UGANDA

Climate Hazard Assessment – Obongi 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, 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 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	South west	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 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 – Obongi District

CONTEXT & RATIONALE

Obongi District is in the West Nile Sub-region region of Northern Uganda, bordered by Moyo District to the north, Adjumani District to the east, Yumbe District to the west, and Madi Okollo District to the south. The district was carved out of Moyo District and officially became operational on 1 July 2019 as part of the Government of Uganda's decentralization policy aimed at improving service delivery and administrative efficiency.[7] The district experiences a **uni-modal rainfall pattern**, with one main rainy season typically occurring between **March and June**, which traditionally supports agricultural activities. However, like much of Northern Uganda, rainfall has become increasingly **unpredictable in recent years**, with delayed onset of rains, prolonged dry spells, and occasional intense rainfall events that disrupt farming schedules and reduce crop yields. [8,9] Obongi lies along the Albert Nile and covers an area of approximately 1,591 km², characterized by low-lying plains, riverine landscapes, wetlands, and fertile agricultural land that support rural livelihoods based mainly on subsistence farming, fishing, and small-scale trade.[10]

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 Obongi will become warmer and moderately wetter by mid-century, with mean annual temperatures rising from **26.1°C to 28.7°C** and annual rainfall increasing from **1,156 mm to about 1,312 mm**.[1] 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 Obongi will become warmer and moderately wetter by mid-century. Mean annual temperatures are projected to rise from **26.1°C to 28.7°C**, while annual rainfall is expected to increase from **1,156 mm to about 1,312 mm**.[2] Despite this increase in rainfall, intensifying heat stress is expected to pose greater risks to rural households and displaced populations.[11]

Obongi District hosts over **142,000 refugees** living in Palorinya Refugee Settlement primarily from the neighboring conflict-affected country - South Sudan. Like other neighboring districts, Obongi hosts a significant number of refugees, which increases pressure on land, water and public resources.[12] This analysis therefore seeks to generate evidence-based insights into historical and projected climate trends to inform climate-resilient humanitarian and development programming in Obongi District.

Key Messages

- Obongi District currently receives **~1,156 mm** of annual rainfall, projected to increase moderately to **~ 1,312 mm** by mid-century under the SSP2-4.5 scenario. However, rainfall gains are expected to be unevenly distributed across the district, with larger increases in **Itula, Obongi Town Council, and Gimara sub-counties**.
- Temperatures are projected to **increase by 2.6-2.8°C** during the warmest month and driest quarters respectively. This implies that already hot seasons will continue being hot, leading to heat stress for people, crops and livestock.
- 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, particularly in Aliba, Gimara and Obongi Town Council. Palorinya Refugee Settlement** also experiences extreme dryness which impacts on soil moisture availability, crop performance, rangeland conditions, and water access.
- Low-lying areas near the River Nile and seasonal rivers have the highest flood risk. Affected areas include **Obongi Town and Palorinya Refugee Settlement.** Affected areas include **Obongi Town and Palorinya Refugee Settlement.** Flooding during intense rainfall and river overflow can damage shelters, roads, and sanitation facilities, posing risks to livelihoods and public health for both host and refugee communities.

[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.

By identifying hazard susceptibility, exposure patterns, and future climate hazards, 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-refugee-hosting districts.

