. This pattern suggests increasing climate stress, particularly for agriculture, water resources, and vulnerable communities dependent on climate-sensitive livelihoods.

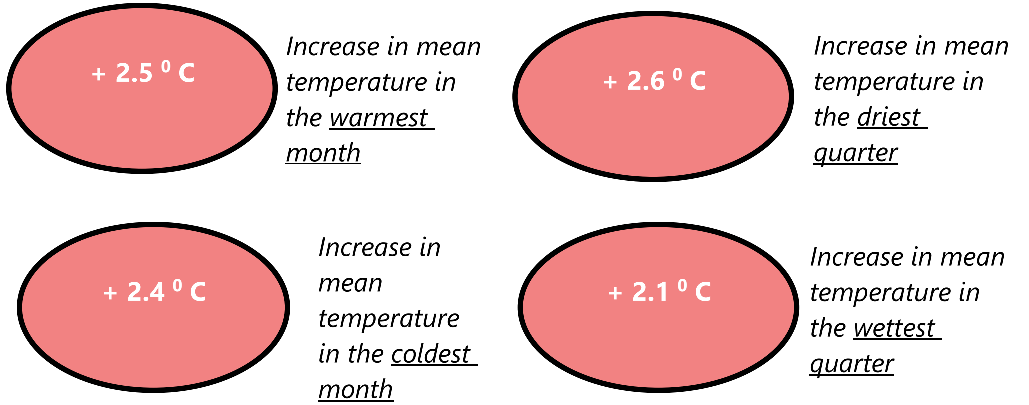


Figure 4: Projected changes in temperature in bioclimatic variables.

Precipitation

Mean annual rainfall is projected to increase from **1,143 mm to 1,363 mm** by mid-century. However, the distribution of rainfall gains is uneven across the district. The largest precipitation increases **(232-249 mm)** are expected in **Lokung, Agoro, Lamwo Town Council and Padibe West**, while areas such **as Madi Opei, Palabek Ogili, and Palabek Gem** show smaller increases **(199-220 mm).**

Precipitation in the **wettest month** is projected to increase by approximately **+48.9 mm**, while rainfall during the **coldest quarter** is expected to rise by about **+108.4 mm**. This indicates that periods which are already relatively wet will experience **substantially higher rainfall amounts**, increasing the likelihood of **intense rainfall events, surface runoff, localized flooding, and soil erosion**, particularly in **low-lying and poorly drained areas**.

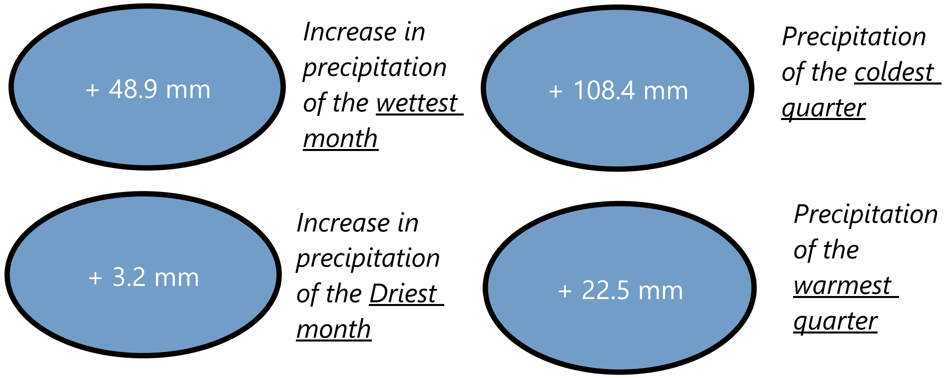
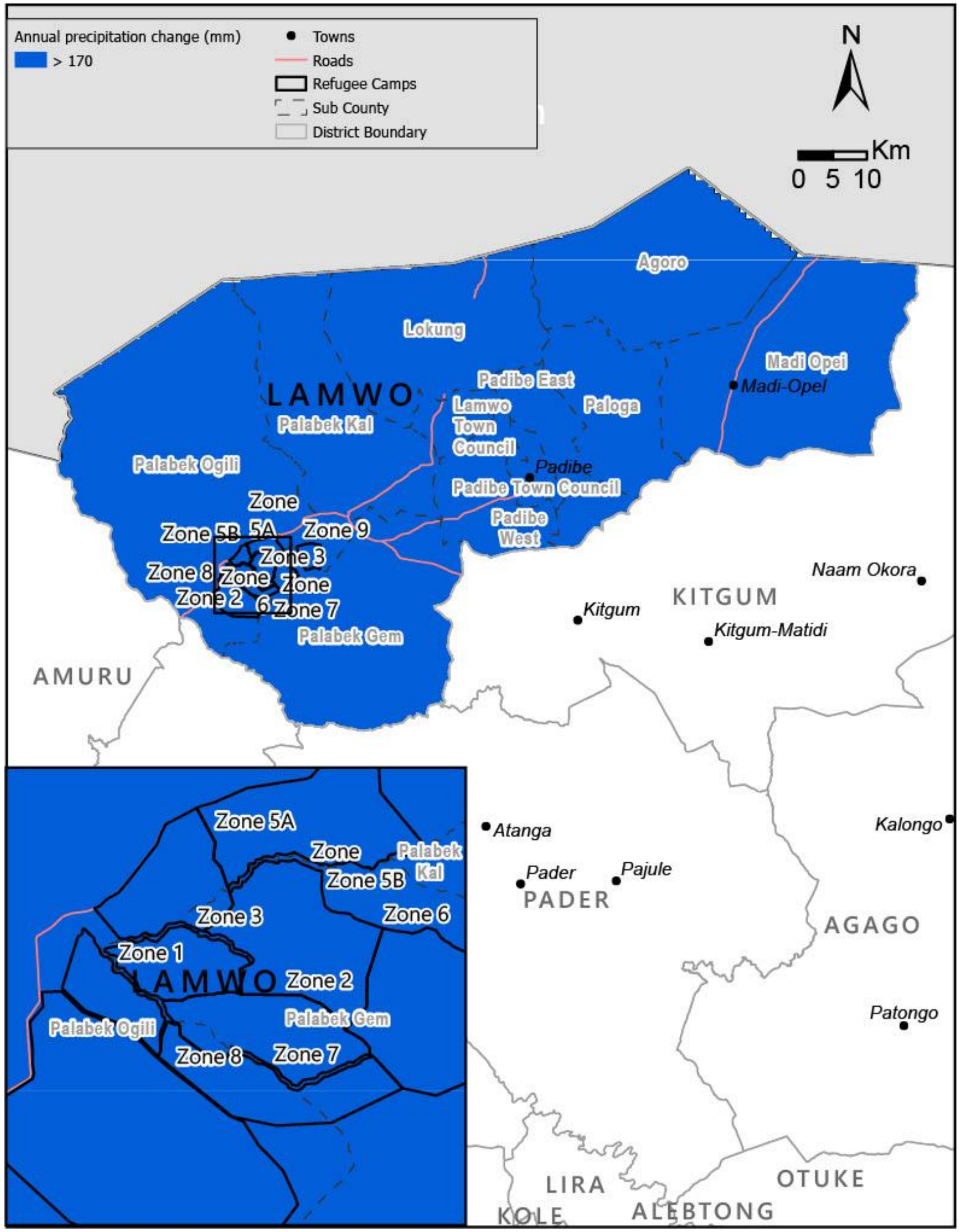


