UGANDA

Climate Hazard Assessment – Adjumani 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.[3'4] 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, long 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 spell	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 MSNA, 2024, 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 spell	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 MSNA, 2024, Southwestern region

Across both regions, warmer and wetter conditions do not reduce climate risk. Instead, they increase overlapping hazards, with 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 – Adjumani District

CONTEXT & RATIONALE

Adjumani District is one of the major refugee-hosting areas in Uganda's West Nile Sub-region along the border of South Sudan, accommodating large refugee populations alongside host communities that rely heavily on climate-sensitive livelihoods. Adjumani District continues to face increasing climate variability, declining soil fertility, unpredictable rainfall, recurrent seasonal droughts, episodic flooding, and rising temperatures that pose great risks to food security, natural resources, and basic services.[7,8] The district's low-lying terrain and seasonal rivers predispose certain areas to flood damage, leading to occasional displacement, loss of property, and damage to crops and infrastructure

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, indicate that Adjumani District will become warmer and moderately wetter by mid-century. Mean annual temperatures are projected to rise from **25°C to 27.5°C**, while annual rainfall is expected to increase from **1,193 mm to about 1,356 mm**.[1] Despite this increase in rainfall, intensifying heat stress is expected to pose greater risks to rural households and displaced populations.[9]

As of December 2025, Adjumani District hosts over **233,000 refugees** living in and around **19 settlements,** such as **Nyumanzi, Pagirinya, Maaji, Elema, and Baratuku**. In their entirety, they are commonly referred to as **Adjumani Settlement**.[10] These refugees represent nearly half of the district's total population, amplifying pressure on services, natural resources and land use systems. These overlapping vulnerabilities highlight the need to assess climate hazards in Adjumani and understand how exposure to seasonal drought and flooding intersects with displacement dynamics. This analysis therefore seeks to generate evidence-based insights into historical and projected climate trends to inform climate-resilient humanitarian and development programming in Adjumani District.

By identifying hazard susceptibility, exposure patterns, and future climate risks, this series of district-level analyses aim 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

- Adjumani District currently receives **~1,193 mm** of annual rainfall, projected to rise moderately to **~ 1,356 mm** by mid-century under the SSP2-4.5 scenario. However, the refugee-hosting areas that are in dryland zones with limited perennial water sources and fragile soils may experience higher deficits and evapotranspiration, intensifying water stress in areas such as **Dzaipi, Ukusijoni Sub-counties**.
- Temperatures are projected to **increase by 2.5-3.0°C** during the **warmest months and driest quarters**, increasing the risk of seasonal drought, heat stress and the frequency of very hot days across agricultural and settlement areas.
- Seasonal droughts remain a dominant hazard, with the Standard Precipitation Index (SPI) and Vegetation Condition Index (VCI) showing **severe dryness across Dzaipi, Pacara, Arinyapa, Ciforo Sub-counties** and refugee settlements, such as **Nyumanzi, Elema, Pagirinya, Ayilo, Alere and Maaji.** This leads to vegetation stress, reduced crop yields, and limited pasture and water availability.
- Recurrent flooding affects certain sub-counties, including **Pacara, Ciforo, Okusijoni and Dzaipi.** This is due to their low elevation and proximity to seasonal river channels. In terms of settlement areas, **Pagirinya, Oliji and Nyumanzi** are particularly affected.

[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/m^2 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.

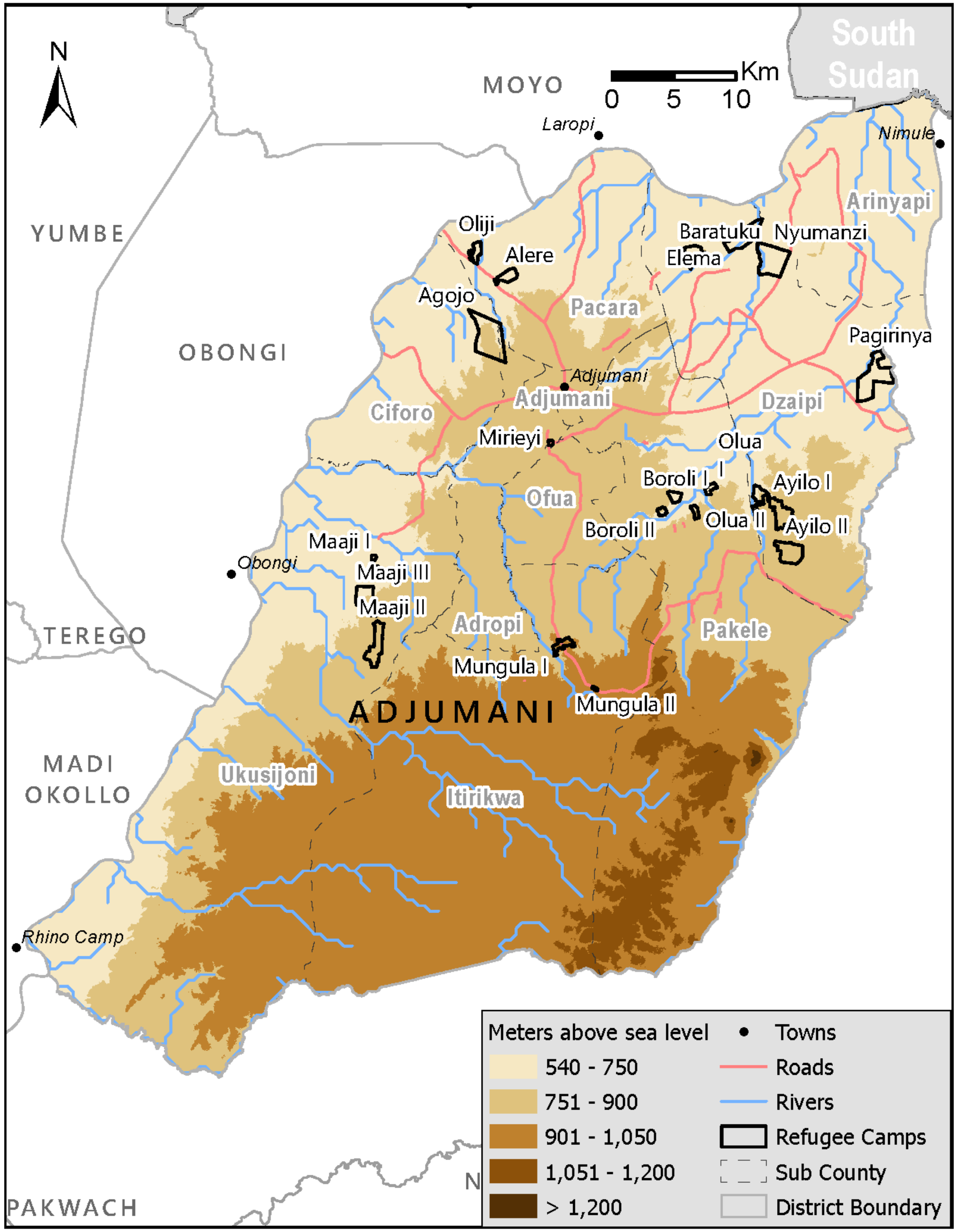
Location and Topography

Adjumani District is in the West Nile Sub-region of Northwestern Uganda. The district lies on the eastern bank of the Albert Nile, which is its common border with Moyo District. It borders the districts of Amuru in the south and east, Arua and Yumbe in the west, and Moyo in the north.[11] The district lies within the savannah plains with gentle undulations and river valleys. As shown in *Map 1,* Adjumani District features gently undulating terrain, with elevations generally ranging between **606 and 1,328 meters** above sea level. Elevation rises towards the southern and southeastern parts of the district with lower riverine and floodplain areas along the north and northwest. **Ciforo, Arinyapi, Pacara and Ofua Sub-counties have lower elevation ranges, between 606 m to 840 m.** These sub-counties and Nile-adjacent flats can concentrate runoff and periodic waterlogging in wet seasons. Parts of **Pakele, Itirikwa, and Adropi Sub-counties** have higher elevation, making it more susceptible to seasonal drought stress, especially during prolonged dry spells. **Oliji, Elema, Nyumanzi, and Alere camps have lower elevations (606-700metres**), **while Mungula, Maaji and Agogo have higher elevations (800-950 metres)**.[12]

This topographic variability influences settlement patterns, land use practices and the effectiveness of climate adaptation measures. Low lying areas tend to accumulate water and support flood plain agriculture but are prone to flooding, while higher and sloped areas are drier and better suited for settlement and different crop types depending on soil and moisture conditions. This underscores the need for location-specific planning and risk reduction strategies.[13]

Demographics and Population Distribution

According to the 2024 National Population and Housing Census, Adjumani District has a population of **over 300,500 people**, making it one of the most densely populated rural districts in Uganda.[14] The majority of the population belongs to the **Madi ethnic group,** followed by the **Lugbara and Acholi**, with **Christianity** being the dominant religion in the district. A significant portion of Adjumani's population comprises refugees, predominantly from South Sudan, hosted in **19 refugee settlements (Agojo, Alere, Ayilo, Baratuku, Boroli, Elema, Maaji, Mirieyi, Mungula, Nyumanzi, Oliji, Olua and Pagirinya)** with an estimated **233,000 refugees** as of December 2025.[15] While refugees constitute a substantial proportion of the district's population, they do not exceed the host community population, accounting for roughly **43%** of