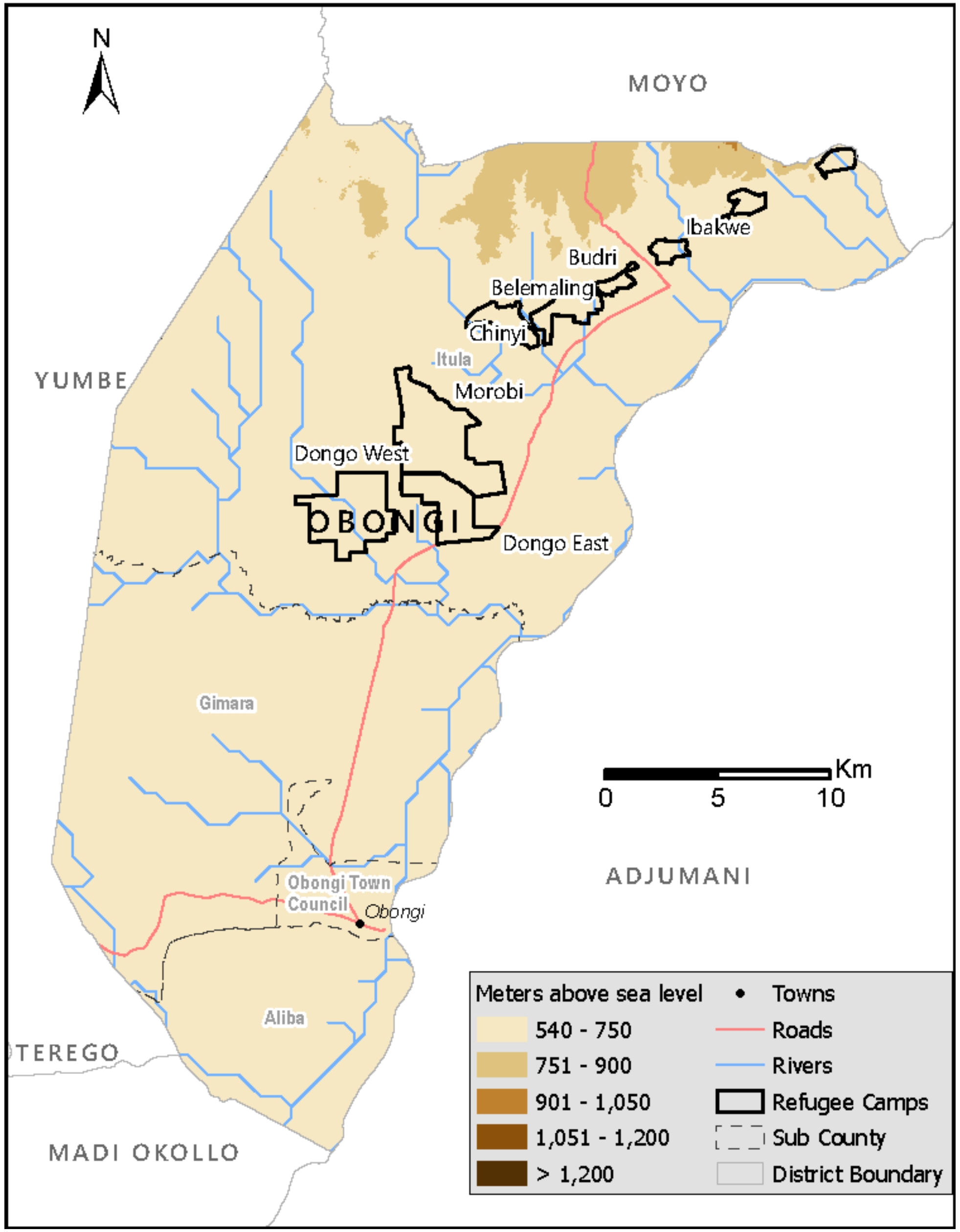
Location and Topography

Obongi District is in the West Nile Sub-region of Northwestern Uganda, bordering Moyo District to the north, Adjumani District to the east, Yumbe District to the west, and Madi Okollo District to the south.[13] The district headquarters are in Obongi Town Council, situated approximately 446-529 km northwest of Kampala, Uganda's capital city. Obongi District was carved out of Moyo District and became operational on 1 July 2019 as part of Uganda's decentralization policy aimed at improving service delivery and local governance. The district is largely rural, and its economy is dominated by subsistence agriculture and fishing, which support most households.[14]

The terrain of Obongi District is **predominantly low-lying and gently undulating, characterized by riverine plains along the Albert Nile, seasonal wetlands, and scattered elevated areas.** Elevations across the district generally range from around **540 m to 900 m** above sea level with an average elevation of **700 m** above sea level. The presence of the Albert Nile floodplain strongly influences settlement patterns, agriculture, and water resources in the district. While the fertile soils along the river support crop cultivation and fishing-related livelihoods, the low-lying terrain also makes several communities vulnerable to seasonal flooding, especially during periods of intense rainfall or when water levels in the Nile rise.

The district's landscape is strongly influenced by the river Nile, which creates wide riverine zones and fertile floodplains along its course. The district's landscape is strongly influenced by the River Nile, which creates wide riverine zones and fertile floodplains along its course. The gentle slopes and plains support widespread cultivation and settlement but also contribute to areas of shallow drainage and surface water accumulation during intense rainfall, especially in flatter localities. In contrast, the isolated hills and elevated terrains provide slightly better natural drainage and are often preferred for habitation and road networks.[15]

Vegetation across Obongi District is largely characterized by savannah woodland and grassland interspersed with shrubs, typical of the West Nile sub-region. Riverine



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

vegetation is common along the Albert Nile and surrounding wetlands, supporting fishing activities and small-scale agriculture. In addition, woodland areas provide fuelwood, charcoal, and construction materials that are essential for rural livelihoods.[16]