Figure 5: Projected changes in precipitation in bioclimatic variables



Map 5: Map showing Projected Precipitation Changes from the Baseline (1970-2000) to the Near Future (2041-2060).

In contrast, precipitation during the **driest month** is projected to increase only slightly, by around **+3.2 mm**, while the **warmest quarter** is expected to receive an additional **+22.5 mm** of rainfall. Although these increases may provide **limited relief during dry and hot periods**, they remain relatively small compared to projected wet season gains and may be **insufficient to offset rising temperatures and increased evapotranspiration**.

Overall, the projections suggest a future climate characterized by notably higher rainfall during already wet periods, particularly during the wettest month and the coldest quarter, alongside only minor increases in rainfall during the driest month. This pattern indicates a growing likelihood of more intense rainfall events, increased surface runoff, and localized flooding during peak rainy periods, while dry-season water stress may persist due to limited rainfall increases and rising temperatures that continue to accelerate evapotranspiration and soil moisture loss.

Implications

The combination of **rising temperatures and uneven increases in rainfall** creates a complex climate hazard profile for **Lamwo District**. Projected increases in mean annual temperature (from **24.1°C to 26.4°C by 2041-2060**) are likely to intensify **heat stress across both dry and wet seasons**, particularly in sub-counties such as **Palabek Ogili**, **Lokung**, and **Agoro**. Elevated temperatures will accelerate **evapotranspiration, increase soil moisture loss, and raise water demand for crops, livestock, and domestic use**, potentially limiting the benefits of projected rainfall increases.

Sub-counties such as Madi Opei, Palabek Ogili, and Palabek Gem, which are expected to receive relatively smaller increases in rainfall, may face heightened risks of seasonal drought, water scarcity, and crop stress, especially during the dry season. Conversely, areas including Lokung, Agoro, Lamwo Town Council, and Padibe West, which are projected to receive larger rainfall increases, may experience increased risks of intense rainfall events, localized flooding, surface runoff, and soil erosion, particularly in low-lying and poorly drained areas.

These changes have direct implications for agriculture, livestock production, water systems, and household resilience. Crops are likely to face moisture stress during hotter and drier periods, while also becoming more vulnerable to waterlogging and erosion during heavy rainfall events. Livestock systems may experience fluctuations in pasture availability and water access, affecting productivity and household incomes. At the same time, water infrastructure and domestic water supply systems may be strained by increased demand during dry periods and flood-related disruptions during the rainy season.

The projected warming and rainfall patterns in Lamwo District align closely with broader national and regional climate trends. According to the Uganda Third National Communication to the UNFCCC[30] and the IPCC Sixth Assessment Report[31], mean temperatures across Uganda are expected to rise by **1.5-2.5°C** by mid-century, while rainfall is projected to increase with greater variability and intensity. The district level projections for Lamwo, including intensified dry-season heat and concentrated wet-season rainfall, fall within these ranges, indicating that the district is experiencing climate shifts consistent with regional patterns.

This analysis highlights the need for **targeted adaptation measures**. Investments in **climate-smart agriculture, water harvesting and storage, soil conservation, pasture management, and flood risk mitigation** will be critical to **sustain livelihoods, protect food security, and strengthen community resilience** under projected climate conditions in Lamwo District.