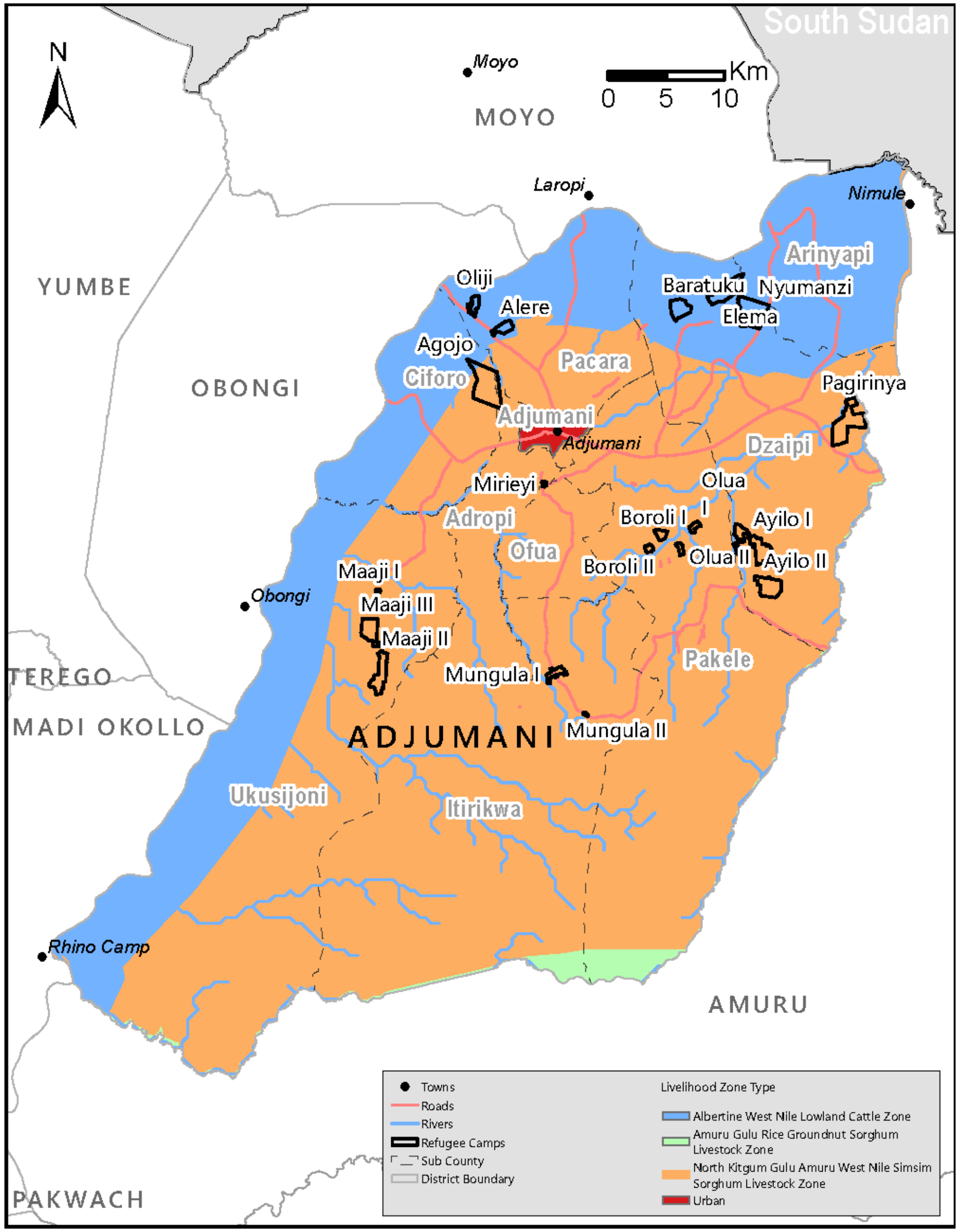
Map 1: Map showing the Location and Elevation of Adjumani District.

the total population, based on the 2025 estimates, with nationals making up the remaining share. This demographic composition has important implications for planning, as both host and refugee populations rely heavily on limited natural resources and basic services, including **education, health, water, and sanitation**.

Livelihoods

Adjumani District lies in three major livelihood zones: The *North Kitgum Gulu Amuru West Nile Simsim Sorghum Livestock Zone*, the *Amuru Gulu Rice Groundnut Sorghum Livestock Zone* and the *Albertine West Nile Lowland Cattle Zone*. Adjumani's livelihood patterns vary geographically, as shown in *Map 2*. Most sub-counties fall within the *North Kitgum–Gulu–Amuru–West Nile Simsim, Sorghum, and Livestock Zone*. Six out of nineteen camps (Oliji, Alere, Baratuku, Elema, Nyumanzi and Agojo) are within the *Albertine West Nile Lowland Cattle Zone*, while the other thirteen (Pagirinya, Maaji, Mungula, Ayilo, Boroli, Olua, Pagirinya and Mirieyi) are within the *North Kitgum–Gulu–Amuru–West Nile Simsim, Sorghum, and Livestock Zone*.[16]

- **The North Kitgum–Gulu–Amuru–West Nile Simsim, Sorghum, and Livestock Zone** is characterized by semi-arid savannah farming systems where households rely on sorghum, sesame (simsim), and livestock as their main sources of food and income. Households depend on sorghum for food security, sesame (simsim) for cash income, and livestock (cattle, goats, poultry) for resilience. This high plateau zone may experience faster surface runoff to lower elevation, making it more prone to early onset of seasonal drought during dry spells.
- **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. Saving groups and small trade provide financial buffers against climate and market shocks.
- **The Albertine West Nile Lowland Cattle Zone is defined by cattle rearing, crop farming, and cross-border trade,** making it a mixed farming system that supports household food security and income. Due to lower elevation, this zone may be exposed to heat stress, increasing livestock water need, pasture stress and flood risk for nearby rivers that flow from lake Albert. To build resilience,



Map 2: Map showing Livelihood Zones in Adjumani District.

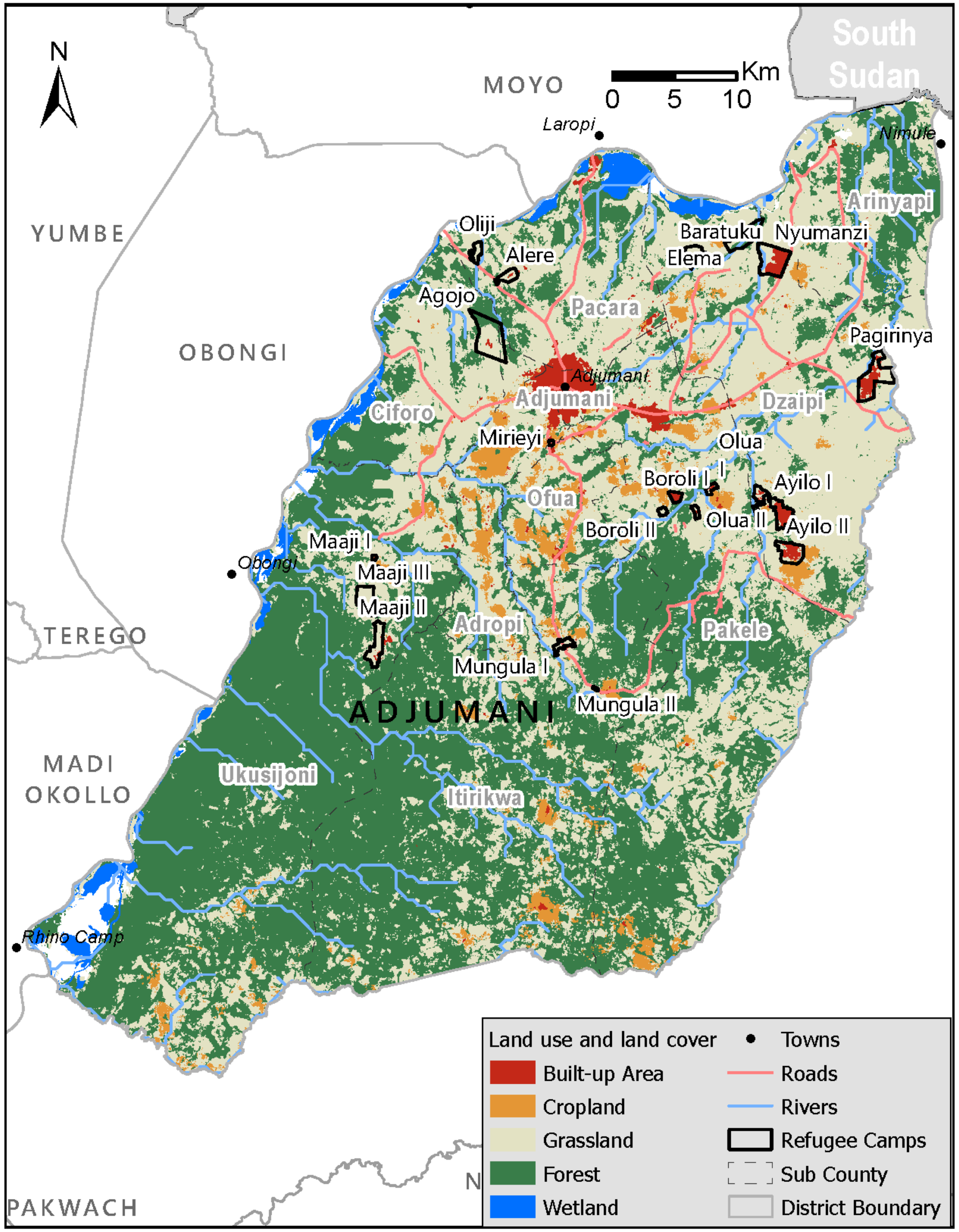
communities practice livestock diversification (cattle, goats, poultry), intercropping maize with cassava, and rotational grazing to preserve pasture. Farmers increasingly adopt vaccination campaigns and tick control measures to reduce livestock mortality.