Demographics and Population Distribution

According to the 2024 National Population and Housing Census, Obongi District has a population of over 142,000 people. This reflects an enormous increase from the 2014 census figure of 43,061 and indicates sustained population growth in the district.[17] The district's population is largely composed of the Madi ethnic group, alongside other West Nile communities such as the Kakwa and Lugbara. Christianity and Islam are the main religions practiced across the district.[18] Obongi District hosts a large refugee population, primarily from South Sudan, with most refugees residing in Palorinya Refugee Settlement, one of the major refugee settlements in Uganda. As of December 2025, Palorinya hosts over 142,000 refugees, making a substantial proportion of the district's total population.[19]

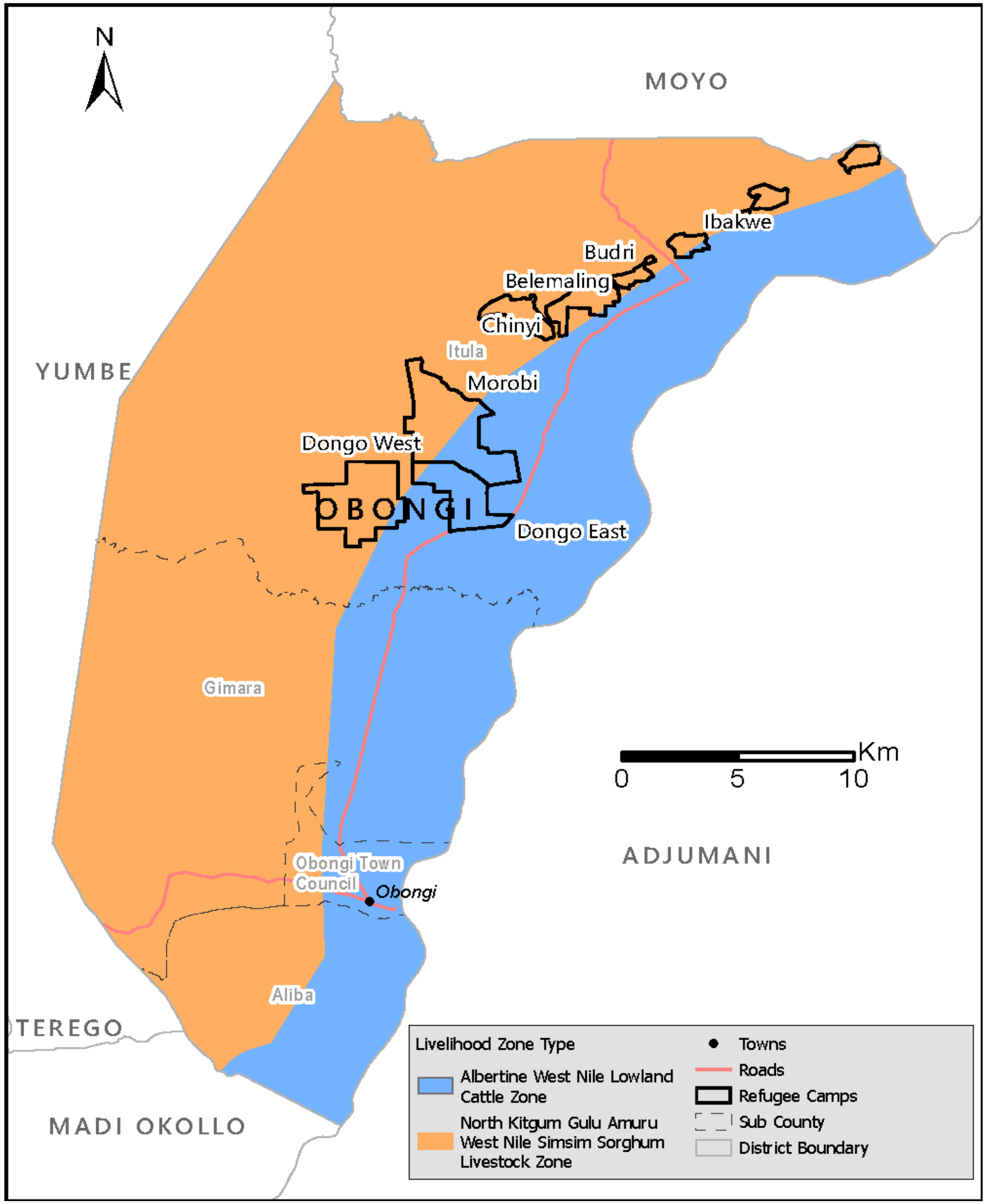
Since refugees represent a large share of Obongi's population, their presence contributes to increased demand for land, water, housing, education, and health services. The rapid population growth associated with both natural populations increase, and refugee inflows continue to shape service delivery, infrastructure planning, and natural resource management across the district.

Livelihoods

Obongi District lies in two major livelihood zones: the N*orth Kitgum Gulu Amuru West Nile Simsim Sorghum Livestock Zone*, and the *Albertine West Nile Lowland Cattle Zone*.