SEASONAL DROUGHT HAZARD ASSESSMENT

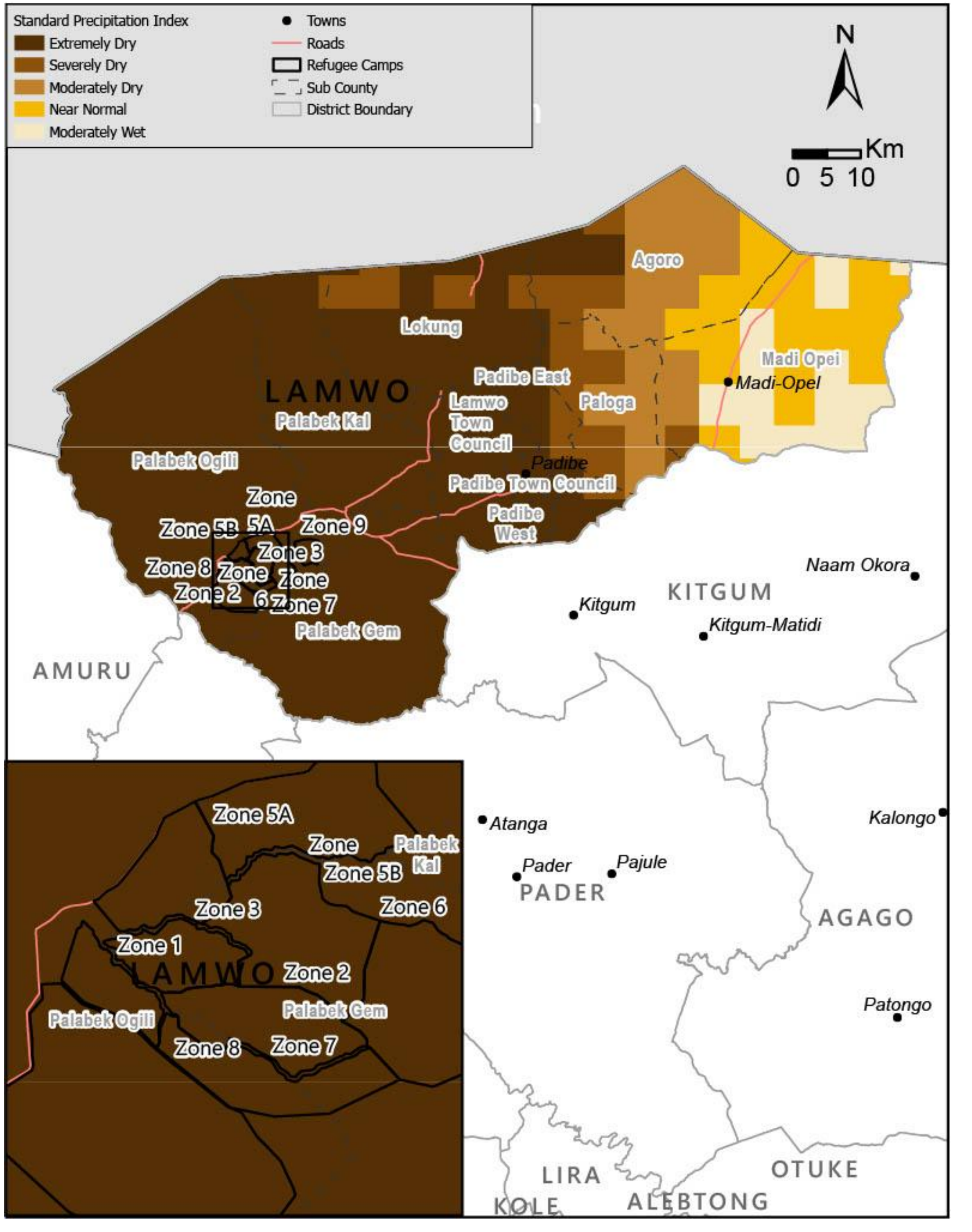
Lamwo District is increasingly facing seasonal drought due to **unpredictable rainfall, frequent dry spells, and rising temperatures**, which are putting pressure on farming activities and making it harder for households that depend on rain-fed agriculture to sustain their livelihoods.[32] Both host communities and refugees in Palabek Refugee Settlement are exposed to recurrent meteorological droughts (periods of significantly below-average rainfall) and vegetation droughts (when crops and natural vegetation show stress due to lack of moisture). These conditions disrupt planting calendars, reduce crop yields, and increase food insecurity, particularly among households dependent on subsistence farming.[33]

This analysis applies the *Standardized Precipitation Index (SPI)* a precipitation-based indicator that measures precipitation/rainfall anomalies by comparing observed rainfall to historical averages and the *Vegetation Condition Index (VCI),* an NDVI[2] based indicator that shows crop biomass and vegetation health responses to precipitation anomalies/moisture stress. Together, these indices capture both meteorological drought conditions and their impact on vegetation, providing an integrated understanding of drought occurrence and severity.

The impacts of seasonal drought have been more evident in recent years, with prolonged dry spells affecting agricultural production and water availability in several sub counties of Lamwo District.[34] While agencies such as WFP, UNHCR, and other partners district authorities have supported affected populations through food assistance and livelihood interventions, recurring seasonal drought events highlight the need for **sustained investment in seasonal drought preparedness, climate-resilient livelihoods, water infrastructure, and long-term adaptation measures**.[35]

SPI Findings

The Standardized Precipitation Index (SPI) analysis shows that March-May 2024 was a critical month for measuring drought because it coincides with the flowering season for first season crops. Much of the district experienced extremely dry precipitation conditions.[36] Parts of the eastern sub-counties like **Paloga, Agoro and Madi Opei** experienced mixed conditions from **severe dry to moderately wet precipitation**



Map 6: Map showing the SPI Index.

[2] NDVI stands for the Normalized Difference Vegetation Index.

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conditions.

Palabek Refugee Settlement, as shown in *Map 6*, experienced extremely dry precipitation conditions. These extremely dry precipitation conditions indicate substantial impacts on soil moisture availability, crop performance, rangeland conditions, and water access, particularly in areas in or close to Palabek Refugee Settlement where livelihood systems are already highly sensitive to rainfall variability.