The majority of Adjumani's population relies on **subsistence agriculture** as their **primary source of livelihood**. **Livestock farming** is practiced on a **small scale**, with households typically rearing **goats, poultry, and cattle**. However, agricultural productivity is constrained by limited access to markets, largely due to poor road infrastructure. Livelihoods are also highly vulnerable to climatic shocks, such as seasonal droughts and floods, which disrupt planting and harvesting cycles and contribute to food insecurity.[17]

Environment, Land Use and Land Cover

Adjumani District is characterized by **savannah woodlands, wetlands and plains. It is an ecologically diverse area with significant forest reserves, wetlands along the Nile, extensive grasslands and croplands that dominate land use**. However, these ecosystems have experienced significant degradation due to deforestation, charcoal production, soil degradation, water scarcity, and waste pollution. This is due to the expansion of agricultural land and human settlements. In recent years, the district's population growth was rapid, increasing from an estimated **225,000 in 2014 to over 300,000 in 2024.**The district hosts many **refugee settlements (19),** established over successive waves of displacement in 2014. The surge in the district's population has increased demand for fuelwood and construction materials, and agricultural land.[18,19]Access to safe and reliable water remains a major challenge, especially during dry spells. High demand for water during seasonal droughts leads to water scarcity and the degradation of catchment areas, threatening both human and ecological health.[20] The district is increasingly exposed to climate-related hazards, such as soil erosion, seasonal flooding, and rising temperatures, which further undermine ecosystem services and reduce resilience to environmental shocks.

As shown in *Map 3*, Adjumani's landscape is predominantly composed of **forestlands, which cover approximately 48.7% of the total land area.** These forestlands stretch across the district and play a vital role in providing fuelwood, timber, and construction poles. They also contribute to soil fertility and erosion control, supporting ecological stability and household energy needs. In addition, these forestlands support key



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

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livelihood activities, such as livestock grazing and the provision of building materials. Areas covered by forest include the well-known Zoka Central Forest Reserve, which has faced increasing pressure from illegal logging for timber harvesting, charcoal burning and firewood collection.[21,22]

Grassland accounts for nearly **42.6%** and supports key livelihood activities, such as livestock grazing and seasonal cultivation. Cropland, which makes up **3.7%** of the district's total area, remains crucial for subsistence farming, with crops such as sorghum, maize, cassava and groundnuts forming the backbone of household food security and income generation.

Built-up areas make up **1.6%** 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 **3.4%** of Adjumani District, key areas such as the Nile wetland corridor in the western part of the district play a vital role in supporting 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 the wetland with domestic and agricultural waste.

CLIMATE CONTEXT

This section presents an analysis of Adjumani 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 associated with these hazards. 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 or wider development planning.

Rainfall

Adjumani District experiences a **long rainy season** stretching from **March to October**, with notable intra-season variability. The long-term average (1981-2024), shown by the dashed line in *Figure 1,* indicates two short dry spells within the rainy season, a dip in rainfall around June-July and another around September before rains peak again in August and October.

The **driest months** remain **December to February**, each typically receiving less than **50 mm** of rainfall. Year-to-year variation is also evident, with 2022, 2023, and 2024 showing different magnitudes and timing of rainfall within these general seasonal patterns. As shown in *Figure 1***,** recent observations (2022-2024) reveal year-to-year variability in both the timing and amount of rainfall compared to historical averages. For example:

- **2022:** Rainfall was generally below the 1981-2024 average, especially from **April-June, August and October-November**. Only **March, July, September and December** recorded totals close to or slightly above the long-term mean.
- **2023:** Rainfall fluctuated around the 1981-2024 average, with **January** recording no rainfall at all (0 mm) and below average totals in **February, April-May, July-September and December. March, June, October and November** were clearly wetter than the long-term mean.
- **2024:** Rainfall departed more strongly from the 1981-2024 average, with below average totals in **March-May and December** whereas **June, August-September and November** recorded clearly above average rainfall. **July and October** received average rainfall.

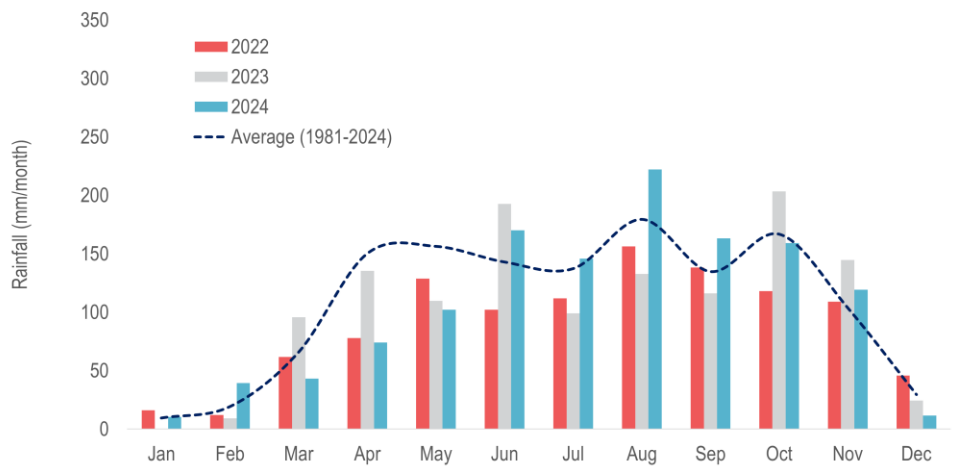


Figure 1: Graph showing Long-term Average Rainfall (2022-2024) in Adjumani District.

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 region and as a result, Adjumani is increasingly vulnerable to both seasonal droughts and flooding. **Prolonged dry spells**, especially during the **December-February period, lead to water scarcity, crop stress, and pasture depletion**. Conversely, **intense rainfall event**s during the **August-October peak can trigger flash floods, crop damage, and disruption of transport and livelihoods**.

The dry season is also marked by high temperatures, often exceeding **28°C,** and low humidity, contributing to increased occurrences of drought and water stress. These conditions are exacerbated by land degradation and limited water infrastructure, affecting domestic use, livestock, and agricultural productivity.[23]

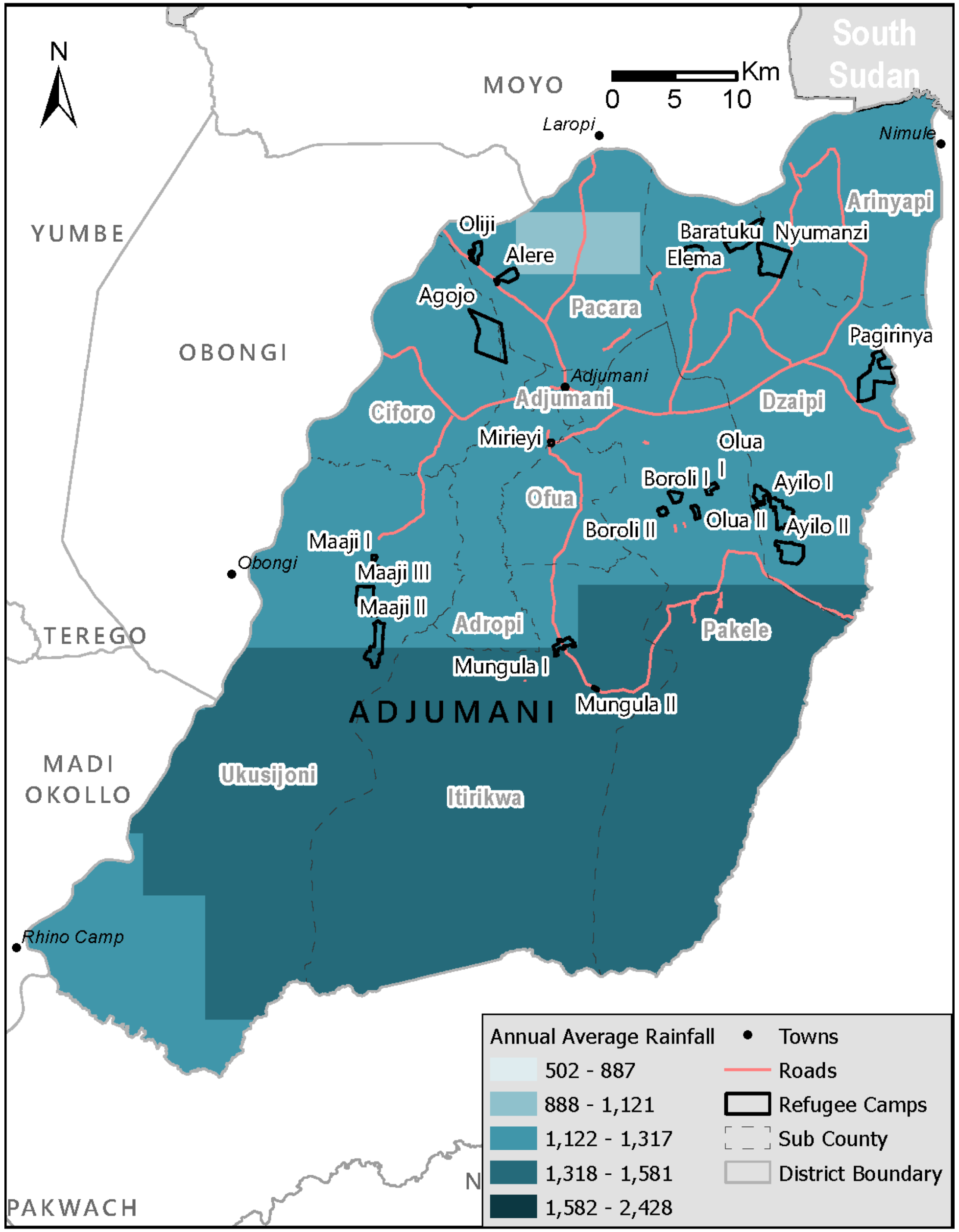
Overall, the increasing variability in rainfall patterns, combined with the district's reliance on rain-fed agriculture, heightens climate risks for both refugee and host communities. **This underscores the urgent need for integrated climate adaptation and resilience strategies to safeguard water availability, food security, and sustainable livelihoods.**

Map 4 displays the spatial distribution of average annual rainfall across Adjumani District for the period 1981-2024, derived from long-term CHIRPS precipitation data. Adjumani District straddles the **502 - 887 mm and 1,318 -1,581 mm** annual rainfall zones, with wetter conditions in the southwestern part of the district. Overall, Adjumani receives approximately **1,200-1,500 mm** of rain per year, placing it within a **moderate to moderately high rainfall zone**. This rainfall regime is generally sufficient to sustain rainfed agriculture and rangeland vegetation.