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. The households depend on sorghum for food security, sesame (simsim) for cash income, and livestock (cattle, goats, poultry) for resilience. This zone as high plateau may experience faster runoff to lower elevation thus may be the first to experience seasonal drought during dry spell.

The *Albertine West Nile Lowland Cattle Zone* is defined by cattle rearing, crop farming,



Map 2: Map showing Livelihood Zones in Obongi District.

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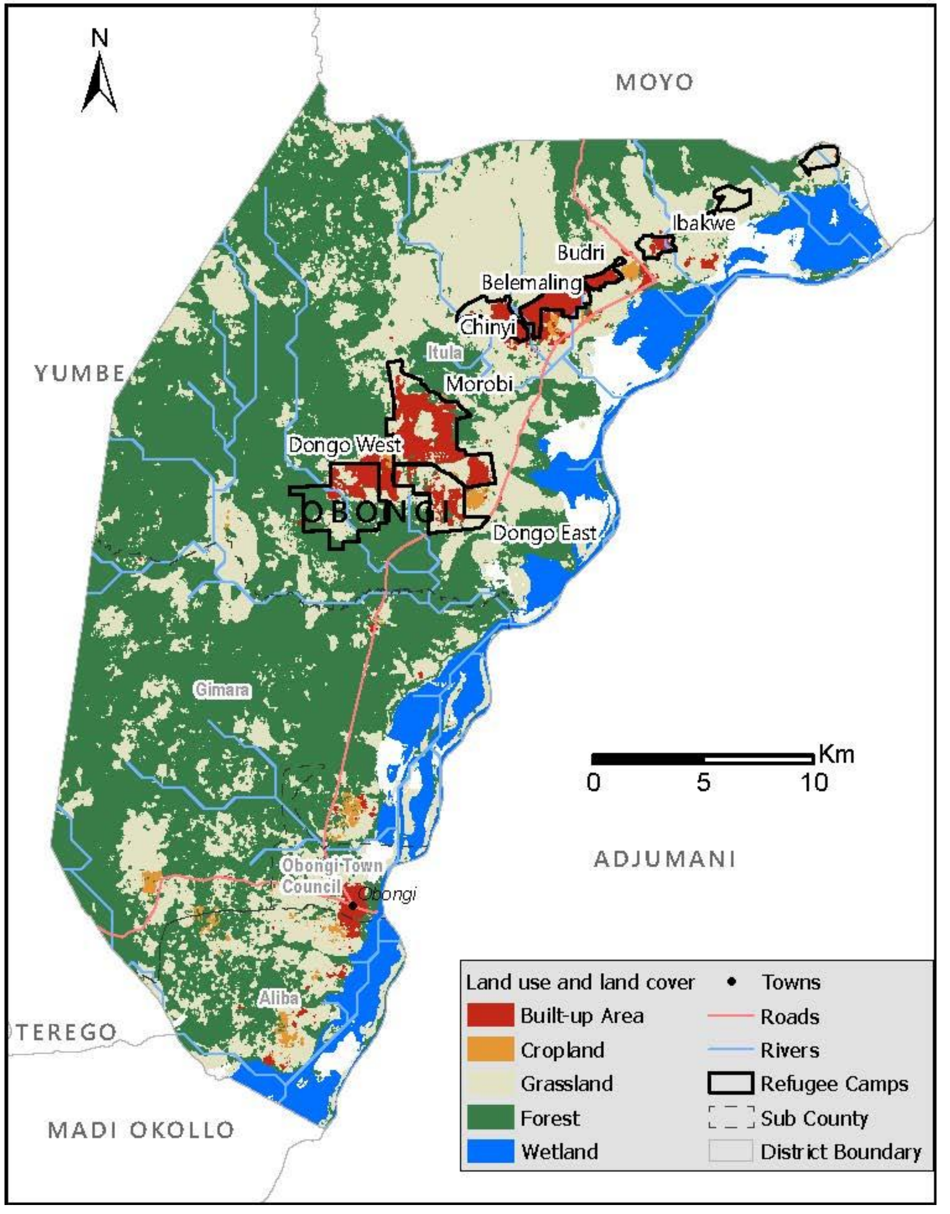
and cross-border trade, making it a mixed farming system that supports household food security and income. The *Albertine West Nile Lowland Cattle Zone* is defined by cattle rearing, crop farming, and cross-border trade, making it a mixed farming system that supports household food security and income. Due to lower elevation this zone may be exposed to heat stress, increasing livestock water need, pasture stress and flood risk, especially near rivers that flow from lake Albert. Due to lower elevation, this zone may be exposed to heat stress, increasing livestock water need, pasture stress and flood risk, especially near rivers that flow from lake Albert.