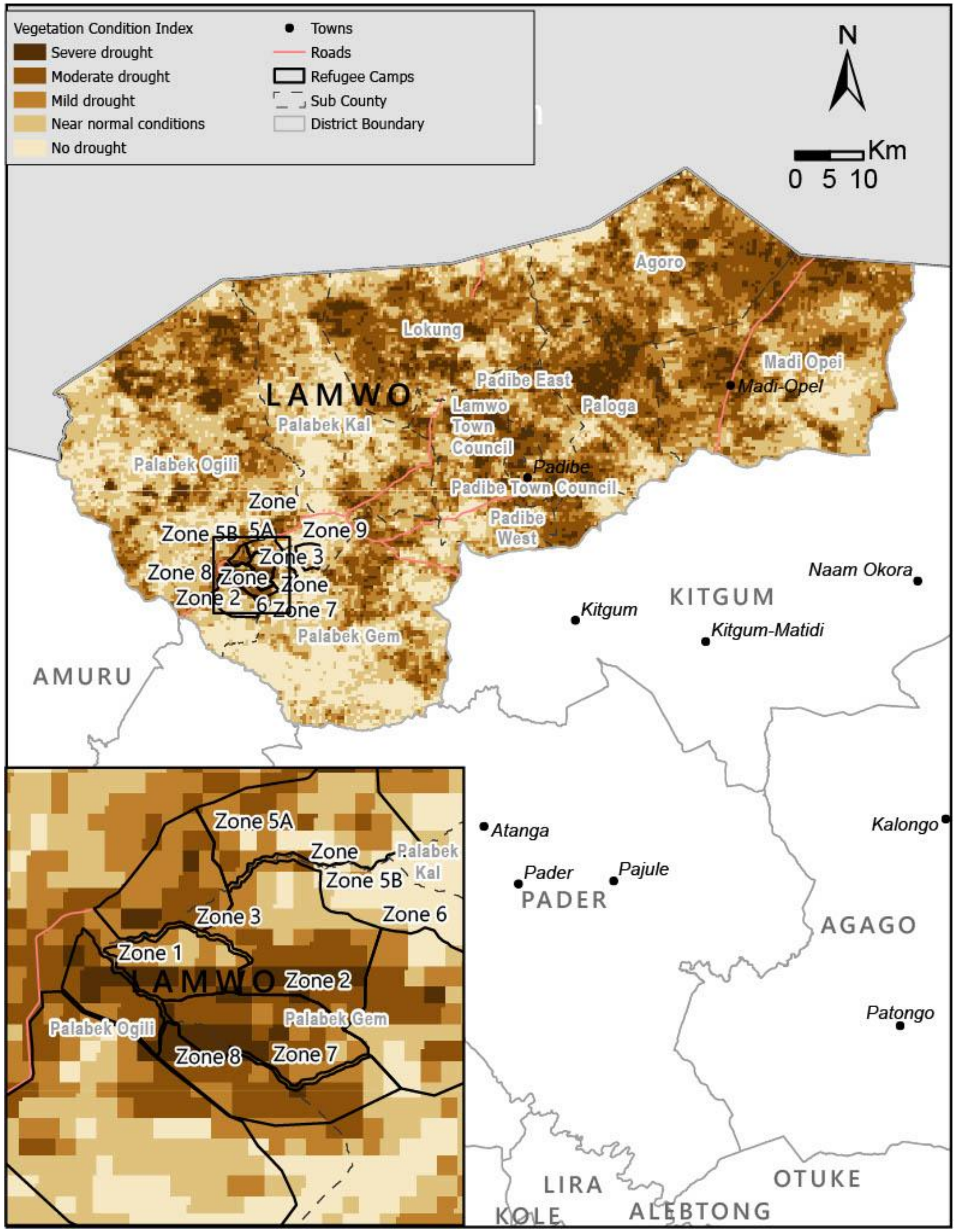
VCI Findings

Lamwo District shows mild to severe vegetation drought conditions, as represented by moderate brown to dark brown tones in *Map 7*.

Although the eastern half of the district received moderately dry to moderately wet precipitation, it shows moderate to severe drought because precipitation is moving westward due to higher elevation. In contrast, the southwestern part of the district received extremely dry precipitation but shows no drought to mild droughts because of low elevation and more concentrated stream networks that receive water from higher elevations.

The three Palabek Sub-counties, which also contain the Palabek Refugee Settlement, show mixed drought conditions, partly because of different land cover types, ranging from forest, grassland, cropland to built-up areas, with each providing different conditions. The VCI map consists of landcover and precipitation deficit spatial distribution.

Overall, the findings illustrate that vegetation health of the district was significantly constrained during this period, affecting both croplands and grazing areas crucial for household food security and livelihoods.



Map 7: Map showing the VCI Index.

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Implications

The combined SPI and VCI findings indicate that **Lamwo District is experiencing seasonal drought conditions that go beyond short-term rainfall shortages**, with wide-ranging implications for agriculture, food security, water access, and livelihoods. The presence of **extremely dry to severely dry SPI conditions** across much of the district, alongside **moderate to severe vegetation stress (VCI)**, highlights heightened vulnerability during critical agricultural periods. Even in eastern sub-counties such as **Paloga, Agoro, and Madi Opei**, where rainfall conditions appeared mixed, vegetation stress remains evident, pointing to underlying challenges related to terrain, drainage, and moisture retention. These overlapping climatic stresses translate into real pressures on household and community systems. These adverse conditions have tangible impacts on agricultural systems. During the **March - May 2024 first season cropping period**, when rainfall is most crucial for crop establishment and flowering, extended dry spells and soil moisture deficits disrupted normal crop development.

Local and regional evidence from the Kitgum and Lamwo Districts shows that erratic rainfall and prolonged dry conditions are affecting agricultural performance, vegetation cover, water resources, and community livelihoods. Seasonal droughts disrupt the **rain-fed agricultural system**, which most households depend on for livelihoods. As a result, farmers face **poor harvests and income losses**, raising fears of food insecurity. The situation highlights how prolonged dry spells can undermine agricultural productivity and increase vulnerability among rural farming communities. For example, farmers reported that both food and cash crops did not germinate properly as they dried up due to lack of moisture.[37]

From a preparedness and resilience standpoint, the findings emphasize the need for early warning systems, climate-smart agricultural practices (such as drought-tolerant seed varieties and conservation agriculture), and strengthened water harvesting and storage infrastructure. Integrating SPI and VCI monitoring into district-level disaster risk management frameworks can support evidence-based planning, enable timely alerts during emerging seasonal drought episodes, and improve resource allocation for both immediate interventions and long-term climate resilience across Lamwo District.

Photo 1: Farmers tending their gardens in Agoro, Lamwo District. Photo Credit: The Independent

In **Lamwo District**, seasonal drought and rising temperatures have intensified **water scarcity**, severely affecting farmers who depend on the **Agoro irrigation scheme**. The scheme, once a key source of water for rice farming, has failed to supply adequate water due to increased demand and poor design, leaving crops **dry and unproductive**. Farmers reported **declining yields and food insecurity**, with some abandoning rice cultivation altogether. As a coping strategy, many shifted to **quick-maturing and less water-dependent crops** such as maize and vegetables. The situation has reduced the area's role as a regional food basket and undermined household livelihoods. This case highlights how seasonal drought, combined with failing infrastructure, can disrupt agricultural systems and force adaptive changes in farming practices.

Source: [Northern Uganda Media Club – Water stressed rice farmers in-Lamwo turn to quick maturing crops after irrigation scheme-fails].