Rainfall dynamics in Adjumani are increasingly influenced by climate variability phenomena, such as unpredictable onset and cessation of rains, prolonged dry spells, and sporadically intense rainfall events. This variability disrupts the traditional agricultural calendar, which guides the timing of planting, growth, and harvesting, therein elevating risks to food production. Prolonged dry spells reduce soil moisture at critical crop development stages, while intense rains can cause localized surface runoff, soil erosion, and waterlogging of low-lying cropland. These impacts undermine crop yields and challenge farmers' ability to schedule field operations reliably.[24]

Smallholder farmers in Adjumani reported that late onset of the rainy season and mid-season dry interruptions have become more common.[25] These patterns are consistent with national and sub-regional observations, showing that Ugandan farmers increasingly perceive seasonal droughts and erratic rainfall patterns as worsening over the past decade, contributing to reduced agricultural productivity and food security stress.[26] Findings from climate-related hazards assessment in Nyumanzi Settlement and parts of Adjumani District Local Government indicate that some areas, including Dzaipi Sub-county, where Nyumanzi settlement is located, have experienced prolonged dry spells and low, unpredictable rainfall patterns, which local authorities report as having undermined water availability and agricultural conditions for both host and refugee communities.[27]

Staple crops commonly grown in Adjumani District, such as **maize, beans, ground**



Map 4: Map showing average annual rainfall (1981-2024) of Adjumani District.

nuts, and sorghum, are sensitive to dry spells that interrupt moisture availability during flowering and grain-filling stages, leading to reduced vegetative growth and lower yields. Extended dry conditions, particularly in the December to early March dry season, also contribute to pasture depletion and water scarcity for both crops and livestock. Conversely, intense rainfall during peak rainy months can damage crops, increase soil runoff, and erode topsoil, particularly where land cover has been reduced by settlement expansion or deforestation.

Temperature challenges exacerbate these issues. Although communities are accustomed to Adjumani District's typically warm climate, rising temperatures and more frequent hot days have intensified evapotranspiration, accelerated soil moisture loss and reduced the viability of late-season crops. Farmers and livestock keepers in sub-counties such as **Pakele, Dzaipi and Ukusijoni** report **faster drying of soils, delayed pasture regeneration and longer distances to reach reliable water sources during extended hot periods, particularly towards the end of the dry season**.[28]

These temperature stresses pose specific challenges for refugee-hosting areas in Adjumani District. Settlements such as **Pagirinya, Nyumanzi and Boroli,** which are in a dryland zone with limited perennial water sources and fragile soils, depend heavily on predictable seasonal rains to sustain household gardens and subsistence agriculture. Rising temperatures and erratic rainfall reduce the coping strategies of refugee communities, who have only limited livelihood diversification options and constrained access to land, increasing their vulnerability compared to the host communities that have large lands, livestock assets and off farm income opportunities.[29]

Overall, it is the increasing variability and rapid shifts in the known climatic patterns that pose growing risks in Adjumani. These shifts influence water availability, crop performance, pasture regeneration and the reliability of rain-fed farming systems that both host and refugee communities depend upon.[30]

Temperature

Over the past four decades, Adjumani District has experienced a substantial rise in temperatures, with an increase of approximately **2.5 to 3°C**, a substantial warming trend for a single district. As shown in *Figure 2,* the most pronounced rise has occurred in recent years **(2015-2023),** indicating a possible acceleration in warming and a growing risk of extreme heat events.

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

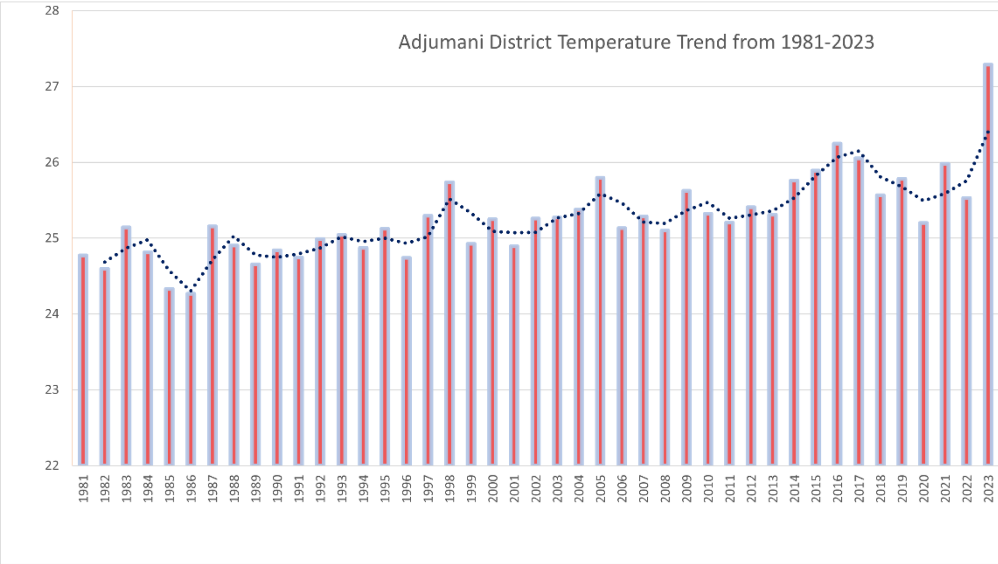


Figure 2: Graph showing the Long-term Temperature Trend (1981-2023) in Adjumani District.

- **1980s-mid 1990s**: Average annual temperatures generally ranged between **24.5°C and 25.1°C,** with modest year to year variability and no strong warming trend.
- **Late 1990s-2014:** Average annual temperatures rose gradually to between approximately **24.7°C and 25.7°C** but remained relatively consistent until 2014.
- **2015 onwards:** A clearer warming signal and greater variability, with most years above **25.5°C** and peaks approaching **26°C-26.2°C,** followed by an exceptional spike above **27°C** in **2023**

This consistent upward trend highlights the growing climate stress in the region, with implications for agriculture, water availability, health and overall resilience.

Seasonal temperature patterns in Adjumani District show consistently warmer conditions during the January-March dry season, when clear skies and high solar exposure drive daytime temperatures above the long-term average. During the April-November rainy period, temperatures remain slightly lower but have been gradually increasing as well. *Figure 3* also indicates a rise in temperature extremes, with recent years showing more days where average daily temperatures exceed the long-term mean. Notably, the sharp increase after 2016 and the peak after 2023 suggest that hotter-than-normal years are becoming more frequent, increasing heat stress on crops, pasture, livestock and water resources. These emerging extremes, coupled with rising seasonal temperatures, highlight Adjumani District's growing vulnerability to climate-induced heat stress.

The long-term monthly temperature average **(2022-2024),** shown by the dashed line in *Figure 3,* indicates a gradual decline in temperature from January to August, followed by a rise towards the end of the year.

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

- **2022**: Based on the seasonal calendar, temperatures during May, which is the crop flowering stage of the first rainy season were below the long-term average, while temperatures in September, corresponding to the second season remained close to the long-term average.

- **2023:** Based on the seasonal calendar, temperatures were below the long-term average in the crop flowering stage of the first season in May-June while is above the long-term average in the second season in August-September.

- **2024:** Temperatures in the crop flowering stage of the first season were above the long-term average in April-June and above long-term average in the second season in September.

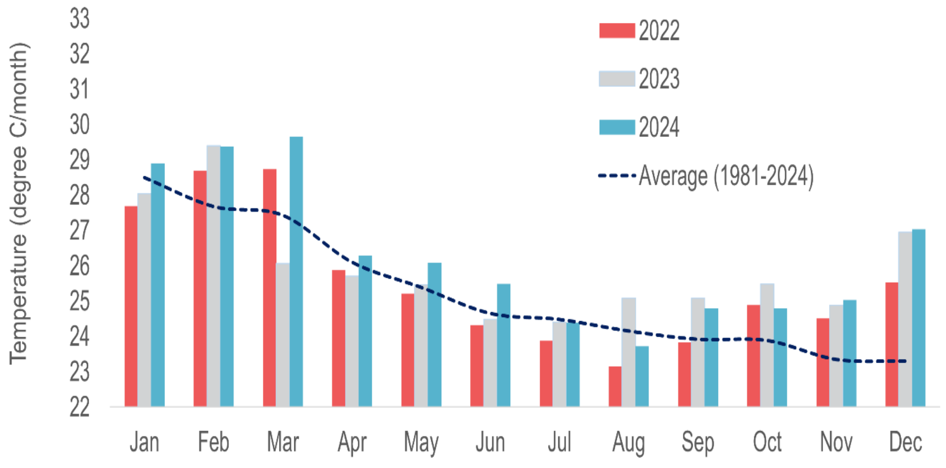


Figure 3: Graph showing Average Annual Temperature (2022-2024) of Adjumani District.

Above long-term average 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, leading to lower seed germination potential of harvested seeds.

Overall, temperatures in the last three years are consistently at or above the long-term average, with 2024 standing out as the warmest year across most months. This indicates a clear warming trend compared to historical norms. In short, heat stress is most damaging during flowering and seed development. Farmers might mitigate the heat stress effect through adjusted sowing dates, use of heat-tolerant varieties and irrigation scheduling.

CLIMATE CHANGE PROJECTIONS

In this section, bioclimatic variables from WorldClim v2.1 are considered as the historical parameter source, which provide high-resolution baseline climate data, such as temperature and precipitation patterns. These 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 where socio-economic 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 indications could be expected to change in future decades, highlighting potential impacts on ecosystems, agriculture, and water resources under a moderately warming future.

Precipitation changes
(1970-2000 vs 2041-2060)
SSP2-4.5 Moderate Emission Scenario
Annual precipitation changes

+163 mm

Temperature changes
(1970-2000 vs 2041-2060)
SSP2-4.5 Moderate Emission Scenario
Annual Mean Temperature Increase

+2.5 °C

Figure 4: Annual precipitation and temperature change in Adjumani District.