To build resilience, 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.[20]

Environment, Land Use and Land Cover

Obongi District is characterized by a tropical savannah environment with significant forest and wetland ecosystems. The district's land use and land cover reflect a balance between natural vegetation and limited agricultural activity, with forests and grasslands dominating the landscape. The district is ecologically diverse, with extensive **forest cover (52.8%)**, **grassland (30.7%)**, and **wetlands (12.5%)**. They provide critical ecosystem services, such as water regulation, biodiversity habitats, and fuelwood. However, these ecosystems have experienced significant degradation due to deforestation, charcoal production, soil degradation, water scarcity, and waste pollution. Accelerated levels of environmental degradation are mostly caused by the expansion of agricultural land and human settlements.[21] The rapid population increase in Obongi has led to a rise in demand for fuelwood, construction materials, and agricultural land.

As shown in *Map 3*, Obongi District's landscape is predominantly composed of forestlands (52.8 %). They stretch across the district and play a vital role in providing fuelwood, timber, and construction poles, while also contributing to soil fertility and erosion control. They are therefore essential for both ecological stability and household energy needs. They also support key livelihood activities, such as livestock grazing and building materials. From 2021 to 2024, Obongi District lost the equivalent of 3% forest cover compared to the year 2000.[22] This loss in forest cover was caused by illegal logging for timber harvesting, charcoal burning, agricultural expansion and



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

firewood collection. Grassland covers approximately 30.7% of the total land area. Extensive grassland supports key livelihood activities such as livestock grazing and seasonal cultivation.

Cropland only makes up 0.8% of the district total, but remains crucial for subsistence farming, with crops such as tobacco, sorghum, maize, cassava and ground nuts forming the backbone of household food security and income generation. Cropland only makes up 0.8% of the district total, but remains crucial for subsistence farming, with crops such as tobacco, sorghum, maize, cassava and ground nuts forming the backbone of household food security and income generation. Built-up areas make up 3.2% of the district's land cover and include settlements, trading centres, and refugee zones.

Wetlands and open water bodies cover 12.5% of Obongi 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 and can therefore 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. This can result in their pollution with domestic and agricultural waste. Compared to many other districts in the West Nile Sub-region, Obongi District has a relatively high percentage of wetland cover (12.5%). This is explained by the district's geographic location along the River Nile and its tributaries. This creates extensive floodplains and seasonal swamps. These wetlands form part of the Albert Nile basin.

CLIMATE CONTEXT

This section presents an analysis of Obongi 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 planning.

Rainfall

Obongi District experiences a unimodal rainfall pattern, with the main rainy season generally extending from March to October, followed by a distinct dry season from December to February. The long-term average (1981-2024), shown by the dashed line in *Figure 1*, shows a gradual onset of rainfall beginning in March, increasing through April and May, and peaking between August and October. The driest months remain January and February, each typically receiving less than 50 mm of rainfall. Average monthly precipitation totals decline again in November and December as the rainy season ends.

The long-term trend also indicates moderate intra-seasonal variability within the rainy season, with rainfall slightly lower around June compared to the peak months of August-October. Overall, rainfall is concentrated in the middle of the year, with the highest monthly totals occurring toward the end of the rainy season.

Year-to-year variation is visible 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 1981-2024 average during much of the rainy season, particularly in April, May, June, August, October and November. March, July, September and December recorded rainfall closer to the long-term mean and these were also the wettest months in 2022.
- **2023:** Rainfall showed mixed deviations from the long-term average. March, June, October and November recorded above average rainfall, while below-average rainfall was observed in February, April, May, July–September, and December.
- **2024**: Rainfall displayed more pronounced departures from the 1981-2024 average. Below-average rainfall was recorded during the early part of the rainy season, particularly in March to May. In contrast, July through September and November experienced substantially above-average rainfall, with pronounced peaks in August and September. December was markedly drier.