FLOOD HAZARD ASSESSMENT

Flood susceptibility refers to how likely an area, community, or system is to experience harmful impacts from flooding, based on physical, environmental, and socio-economic factors.
Several factors determine how an area exposure to flood is ranked from low to high. These factors include hydrological (e.g. intensity and duration of rainfall), geographical (proximity to rivers, soil type, and topography), land use and community livelihood types.

For this assessment thirteen indicators were analysed by ranking into five score levels to flood risk.[38] The score rank of the thirteen indicators was summed and ranked into three level of risk.

1. Distance to Permanent water ranked from higher risk to lower risk at 100 meters, 250 meters, 500 meters, and 750 meters.[39]

2. Elevation above sea level ranked from higher risk to lower risk at 600 meters, 700 meters, 800 meters, and 1000 meters.[40]

3. Slope of the area in degrees ranked from higher risk to lower risk at 2, 5, 10, 15.[41]

4. Landcover ranked from higher risk to lower risk as built-up, cropland (include water, flooded vegetation), grassland, shrub and forest.[42]

5. Topographic Position Index ranked from higher risk to lower risk at -8, -6, -4, -2, 0.

6. Normalized Difference Vegetation Index ranked from higher risk to lower risk at 0.2, 0.4, 0.6, 0.8[43]

7. Normalized Difference Water Index (NDWI ranked from higher risk to lower risk at 0.6, 0.2, -0.2, -0.6.

8. Flood Return period ranked from higher risk to lower risk at 10 years, 20 years, 50 years, 100 years, 200 years.[44]

9. Rainfall Intensity as average maximum annual rainfall ranked from higher risk to lower risk at 33 mm, 31 mm, 29 mm, 27 mm.[45]

10. Monthly Number of Days with Rainfall ranked from higher risk to lower risk at 13 days, 10 days, 7 days, 3 days.[46]

11. Frequency of -days with continuous Rainfall ranked from higher risk to lower risk at 2, 1.2, 0.8, 0.4.[47]

12. Height Above Nearest Drainage (HAND) ranked from higher risk to lower risk at 2 meters, 5 meters, 10 meters, 20 meters.[48]

13. Soil texture ranked from higher risk to lower risk with (clay, clay loam, silty loam), (silty clay, silty clay loam), (sandy clay, sandy clay loam), (loam, sandy loam), (loamy sand, sand).[49]

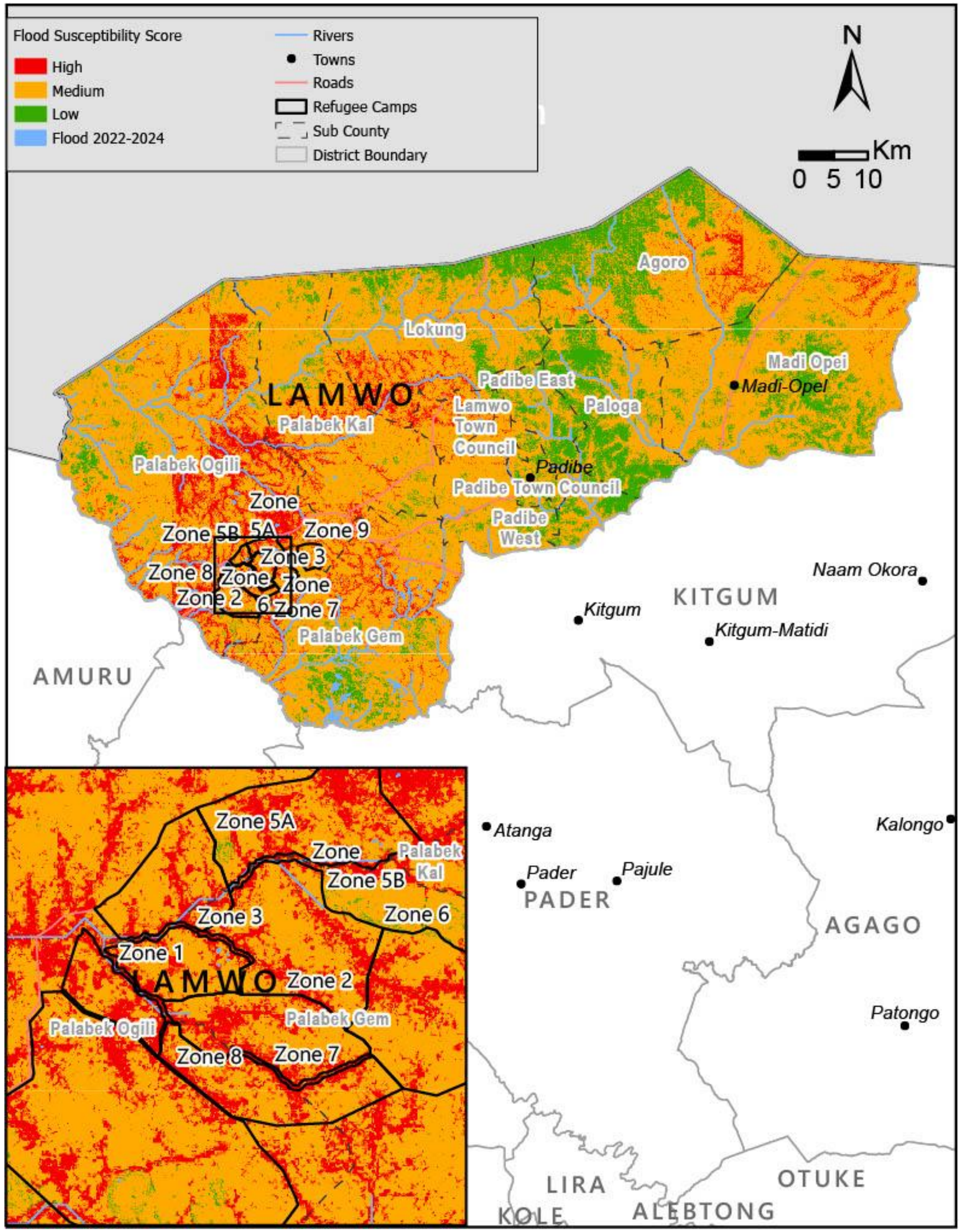
Height Above Flood susceptibility mapping relies on integrating multiple environmental, hydrological, and climatic indicators to assess risk levels. Recent literature emphasizes that parameters such as proximity to water bodies, elevation, slope, land cover, vegetation indices, and rainfall characteristics are critical determinants of flood vulnerability. Studies highlight that areas closer to permanent water sources, with low elevation and gentle slopes, are more prone to inundation. Similarly, built-up and cropland land covers tend to amplify flood risk due to reduced infiltration capacity, while vegetation indices (NDVI, NDWI) provide insights into soil moisture and vegetation health, which influence runoff and water retention. The inclusion of topographic indices like HAND and TPI further refines susceptibility mapping by capturing micro-topographic variations that affect drainage and water accumulation