Temperature

The mean annual temperature in Adjumani is projected to rise from **25.0°C** in the historical baseline to **27.5°C** by 2041-2060. Both minimum and maximum temperatures show substantial increases. The strongest warming **(up to 2.53-2.59°C**) is expected in the **southern and southwestern sub-counties, including Ukusijoni, Ciforo and Pacara**. **Northern sub-counties, such as Arinyapi and Dzaipi, and eastern sub-counties like Pakele experience slightly smaller increases (~2.47°C) but still exceed the districtwide warming trend.**

An increase in mean temperature during both the **warmest month (2.5°C)** and **driest quarter (2.7°C)** indicates more intense heatwaves during the dry season. This combination intensifies heat stress for people, crops and livestock, leading to greater evapotranspiration, and reduced soil-moisture retention.

An increase in mean temperature during both the **coldest month (+2.6°C)** and the **wettest quarter (+2.6°C)** indicates general warming even during traditionally cooler and rainy periods. **This reduces seasonal cooling, increases heat stress**, posing challenges for livelihoods, infrastructure, and human health in flood prone and low-lying areas.

These effects create difficulties for crop production, livestock and human health, especially in areas with limited vegetation cover such as parts of Alere, Oliji, Maaji II and Agojo settlements.

+ 2.5 °C — *Increase in mean temperature in the warmest month*

+ 2.7 °C — *Increase in mean temperature in the driest quarter*

+ 2.6 °C — *Increase in mean temperature in the coldest month*

+ 2.6 °C — *Increase in mean temperature in the wettest quarter*

Figure 5: Projected changes in temperature in bioclimatic variables in Adjumani District.

Precipitation

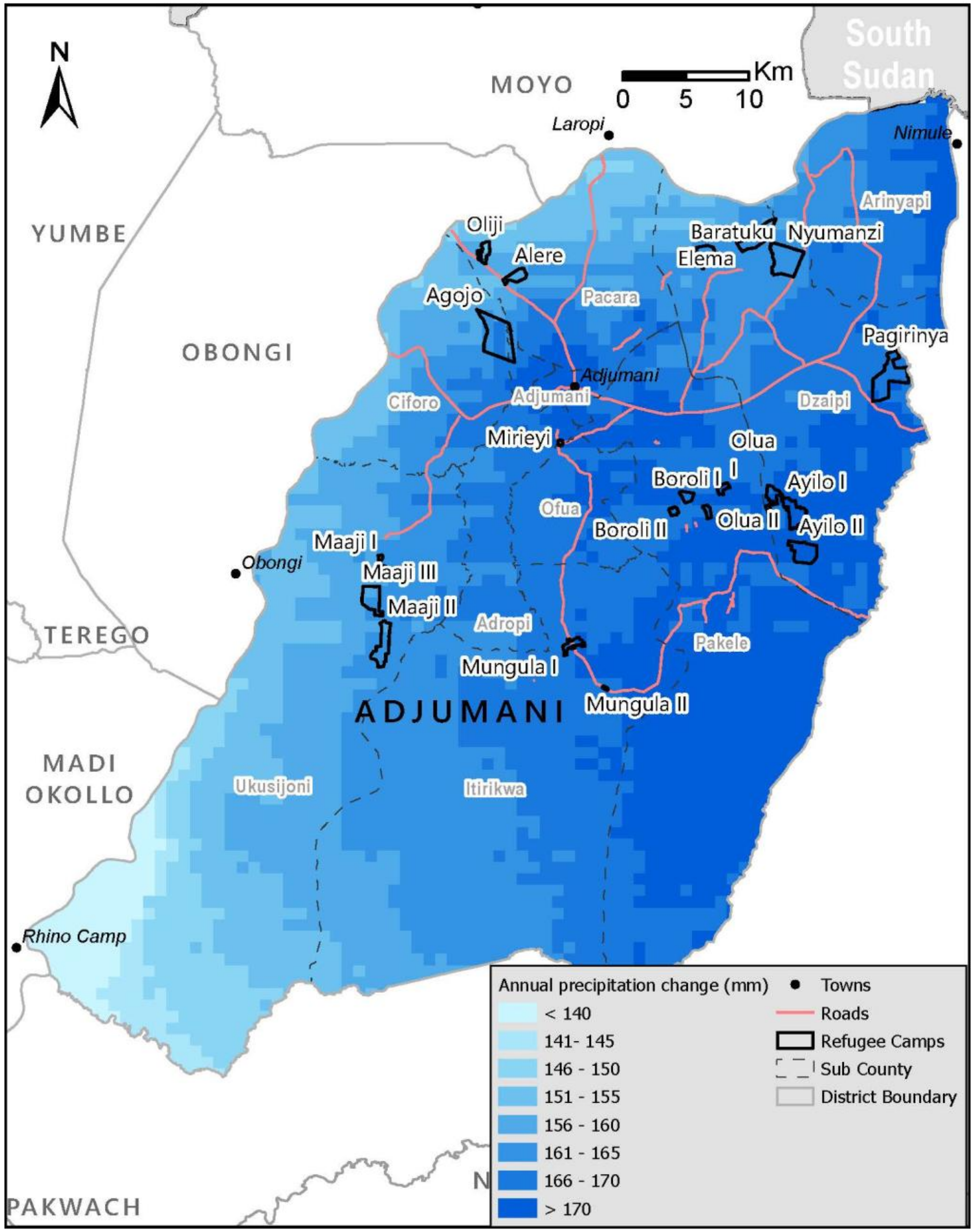
Mean annual rainfall is projected to increase from **1,193 mm to 1,356 mm** by mid-century. However, the distribution of rainfall gains is uneven across the district. The largest increases **(167-172 mm)** are expected in **Pakele, Adjumani Town, Ofua, and Dzaipi,** while sub-counties such **as Ukusijoni, Ciforo and Pacara show smaller increases (153-160 mm).**

An increase in precipitation of the wettest month **(40.3 mm)** and coldest quarter (**65.2 mm)** indicates **intensifying rainfall during already wet and cold periods**. **This may lead to more frequent and intense floods, waterlogging, with potential impacts on agriculture, settlements and access to services.**

An increase in precipitation during the driest month **(3.1 mm)** and the warmest quarter **(20 mm)** indicates **a shift toward wetter conditions outside the traditional rainy season.** This means dry-season water scarcity will persist, even under wetter annual conditions. This change reflects increasing seasonal variability, with implications for agricultural planning as shown in ***Figure 6 below***.

+ 40.3 mm	*Increase in precipitation of the wettest month*	+ 20.0 mm	*Precipitation of the warmest quarter*
+ 3.1 mm	*Increase in precipitation of the Driest month*	+ 65.2 mm	*Precipitation of the coldest quarter*

Figure 6: 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).

Implications

The projected rise in temperature from **25.0°C to 27.5°C** by mid-century, combined with uneven rainfall increases, indicates growing climate stress in Adjumani District. Stronger warming in the southern and southwestern sub-counties **(Ukusijoni, Ciforo, Pacara),** which also receive smaller rainfall gains, is likely to **intensify evapotranspiration, soil moisture loss, and heat stress, increasing vulnerability for rain-fed agriculture and livestock systems.**

Although annual rainfall is projected to increase, the persistence of extremely low dry-season rainfall means that dry-season water scarcity will remain a key challenge. Continued mid-season dry spells, such as the July break, may disrupt planting cycles and reduce crop yields despite higher annual totals. **Rising temperatures across both wet and dry seasons will further affect crop performance, pasture regeneration, and water availability, particularly in refugee settlement areas, such as Alere, Oliji, Maaji II and Agojo, where livelihood options and water infrastructure are limited.** While widespread flooding is not expected to increase substantially, short, intense rainfall events may still cause localized flash flooding in low-lying areas.

These projections align closely with broader national and East African climate patterns. According to the Uganda Third National Communication to the UNFCCC[31] and the IPCC Sixth Assessment Report[32], 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 projected warming and rainfall changes observed in Adjumani District fall within these ranges, indicating that the district is experiencing climate shifts consistent with regional trends. Overall, Adjumani District's climate hazards are primarily driven by heat stress, rainfall variability, and persistent dry season rather than declining annual rainfall, with important implications for agriculture, water resources, and community resilience.