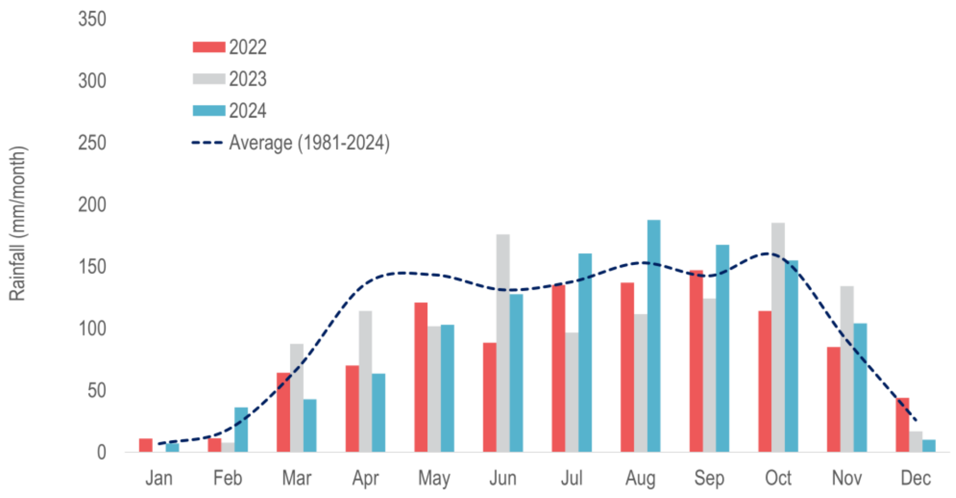


Figure 1: Graph showing Long-term Average Rainfall (2022-2024) in Obongi District.

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. 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, Obongi 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 events during the August-October peak can trigger flash floods, crop damage, and disruption of transport and livelihoods.

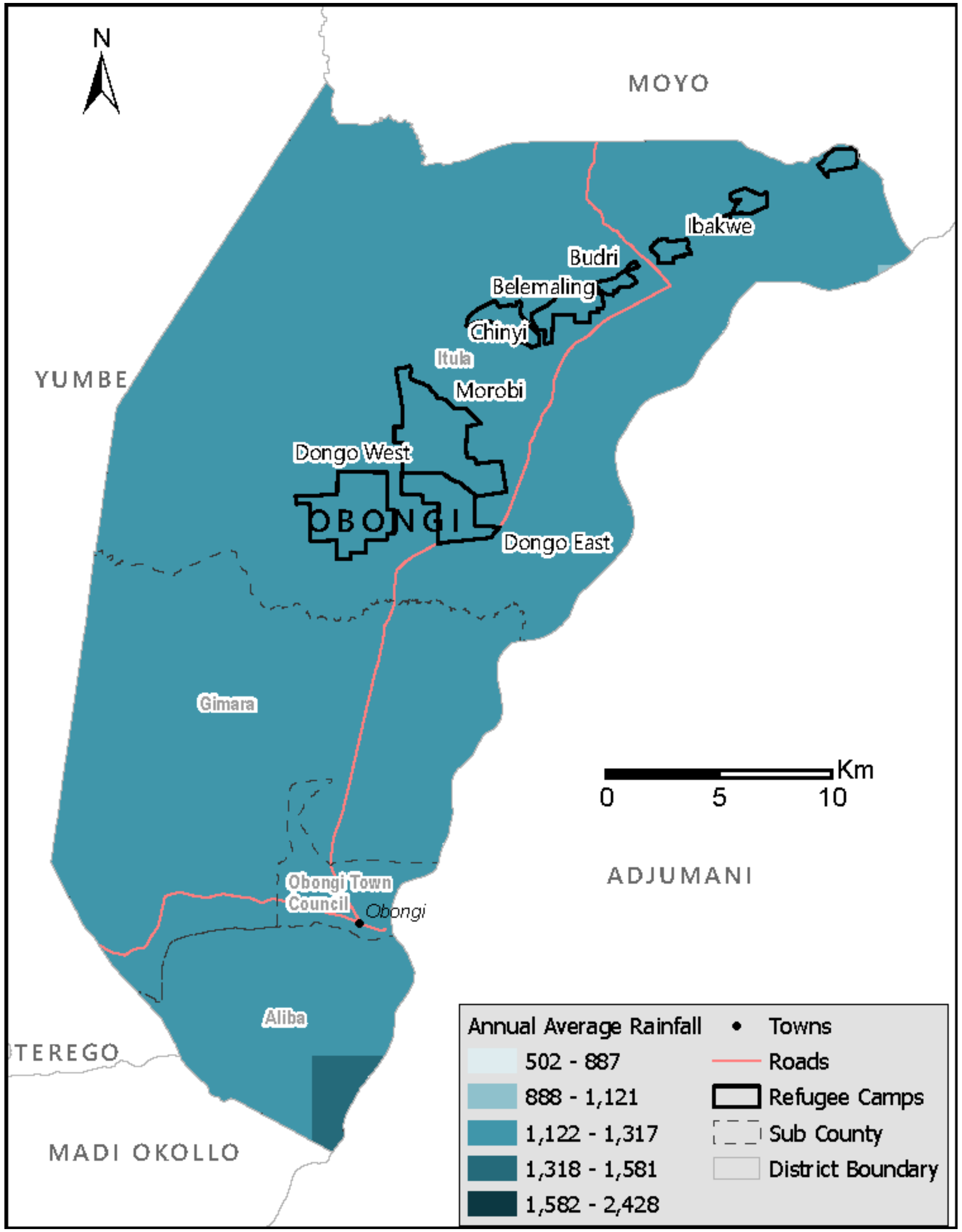
The dry season is also marked by high temperatures, often exceeding **29°C**, and low humidity, contributing to increased occurrences of seasonal drought and water stress. These conditions are exacerbated by land degradation and limited water infrastructure, affecting domestic use, livestock, and agricultural 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 shows the spatial distribution of **average annual rainfall in Obongi District** 1981 – 2024, derived from long-term CHIRPS precipitation data. The map indicates that most parts of Obongi District receive between **1,122 mm and 1,317 mm** of rainfall per year, while some southern areas near **Aliba and parts of the Albert Nile corridor** receive slightly higher rainfall ranging from **1,318 mm to 1,581 mm** annually. This suggests that the district generally experiences moderate to moderately high rainfall conditions, suitable for rain-fed agriculture, livestock grazing, and natural vegetation growth.