Hydro-climatic indicators such as rainfall intensity, frequency of continuous rainfall days, and flood return periods are equally vital in flood risk assessment. Literature shows that extreme rainfall events, particularly when sustained over consecutive days, significantly increase flood hazards. Soil texture also plays a crucial role, with clay-rich soils exhibiting lower infiltration rates and higher runoff potential compared to sandy soils. Integrating these thirteen indicators into a composite scoring system aligns with established frameworks that rank susceptibility into multiple risk levels. Such multi-criteria approaches are widely recommended because they capture the complex interplay between terrain, hydrology, and climate, thereby improving the accuracy of flood hazard mapping and supporting disaster risk reduction strategies. 36.9 % of Lamwo district falls within high-risk areas.

Findings

Several geographic and infrastructural factors exacerbate flood risks in the district. Lamwo's landscape is complex, ranging from gently sloping terrain to sandy and sandy-clay soils, with natural drainage infrastructure supporting water infiltration and increase surface runoff, particularly in low-lying areas and along seasonal streams and permanent rivers like Nyimur, Achwa, Okura and Aringo. Although 10.5 % of the district falls into high-risk flood areas, Lamwo is considered having low flood risk, thanks to it landscape and river network.

Satellite-based assessments reveal that **10.5 % of** Lamwo District falls within **high-risk flood areas**. Its hilly terrain with deep valleys makes it prone to flash floods and lightening.[50] Although the three Palabek (Kal, Ogili & Gem), **Paloga, and Lokung Sub-counties seem to be in high-risk flood zones** (at least according to *Map 8),* **there were not more than three major reported flash and riverine flood incidences in 2007, 2012 and 2017 in the neighbouring Amuru district.[51]** Their vulnerability stems from low elevation and proximity to seasonal river channels. Palabek **is susceptible to water logging and flash floods due to low elevation, its downstream position and low forest cover**. The settlement's zones are situated on gently sloping terrain that accumulates runoff during peak rainfall periods, resulting in repeated damage to shelters, latrines, and access roads. Such events disrupt humanitarian operations and pose significant public health risks, including water contamination.



Map 8: Map of Lamwo District showing Flood Susceptibility (2022-2024)

Risk on Cropland and Settlement

The land cover analysis revealed that **grassland covers 48.2%, forest 41.9%, built-up areas 1 %, while cropland covers 9.2 %**. **11.2% of cropland falls within high-risk flood zones.** For built-up areas, this figure rises to **27.8%**. Built-up areas emerge as the most affected by flooding, when measured in terms of area inundated compared to cropland, however, these estimates represent district-wide averages and therefore conceal substantial spatial concentration of impacts at local levels.

The *Land Use and Landcover Map* (*Map 3)* shows that cropland cells are concentrated in the central part of the district, falling into low- to high-risk flood zones. This points to selective exposure for households cultivating around floodplains and poorly drained depressions. For households in flood-prone areas, localized flash flooding events can result in crop damage, delayed planting, and yield losses, likely to contribute to income losses and seasonal food insecurity. Built-up areas, which overlap with cropland around Palabek Refugee Settlement, are within medium- to high-risk flood zones.

The flooding trend corresponds with periods of above-average rainfall and seasonal river overflow, implying a strong link between climatic variability and local hydrological responses. Additionally, expanding settlement and land-use changes, especially around refugee-hosting areas, have contributed to reduced infiltration and increased runoff, thereby amplifying flood recurrence

Flood Impacts

Flooding in Lamwo District has had multidimensional socio-economic and environmental impacts. That said, flooding is highly localized, primarily affecting the central and western parts of the district. In these areas, recurrent inundations have led to damage of crops and agricultural land, disrupting food production and household income for both host and refugee communities. Access roads and footpaths in flood-prone areas become impassable during heavy rainfall, affecting mobility and access to markets, schools, and health facilities.[52] Floods have also contaminated water sources and damaged sanitation facilities, increasing the risk of waterborne diseases.

Photo 2: A section of the road that has been completely submerged in the flood water in Mucwini East Subcounty Kitgum District. Photo Credit: URN

In **Kitgum and Lamwo District**, heavy and continuous rainfall caused the **Aringa stream to burst its banks**, flooding the feeder road that links **Mucwini in Kitgum** to **Padibe East in Lamwo District**, cutting it off for nearly a week. Residents were **stranded** and had to detour an extra 4 km or walk to reach **health services and trading centres**, affecting access to medical care and essential goods. The flooding highlighted **poor road design**, with undersized culverts and low murram surfaces unable to cope with excess water. Community members called for urgent repair, noting that the road had not been properly fixed for years. District engineers reported **limited funds** delayed repairs, even as plans for larger culverts were made. This incident shows how floods can disrupt **transport connectivity**, increase travel distances, and hinder access to **services and markets** for rural populations.

Source: [Floods Cut off Kitgum, Lamwo District Access Road - Uganda Radio network]

Photo 3: Torrential rains caused floods in Lamwo and displaced some individuals.

In Lamwo District, heavy and persistent rains caused streams to overflow, leading to severe flooding that forced at least **300 households** in **Okol and Lawiye-Oduny parishes** to flee their homes. Many families sought shelter at **Kirombe Primary School** or with neighbors and relatives. The floodwaters **submerged houses and latrines, cutting off roads and isolating communities**. Local leaders reported that more **than 135 houses were** under water, disrupting daily life and mobility. In addition, the floods destroyed over **300 acres of crops such as millet, simsim, and maize**, **raising concerns about food security.** A rapid assessment was underway to inform the district disaster management committee for support planning. This incident illustrates how flooding can displace households, damage infrastructure, and threaten livelihoods in rural Uganda.