SEASONAL DROUGHT HAZARD ASSESSMENT

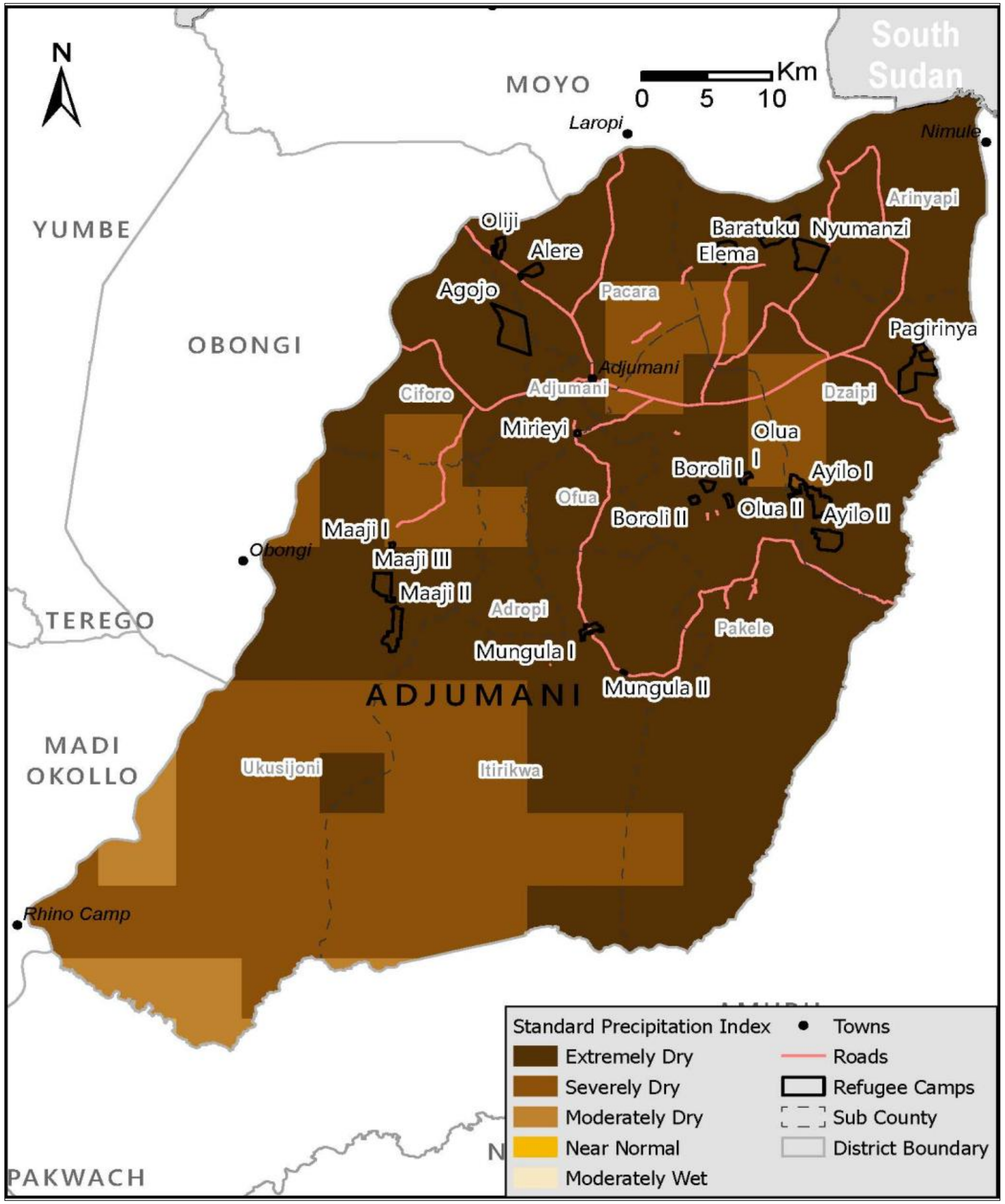
Adjumani District faces increasing seasonal drought risk due to unreliable rainfall, prolonged dry spells, and rising temperatures, which undermine agricultural production and household livelihoods in this predominantly rain-fed system.[33] Both host and refugee communities, including those in refugee settlements, experience recurrent meteorological droughts (periods of significantly below-average rainfall) and vegetation droughts (when crops and natural vegetation show stress due to lack of moisture), which disrupt planting seasons, reduce yields, and intensify food insecurity.[14,34]

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 effects were pronounced in 2022, when severe seasonal drought conditions hit seven of the sub-counties where all the thirteen refugee settlements are, including Nyumanzi, resulting in crop failure, water shortages, and heightened humanitarian needs.[35] While agencies such as WFP, UNHCR, and other partners provided emergency assistance, limited resources and logistical constraints underscored the district's urgent need for sustained investment in drought preparedness, climate-resilient livelihoods, and long-term adaptation measures.[36]

SPI Findings

The *Standardized Precipitation Index (SPI)* analysis shows that March-May 2024 was a critical seasonal drought month for Adjumani District, with much of the area experiencing below-normal rainfall. The eastern, northern, and central sub-counties including **Pakele, Dzaipi, Arinyapi, Pacara, Cifroro, Adjumani and Adropi fall within extremely dry conditions**. **All 19 refugee settlements recorded extremely**



Map 6: Map showing the SPI Index.

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

dry conditions, as indicated by the dark brown shades on the map in ***Map 6*****.** These areas correspond to the district's most drought-prone zones and reflect significant rainfall deficits during the assessment period.

In contrast, the southern and some central parts of Adjumani district - particularly **Ukusijoni, and Ikirikwa - experienced near moderately dry to severe dry conditions, suggesting comparatively lower meteorological drought stress.** The overall pattern shows a clear south-to-north gradient of increasing dryness, with the most pronounced deficits concentrated in the refugee settlement-hosting sub-counties (see *Map 6).*

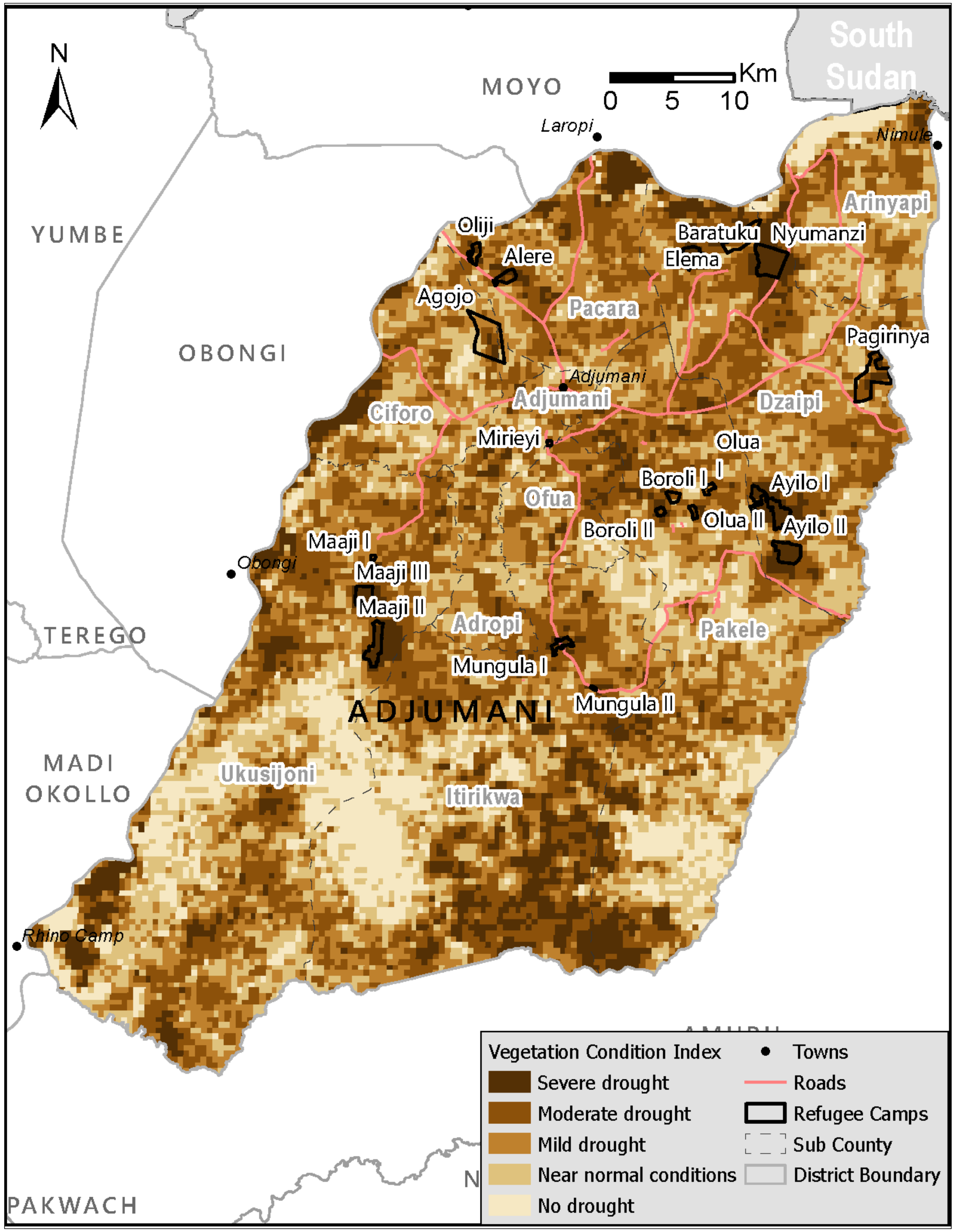
This indicates **substantial impacts on soil moisture availability, crop performance, rangeland conditions, and water access,** particularly in areas overlapping with Adjumani Refugee Settlement where livelihood systems are already highly sensitive to rainfall variability.[37]

VCI Findings

The interpretation of the *Vegetation Condition Index (VCI)* involves combining information on landcover type from *Map 3* and Precipitation Index for the corresponding months shown in *Map 7***.** Grasslands provide the clearest and most reliable signal of drought severity because they are shallow-rooted and are highly sensitive to rainfall variability. Croplands follow depending on crop type and seasonal calendar timing shifts, forests mask short-term drought because they have deeper root systems and higher biomass, and built-up areas give misleading signals because of bare surfaces and less green vegetation.

The **most affected sub-counties Pacara, Arinyapi, Dzaipi, Ciforo, and Ikirikwa** show **moderate to severe** vegetation drought, represented by the darker brown tones on the map in *Map 7*. **Nyumanzi, Elema, Pagirinya, Ayilo, Alere and Maaji** show **severe** vegetation drought. These patterns reflect **reduced vegetation vigour, declining pasture availability and early signs of crop failure**.

Severe seasonal drought in the southeastern district occurred in cropland areas at high elevations, where there were extreme dry precipitation conditions. **The moderate to severe drought conditions in most of the settlements (Nyumanzi, Ayilo, Alere, Maaji, Olua and Mungula) are combinations of true existence of cropland and grassland plus false reflectance from built-up areas.** The *VCI Map* in demonstrates



Map 7: Map showing the VCI index.

a notable intensification of vegetation drought, consistent with the spatial distribution of rainfall deficits.

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

Implications

The combined SPI and VCI analyses provide a comprehensive picture of seasonal drought dynamics in Adjumani District, revealing a strong linkage between rainfall deficits (meteorological drought) and declining vegetation vigour (agricultural drought). The simultaneous occurrence of severe SPI dryness and low VCI values indicates that these areas face acute vulnerability during short-term rainfall deficits. Climatic pressures translated into tangible impacts in 2023, where erratic rainfall and intermittent dry periods during key planting periods disrupted agricultural activities for farmers and refugees within the Adjumani Refugee Settlements, undermining prospects for favorable harvests.[38]

Local reporting from Adjumani District documented that dry spells have caused **massive crops failures**, with simsim, sweet potatoes, maize, beans, ground nuts, and cassava withering before maturity.[39] These observed agricultural challenges reflect the link between SPI and VCI signals. Agricultural output, food availability, and livelihood resilience is reduced, in both host and refugee communities.