Rainfall distribution across the district appears **relatively uniform**, with most sub-counties such as **Dongo West, Dongo East, Morobi, Itula, and Gimara** falling within the **1,122 - 1,317 mm rainfall zone**. Areas closer to the **River Nile and southern sections of the district**, including **Aliba and Obongi Town Council**, experience **slightly higher rainfall levels**, which can support crop production but also increase the risk of **localized flooding in low-lying riverine areas**. Overall, the rainfall received in Obongi is generally sufficient to support **smallholder farming systems**, where households cultivate crops such as **cassava, maize, beans, sorghum, and groundnuts.**

However, rainfall patterns in Obongi District have become **increasingly variable in recent years**, with communities reporting **unpredictable onset of rains, prolonged dry spells, and occasional intense rainfall events**. These changes have disrupted the **traditional agricultural calendar**, making it harder for farmers to determine the best planting and harvesting periods. When rains arrive late or stop unexpectedly during



Map 4: Map showing Average Annual rainfall (1981-2024) of Obongi District.

the growing season, crops often experience **water stress**, leading to reduced yields.[24]

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.[25]

Periods of intense rainfall have occasionally caused flooding along the River Nile and in low-lying communities. For example, severe flooding in 2020 along the Nile affected several parts of Obongi District including **Aliba, Ewafa, Gimara, Itula, Palorinya, and Obongi Town Council,** displacing households and submerging farmland and homes. Reports indicated that about 1,734 households (approximately 13,083 people) were affected as floodwater destroyed crops, damaged infrastructure, and disrupted access to markets and social services.[26] In addition, heavy rains in the wider **Madi sub-region have periodically washed away roads and culverts**, limited movement and affecting trade and service delivery in Obongi and neighboring districts.

These rainfall changes reflect **broader climate variability across northern Uganda**, where alternating **dry spells and heavy rainfall events** are becoming more common. Such variability increases the **vulnerability of rain-fed farming systems**, particularly for households that depend heavily on seasonal rainfall for crop production and income.

Temperature challenges increasingly exacerbate livelihood pressures in Obongi District. While communities in the district are historically accustomed to relatively warm conditions, typical of the West Nile sub-region, rising temperatures and increased climate variability have intensified evapotranspiration, reduced soil moisture retention, and weakened the reliability of rain-fed farming systems. Agriculture remains the backbone of livelihoods in the district, with households cultivating crops such as cassava, maize, beans, groundnuts, and vegetables primarily for subsistence. However, these farming systems are becoming increasingly vulnerable to irregular rainfall and prolonged dry periods that affect crop growth and yields.[27]

Farmers in parts of Obongi and the wider West Nile Sub-region report that maize, beans, cassava, and simsim frequently dry up before maturity when rains delay or stop unexpectedly. In some seasons, crops planted early in anticipation of the rain have withered due to extended dry periods, resulting in significant losses and heightened food insecurity among smallholder households.[28]

Rising temperatures and water scarcity also place pressure on livestock production systems. During extended hot and dry periods, pasture availability declines and natural water sources become unreliable, forcing livestock keepers to travel longer distances in search of grazing areas and watering points. These conditions reduce livestock productivity and increase the risk of animal losses, particularly for households that rely on cattle, goats, or sheep as a key livelihood asset. Across the West Nile region, the combination of prolonged dry spells and irregular rainfall has contributed to declining pasture regeneration and growing stress on livestock production systems.[29.30]

Overall, the growing variability and unpredictability of climatic conditions pose increasing risks for livelihoods in Obongi District. Changes in temperature, rainfall patterns, and extreme weather events influence crop productivity, water availability, and pasture regeneration. These challenges are compounded by population pressure, environmental degradation, and the limited availability of irrigation infrastructure, leaving both refugee and host communities highly dependent on increasingly unreliable rain-fed agricultural systems.