Environmentally, flooding contributes to soil erosion, sedimentation of streams, and loss of vegetation cover, which further degrade the natural drainage systems and exacerbate future flood risk. Socially, households in flooded areas often face temporary displacement, loss of shelter, and vulnerability due to inadequate infrastructure and limited adaptive capacity. These cumulative impacts underline the need for integrated flood management, infrastructure improvement, and community-based adaptation strategies to enhance resilience in Lamwo District.

Conclusion

The findings of this geospatial analysis highlight the substantial influence of climate-related hazards on both refugee and host communities in Lamwo District. Over the assessment period, the district has experienced seasonal drought conditions at the flowering season for first season crops and localized riverine and flash flooding, which together pose major risks to agricultural productivity, water availability, and settlement infrastructure. The SPI and VCI analyses reveal vegetation stress and rainfall deficits, especially during the 2023 crop flowering stage. Palabek **is susceptible to water logging and flash floods due to low elevation, its downstream position and low forest cover**. These findings underscore the growing climate vulnerability of Lamwo District, emphasizing the need for targeted adaptation measures, including improved roads, water resource management, resilient agricultural practices to safeguard livelihoods and enhance resilience for both refugee and host populations.

Methodology Overview

The climate hazard assessment for Lamwo District used a combined geospatial, remote-sensing, and climate-modelling approach integrating historical baselines, future projections, and hazard-specific analyses. Historical climate conditions (1970-2000) were derived from WorldClim v2.1 using BIO1 (Annual Mean Temperature) and BIO12 (Annual Precipitation), clipped to the district and summarised through spatial and statistical analysis. Future projections for 2041-2060 were obtained from the UKESM1-0-LL model[53] under the SSP2-4.5 scenario, processed using the same bioclimatic variables to ensure comparability with the historical baseline.[54]

Drought assessment followed UN-SPIDER protocols[55], using SPI calculated in Google Earth Engine (GEE)[56,57] from CHIRPS rainfall data[58] (2014-2024) and VCI derived from NDVI time-series to measure vegetation stress. Agricultural and rangeland areas were manually delineated to improve spatial accuracy, and VCI classification followed Kogan (1995) standards.[59] Outputs were visualized and analysed in ArcGIS.

Flood mapping was conducted using Sentinel-1 SAR imagery processed in GEE to identify inundation for 2022-2024.[60] Annual flood layers were imported into ArcGIS, where raster summation generated a districtwide flood-frequency map. Together, the historical and projected climate datasets, SPI-VCI drought indicators, and multi-year flood mapping provide an integrated picture of climate hazards affecting both host communities and the Palabek refugee settlement in Lamwo District.

Limitations

The assessment primarily relied on remote-sensing and global climate datasets, which, while widely used, may not fully capture localized micro-climatic variations or ground-level conditions affecting vulnerability. Community-level vulnerability indicators such as coping capacity, water access constraints, and infrastructure fragility were not systematically integrated due to limited available data. Field verification of drought and flood extents was not conducted, though the satellite image processing followed established and validated UN-SPIDER protocols.

Further background information can be found in the Climate Risk Profiles for Refugee-Hosting Districts in Uganda Terms of Reference (TOR).

Note on Data Sources

Historical climate estimates in this report use both WorldClim (1970-2000 climatology) and ERA5-Land (1981-2024 reanalysis). These datasets use different observational networks, spatial resolutions and interpolation/assimilation methods and consequently report slightly different estimates of mean annual temperature for Lamwo (WorldClim ≈ 25.7°C for 1970-2000, ERA5-Land ≈ 24.7°C for early 1980s-2000). These differences are within the expected uncertainty range for gridded climate datasets and do not affect the overall interpretation of a warm tropical baseline and a clear recent warming trend. All historical temperatures in this report should therefore be understood as approximate values in the mid-20s (around 25-26°C) rather than exact point estimates.

To view/access the Climate Hazard Analyses for any of the following districts:

- Adjumani District
- Koboko District
- Yumbe District
- Terego District
- Madi Okollo District
- Lamwo District
- Obongi District
- Kyegegwa District
- Kiryandongo District
- Kamwenge District
- Kikuube District
- Isingiro District

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Definitions

Hazards: A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.[61]

Flood: The overflow of water onto land that is normally dry, resulting from the temporary inundation of areas due to factors such as intense or prolonged rainfall, river overflow, surface runoff, or failure of water control structures. Floods can vary in scale and duration and may cause damage to infrastructure, livelihoods, ecosystems, and human health.[62]

Flood Susceptibility: The likelihood of flooding occurring in an area based on physical, environmental, and climatic factors such as topography, rainfall intensity, and proximity to water bodies.[63]

Seasonal Drought: A temporary period of below-average rainfall within a specific season, resulting in soil moisture deficits and vegetation stress, particularly during critical agricultural periods.[64]

Meteorological Drought: A period of abnormally dry weather sufficiently prolonged to cause a serious hydrological imbalance, typically defined by a lack of precipitation relative to the long-term average[65]

Exposure: The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.[66]

Risk: The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity.[67]

Disclaimer

This report provides an evidence-based overview of climate trends, hazards, and projected impacts in Uganda's refugee-hosting districts to support informed planning and decision-making. The analysis draws on historical climate datasets, remote sensing products, and modeled projections, all of which are subject to inherent uncertainties, assumptions, and methodological limitations.

The drought assessment presented in this report focuses primarily on seasonal drought conditions, using indicators such as the Standardized Precipitation Index (SPI) and the Vegetation Condition Index (VCI). These indicators capture short- to medium-term rainfall deficits and vegetation stress within specific seasons and should not be interpreted as representing long-term or permanent drought conditions.

Accordingly, the findings should be considered indicative rather than definitive, particularly at localized scales, where microclimatic variability, environmental conditions, and socio-economic factors may differ. While every effort has been made to ensure data accuracy, this report does not replace site-specific assessments or field verification.