The impacts extend across several livelihood dimensions. **Reduced soil moisture and weakened vegetation cover directly undermine crop yields, pasture availability, and water resources, heightening food insecurity for both host and refugee communities**.[40] Vegetation loss also exacerbates **soil erosion and land degradation, weakening the district's overall ecological resilience to future shocks**. These conditions place additional pressure on settlement areas, where higher population density and limited natural resource buffers magnify drought impacts.

From a preparedness standpoint, the findings emphasize the need for **early warning systems, climate-smart agriculture, water harvesting and storage, and strengthened natural resource management**. Integrating SPI and VCI **monitoring into district-level disaster risk management frameworks can enhance evidence-based planning, support timely alerts during emerging drought episodes, and improve resource allocation for both immediate response and long-term climate resilience across Adjumani District.**

Photo 1: Dried up maize garden in West Nile region due to prolonged drought. Photo Credit: Nile Post

In recent years, *Adjumani District*, particularly in and around *Nyumanzi Refugee Settlement*, has experienced recurrent **prolonged dry spells and low rainfall.** This has reduced **crop yields**, limited **pasture availability** and strained already fragile household food systems. Farmers reported difficulties in planting and poor crop performance due to inadequate soil moisture during critical growing stages. Water sources for domestic use and livestock also declined during peak dry periods, increasing the time and effort required to access water.

Local assessments highlight that drought conditions have intensified **food insecurity and income loss**, pushing vulnerable households to rely more on casual labour and other coping strategies. While some farmers have attempted crop diversification and water conservation practices, limited access to irrigation and climate-resilient inputs continues to constrain adaptive capacity, leaving communities exposed to recurring climate shocks.

Source: Living with Climate related Hazards - ULEARN

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.[41] 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.[42]

2. Elevation above sea level ranked from higher risk to lower risk at 600 meters, 700 meters, 800 meters, and 1000 meters.[43]

3. Slope of the area in degrees ranked from higher risk to lower risk at 2, 5, 10, 15.[44]

4. Landcover ranked from higher risk to lower risk as built-up, cropland (include water, flooded vegetation), grassland, shrub and forest.[45]

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[46]

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.[47]

9. Rainfall Intensity as average maximum annual rainfall ranked from higher risk to lower risk at 33 mm, 31 mm, 29 mm, 27 mm.[48]

10. Monthly Number of Days with Rainfall ranked from higher risk to lower risk at 13 days, 10 days, 7 days, 3 days.[49]

11. Frequency of -days with continuous Rainfall ranked from higher risk to lower risk at 2, 1.2, 0.8, 0.4.[50]

12. Height Above Nearest Drainage (HAND) ranked from higher risk to lower risk at 2 meters, 5 meters, 10 meters, 20 meters.[51]

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).[52]

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.

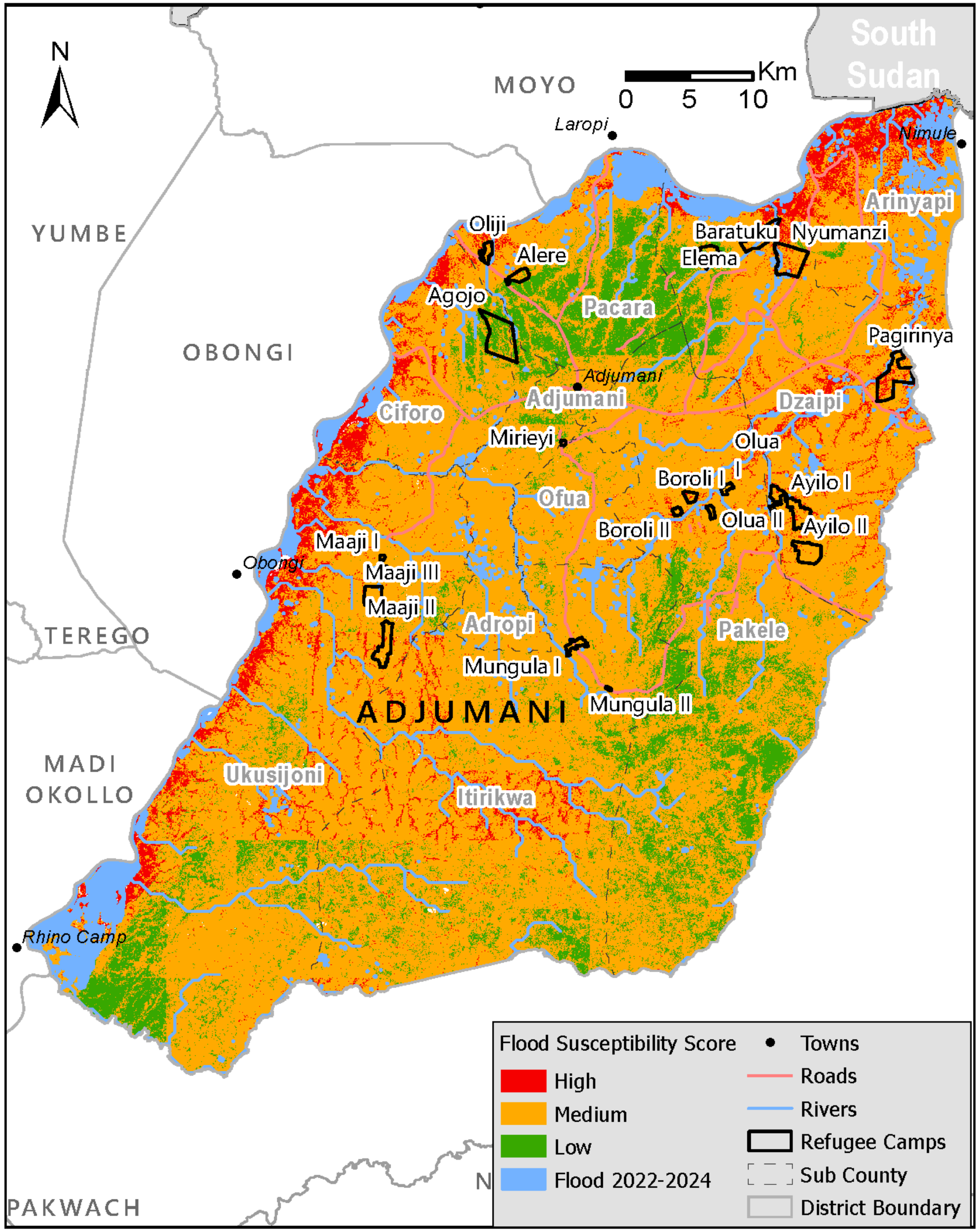
Findings

Several geographic and infrastructural factors exacerbate flood risks in the district. Adjumani is predominantly flat, with clayey soils and insufficient drainage infrastructure, which limits water infiltration and increases surface runoff, especially in low-lying areas and along seasonal streams and permanent rivers.

Satellite-based assessments reveal that **11.8 % of Adjumani District falls within high-risk flood areas**. **Arinyapi, Pacara, Ciforo, Ukusijoni and Dzaipi Sub-counties are the most flood-prone zones.** Their vulnerability stems from low elevation and proximity to seasonal river channels. Within Adjumani Refugee Settlement, **Pagrinya, Oliji and Nyumanzi are especially susceptible to flooding**. These 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.[53]

The flood susceptibility analysis for Adjumani District (2022-2024) in *Map 8* shows that flooding is highly localized, with the greatest concentration of inundation occurring in the northeastern and western parts of the district.

Flood recurrence is strongest in areas aligned with seasonal river channels, low-lying plains, and poorly drained terrain, highlighting the influence of local topography and hydrological pathways. Recurrent flooding in western and north Adjumani suggests limited natural drainage capacity, potential siltation of watercourses, and increasing surface runoff linked to land cover modification, including vegetation clearance and the expansion of built-up areas within the broader catchment. These conditions reduce infiltration and increase the likelihood of rapid accumulation of surface water following intense rainfall events.



Map 8: Map of Adjumani showing Flood Susceptibility (2022-2024).

Risk on Cropland and Settlement

The land cover analysis revealed that **grassland covers 42.6%, forest 48.7%, built-up areas 1.6%, while cropland only covers 3.8 %**. Less than **8% of cropland falls within the low-risk flood zone,** while less **than 12% of built-up areas are within the low-risk flood zone**. Cropland emerges as the most affected by flooding when measured in terms of area inundated compared to built-up areas. However, these estimates represent district-wide averages and therefore conceal substantial spatial concentration of impacts at local levels.

The *Land Use and Landcover Map* in *Map 3* shows that most cropland areas are located near Adjumani Town and within the southern river valleys, which lie in the high-risk flood zone. This suggests that households cultivating in and around floodplains and poorly drained lowlands face chronic exposure to flooding. For these households, even localized flooding events can result in recurrent crop damage, delayed planting, and yield losses, likely contributing to recurrent income losses and seasonal food insecurity. Built-up areas, which always overlap with cropland around Adjumani Town and Adjumani Refugee Settlements, are within medium to high-risk flood zones.

Overall, the findings indicate that flood risk in Adjumani is spatially concentrated in specific terrain types and closely linked to settlement patterns. Effective flood risk management will require targeted interventions in the northern and central corridor, where most of the built-up areas lie. These interventions could include improved drainage infrastructure, watershed and riverbank restoration, and strengthened early warning systems at the community level. Integrating flood hazard information into land-use planning and settlement management is essential for reducing vulnerability, particularly in flood-affected sections of the Adjumani Refugee Settlements around **Nyumanzi, Pagirinya, Oliji Ayilo and Maaji.**

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. Overall, the temporal trend points to increasing flood persistence, which poses growing challenges for local livelihoods and infrastructure resilience.

Agricultural Losses: Farmers, who make up majority of the population, have suffered immense losses. In 2023 alone, **over 2,000 acres of crops including cassava, maize, rice, soybeans, and sugarcane were submerged or destroyed**. **One farmer in Dzaipi Sub-county reported losing crops worth Shs20 million.**[54]

Flood Impacts

Flooding in Adjumani District has had multidimensional socio-economic and environmental impacts. Recurrent inundation has 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.

Floods have also contaminated water sources and damaged sanitation facilities, increasing the risk of waterborne diseases particularly within the Nyumanzi Refugee Settlement zones.[55]

Photo 2: Flooded homes in Adjumani District. Photo Credit: IMPACT

In **September 2023**, severe flooding in parts of *Adjumani District* especially in *Nyumanzi Refugee Settlement* located in Dzaipi sub county affected over **4,000 refugees and host community members**, displacing families as their homes were inundated and forcing some to sleep outdoors after shelters were damaged or destroyed. Floodwaters washed away **pit latrines**, raising **health and sanitation risks**, and damaged key infrastructure such as **roads, culverts, and bridges** that disrupted movement and access to services. The floods also ruined crops and personal property, with an initial **loss and damage estimate of about UGX 70 million**, compounding food insecurity and economic losses for already vulnerable households. Local leaders and humanitarian officials noted increased urgency to **relocate households in flood-prone areas** to safer ground to reduce recurring disaster impacts.

Source: Monitor UG – Over 4000 hit by floods in Adjumani

Environmentally, repeated 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 persistently flooded areas often face temporary displacement, loss of shelter, and heightened vulnerability due to inadequate infrastructure and limited adaptive capacity. These cumulative impacts underline the urgent need for integrated flood management, infrastructure improvement, and community-based adaptation strategies to enhance resilience in Adjumani District.

Conclusion

The findings of this geospatial analysis highlight the substantial influence of climate-related hazards on both refugee and host communities in Adjumani District. Over the assessment period, the district has experienced prolonged dry spells and recurrent localized flooding, which together pose major risks to agricultural productivity, water availability, and settlement infrastructure. The SPI and VCI analyses reveal widespread vegetation stress and rainfall deficits, especially during the 2023 crop flowering for the first season, while flood mapping indicates high exposure in low-lying sub-counties, such as **Arinyapi, Pacara, Ciforo, Ukusijoni and Dzaipi**. These findings underscore the growing climate vulnerability of Adjumani District, emphasizing the need for targeted adaptation measures including improved water resource management, resilient agricultural practices and settlement planning to safeguard livelihoods and enhance resilience for both refugee and host populations.[56,57]

Methodology Overview

The climate risk assessment for Adjumani 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[58] under the SSP2-4.5 scenario, processed using the same bioclimatic variables to ensure comparability with the historical baseline.[59]

Drought assessment followed UN-SPIDER protocols[60], using SPI calculated in Google Earth Engine (GEE)[61,62] from CHIRPS rainfall data[63] (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.[64] 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.[65] 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 Bidibidi refugee settlement in Adjumani 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 Adjumani (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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REACH Informing more effective humanitarian action

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.[66]

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.[67]

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.[68]

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.[69]

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[70]

Exposure: The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.[71]

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.[72]

Water Stress: Water stress occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use. Water stress causes deterioration of freshwater resources in terms of quantity (aquifer over-exploitation, dry rivers) and quality (eutrophication, organic matter pollution, saline intrusion).[73]

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] UNHCR, Refugee Response Portal - Uganda
[2] UNCDF, Uganda-Climate Risk and Vulnerability Assessment
[3] Ministry of Water and Environment (MWE). (2015). *Uganda's National Climate Change Policy*. Government of Uganda.
[4] World Bank. (2021). *Climate risk country profile: Uganda*. Washington, DC: World Bank Group.
[5] Uganda National Meteorological Authority (UNMA). (2024, July 24). *UNMA explains unreliable rains, urges farmers to harvest water*.
[6] REACH_UGA_2024-MSNA-Report_July-2025
[7] ULEARN - Living with Climate Related Hazards (May 2025)
[8] UNDP - Adjumani District HRV Profile (2016).
[9] World Bank – climateknowledgeportal – Climate data projections - Uganda IPCC Assessment Reports.
[10] UNHCR - Population Statistics Dashboard (December 2025),
[11] UNDP - Adjumani District, Hazard, Risk and Vulnerability Report (2016),
[12] Adjumani topographic map, elevation, terrain
[13] Gabrir, G., Diekkruger, B. Naschen, K., Leemhis, C., van der Linden, R., Majaliwa, J g. M., & Obando, J.A. (2020). Impact of Climate and Land Use/Land Cover Change on the Water Resources of a Tropical Inland Valley Catchment in Uganda, East Africa
[14] UBOS – National Population and Housing Census (2024_Final-Report
[15] UNHCR - Population Statistics Dashboard (December 2025)
[16] USAID -Uganda – Livelihood zones
[17] World Bank. (2021). Climate risk country profile: Uganda. Washington, DC: World Bank Group. Ibid.
[18] UBOS - National Census - Main Report (2014)
[19] UBOS – National Population and Housing Census (2024_Final-Report
[20] IRC + water for people – Climate Change, Water resources and WASH systems in Uganda (2021)
[21] Global Forest Watch (GFW - Adjumani, Uganda Deforestation Rates & Statistics.
[22] Monitor UG - Adjumani leaders seek to protect depleted forests, 2025
[23] FAO – Climate Change and Food Security, Risks and Responses
[24] ULEARN - Living with Climate Related Hazards (May 2025)
[25] REACH - Impact-of-Climate-Hazards_Final-Report,2025
[26] EFD - climate-variability-and-agricultural-productivity-Uganda
[27] ULEARN - Living with Climate Related Hazards (May 2025)
[28] IPCC - AR6 Synthesis Report: Climate Change Report 2023
[29] ULEARN - Living with Climate Related Hazards (May 2025)
[30] IPCC - AR6 Synthesis Report: Climate Change Report 2023
[31] United Nations Framework Convention on Climate Change (UNFCCC) – Third National Communication of Uganda to the UNFCCC. Kampala: Government of Uganda
[32] 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.
[33] ULEARN - Living with Climate Related Hazards (May 2025)
[34] UN Women – Supporting refugees and host communities in Uganda to increase agriculture productivity and build resilience to climate change risks (2022)
[35] IMPACT - Uganda - Mapping Exposure to Climate-Related Hazards: GIS and Remote Sensing Perspective on

ABOUT REACH

REACH Initiative facilitates the development of information tools and products that enhance the capacity of aid actors to make evidence-based decisions in emergency, recovery and development contexts. The methodologies used by REACH include primary data collection and in-depth analysis, and all activities are conducted through inter-agency aid coordination mechanisms. REACH is a joint initiative of IMPACT Initiatives, ACTED and the United Nations Institute for Training and Research - Operational Satellite Applications Programme (UNITAR-UNOSAT).

Nyumanzi Settlement (April 2025) - Uganda
[36] Royal Danish Embassy – Climate Resilience for Refugee Affected areas and Regions in Uganda -Feasibility Study
[37] IMPACT Initiatives - GIS and Remote Sensing Perspective on Nyumanzi Settlement (April 2025) - Uganda
[38] Radio Pacis - MORE THAN 1000 RESIDENTS OF ADJUMANI DISTRICT AFFECTED BY FLOODING.
[39] Monitor UG -. National dry spell causes massive crop failures.
[40] The Cooperator - Adjumani and Lamwo districts to implement Shs 22.83bln refugee project.
[41] MDPI - Flood Risk Mapping by Remote Sensing Data and Random Forest Technique
[42] European Commission - Global Surface Water Explorer (2021)
[43] NASA Shuttle Radar Topography Mission Global 1 arc second V003 – NASA Earth data
[44] NASA Shuttle Radar Topography Mission Global 1 arc second V003 – NASA Earth data
[45] World Resources Institute - Research for People & Planet
[46] sentinel.esa.int
[47] European Commission - Joint Research Centre Data Catalogue-Global River flood hazard maps
[48] CHIRPS: Rainfall Estimates from Rain Gauge and Satellite Observations – UC Santa Barbara
[49] CHIRPS: Rainfall Estimates from Rain Gauge and Satellite Observations – UC Santa Barbara
[50] CHIRPS: Rainfall Estimates from Rain Gauge and Satellite Observations – UC Santa Barbara
[51] Yamazaki Lab – Global Hydrodynamics Lab
[52] iSDA
[53] UNHCR - Compendium_Flood_Management_humanitarian_Settlements.
[54] Monitor UG- Flash floods displace 5,000 Adjumani locals
[55] Monitor UG- Flash floods displace 5,000 Adjumani locals
[56] The Cooperator - Adjumani Stakeholders demand community inclusion in climate-smart agriculture project
[57] The Cooperator - Adjumani and Lamwo districts to implement Shs 22.83bln refugee project
[58] RMetS – Evaluation of precipitation simulations in CMIP6 models over Uganda
[59] 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
[60] UN SPIDER _ Standardized Precipitation Index (SPI) in Google Earth Engine, n.d.
[61] UN-Spider Agriculture Drought Monitoring and Hazard Assessment
[62] World Meteorological Organization (WMO). (2012). Standardized Precipitation Index user guide (WMO-No. 1090). Geneva: WMO.
[63] CHIRPS Daily: Climate Hazards Center InfraRed Precipitation with Station Data (Version 2.0 Final)
[64] Kogan, F. N. (1995). Application of vegetation index and brightness temperature for drought detection. Advances in Space Research, 15(11), 91–100.
[65] UN-Spider Flood Mapping Methodology
[66] United Nations General Assembly Resolution A/71/644, (UNGA, 2016).
[67] UNDRR-Disaster risk reduction terminologies,2017
[68] MDPI-Flood Susceptibility Assessment for Improving the Resilience Capacity of Railway Infrastructure Networks,2024
[69] MDPI-A General Overview of the Risk-Reduction Strategies for Floods and Droughts,2020
[70] NDMC-Types of Drought,2026
[71] United Nations General Assembly Resolution A/71/644, (UNGA, 2016).
[72] United Nations General Assembly Resolution A/71/644, (UNGA, 2016).
[73] European Environment Agency, Glossary Definitions, Water Stress