The views expressed herein do not necessarily reflect those of any government, organization, or funding partner. This report should not be used as the sole basis for policy, investment, or operational decisions without further contextual analysis and validation.

Users are encouraged to complement these findings with local knowledge, stakeholder consultation, and additional data sources when designing interventions or resilience strategies.

In case of questions, feedback, or requests for tailored, area-specific remote-sensing products, kindly contact uganda@reach-initiative.org.

Endnotes

[1] Country - Uganda
[2] Uganda-CRVA-Volume-1-Main-Report-LR.pdf
[3] 5. National Climate Change Policy 2015.pdf
[4] 15464-WB_Uganda Country Profile-WEB (1).pdf
[5] UNMA explains unreliable rains, urges farmers to harvest water - Published By UPPC
[6] REACH_UGA_2024-MSNA-Report_July-2025.pdf
[7] Lamwo District Local Government - Location & Size
[8] World Bank - Climate Risk Profile – Uganda (2021)
[9] World Bank Climate Change Knowledge Portal. (n.d.). Uganda climate data & projections (CMIP6). World Bank Group.
[10] UNHCR – Uganda Comprehensive refugee response portal (February 2026)
[11] Lamwo District Local Government - Location & Size
[12] Approved Lamwo District Development Plan III.pdf
[13] Approved Lamwo District Development Plan III.pdf
[14] Approved Lamwo District Development Plan III.pdf
[15] UBOS – National Population and Housing Census (2024_Final-Report
[16] UBOS – National Population and Housing Census (2024_Final-Report
[17] UNHCR – Uganda Comprehensive refugee response portal (February 2026)
[18] UNHCR - Refugee response planning frameworks for northern Uganda
[19] USAID – Livelihood mapping and zoning exercise – Uganda (2010)
[20] Approved Lamwo District Development Plan III.pdf
[21] Approved Lamwo District Development Plan III.pdf
[22] UBOS – National Population and Housing Census (2024_Final-Report

[23] The cooperator news – Adjumani and Lamwo districts to implement shs 22.83bln refugee project
[24] GFW - Lamwo, Uganda, Kitgum Deforestation Rates & Statistics
[25] Approved Lamwo District Development Plan III.pdf
[26] Lamwo District Hazard, Risk and Vulnerability Profile
[27] Northern Uganda Media Club – Water stressed rice farmers in-Lamwo turn to quick maturing crops after irrigation scheme-fails.
[28] Uganda Radio Network – Prolonged dry spell sparks panic for farmers in Kitgum & Lamwo Districts
[29] EfD - Climate variability and agricultural productivity Uganda (2024)
[30] United Nations Framework Convention on Climate Change (UNFCCC). (2022). Third National Communication of Uganda to the UNFCCC. Kampala: Government of Uganda.
[31] Intergovernmental Panel on Climate Change (IPCC). (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the IPCC. Cambridge University Press.
[32] IPC, Analysis Partners - IPC_Uganda_Acute_Food_Insecurity_Aug_2023_June_2024_Report.
[33] ULEARN - URRI_GAP_Analysis_Report_2025
[34] Uganda Radio Network – Prolonged dry spell sparks panic for farmers in Kitgum & Lamwo Districts
[35] Irish Aid _ Uganda Country Climate Risk Assessment Report (2018)
[36] Data Commons - Lamwo District - Disasters Dashboard
[37] Uganda Radio Network – Prolonged dry spell sparks panic for-farmers in Kitgum& Lamwo Districts
[38] MDPI - Flood Risk Mapping by Remote Sensing Data and Random Forest Technique
[39] European Commission - Global Surface Water Explorer (2021)
[40] NASA Shuttle Radar Topography Mission Global 1 arc second V003 – NASA Earth data
[41] NASA Shuttle Radar Topography Mission Global 1 arc second V003 – NASA Earth data
[42] World Resources Institute - Research for People & Planet
[43] sentinel.esa.int
[44] European Commission - Joint Research Centre Data Catalogue-Global River flood hazard maps
[45] CHIRPS: Rainfall Estimates from Rain Gauge and Satellite Observations – UC Santa Barbara
[46] CHIRPS: Rainfall Estimates from Rain Gauge and Satellite Observations – UC Santa Barbara
[47] CHIRPS: Rainfall Estimates from Rain Gauge and Satellite Observations – UC Santa Barbara
[48] Yamazaki Lab – Global Hydrodynamics Lab
[49] iSDA
[50] UNFPA Uganda - Protecting the Most Vulnerable in an Era of Constrained Resources
[51] Relief Web - Elegu floods: One feared dead, thousands stranded - Uganda
[52] UNFPA Uganda - Protecting the Most Vulnerable in an Era of Constrained Resources
[53] RMetS – Evaluation of precipitation simulations in CMIP6 models over Uganda
[54] Berio Fortini et al Bioclimatic variables dataset for baseline and future climate scenarios for climate change studies in Hawai'i | U.S. Geological Survey (2022)
[55] UN SPIDER _ Standardized Precipitation Index (SPI) in Google Earth Engine, n.d
[56] UN-Spider Agriculture Drought Monitoring and Hazard Assessment
[57] World Meteorological Organization (WMO). (2012). Standardized Precipitation Index user guide (WMO-No. 1090). Geneva: WMO.
[58] CHIRPS Daily: Climate Hazards Center InfraRed Precipitation with Station Data (Version 2.0 Final)
[59] Kogan, F. N. (1995). Application of vegetation index and brightness temperature for drought detection. Advances in Space Research, 15(11), 91–100.
[60] UN-Spider Flood Mapping Methodology
[61] United Nations General Assembly Resolution A/71/644, (UNGA, 2016).
[62] UNDRR-Disaster risk reduction terminologies,2017
[63] MDPI-Flood Susceptibility Assessment for Improving the Resilience Capacity of Railway Infrastructure Networks,2024

[64] MDPI-A General Overview of the Risk-Reduction Strategies for Floods and Droughts,2020
[65] NDMC-Types of Drought,2026
[66] United Nations General Assembly Resolution A/71/644, (UNGA, 2016).
[67] United Nations General Assembly Resolution A/71/644, (UNGA, 2016).
[68] European Environment Agency, Glossary DefinitionFs, Water Stress