Temperature

Over the past four decades, Obongi District has experienced a significant rise in temperatures, with an increase of approximately **2.6°C to 3.0°C,** a substantial warming trend for a single district. As shown in *Figure 2* Obongi District exhibits a clear long-term trend from 1981 to 2023, with the most pronounced increases occurring in the recent years, suggesting an acceleration in warming and a rising risk of heat related extremes.

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

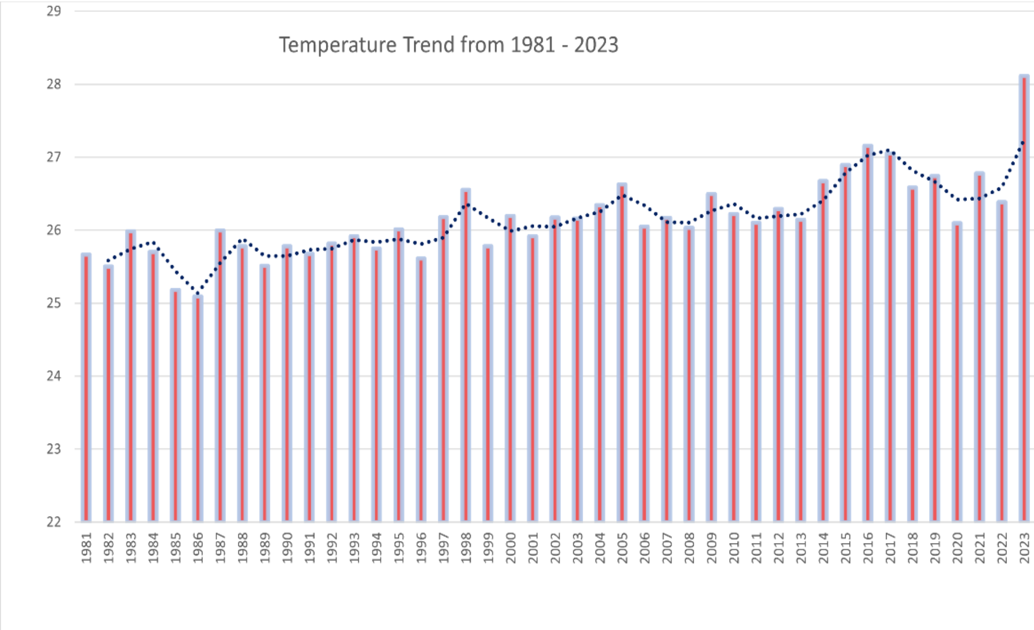


Figure 2: Graph showing the Long-term Temperature Trend (1981-2023)

- **1980s-mid 1990s:** Average annual temperatures remained relatively stable generally hovering between about **25.1°C and 25.9°C**, with minimal year to year variability and no strong warming trend.
- **Late 1990s-2014**: Average annual temperatures began to increase gradually, with several warmer years reaching **around 26.0°C and slightly above**. While the warming signal remained moderate, this period represents the initial shift away from the earlier stable temperature to the beginning of a longer-term warming pattern.
- **2015 onwards:** A more pronounced and sustained warming trend becomes evident after 2014, accompanied by greater inter-annual variability. Many years during this period recorded temperatures above 26.5°C, with noticeable peaks around 2016-2017. After a short phase of relative moderation between 2018 and 2021, temperatures increase again sharply, culminating in 2023 as the warmest year in the record, exceeding 28°C. This consistent upward trend highlights the growing climate stress in the region, with implications for agriculture, water availability, health and overall resilience.

This consistent upward trend reflects increasing climate warming in the district, which may **intensify heat stress, evapotranspiration, and pressure on water and agricultural systems, highlighting growing climate risks for livelihoods, food production, and community resilience.**

Seasonal temperature patterns in Obongi District show consistently warmer conditions during the **December-March dry and early transition period**, when clear skies and strong solar radiation drive temperatures well above the long-term average. Temperatures then decline gradually from **April through August**, reaching their lowest levels around **July-August**, before increasing again from **September to December** as the district transitions back toward the dry season.

The long-term monthly temperature average (1981-2024), represented by the dashed line in *Figure 3,* shows a clear seasonal cycle. Temperatures peak at the beginning of the year (January - February), decline steadily through the mid-year months, and begin rising again toward the end of the year (October- December). Compared to rainfall variability, seasonal temperature fluctuations remain relatively moderate, with slightly cooler conditions typically occurring during the peak rainfall months.

Recent observations (2022–2024) indicate persistent warming relative to the long-term average, particularly during the early months of the year and the crop growing seasons. The recent monthly temperature trends can be summarized as follows:

- **2022:** Monthly temperatures during the first season flowering period (April-May) were above the long-term average, while temperatures during the second season (around September) remained closer to the long-term average.

- **2023:** Temperatures during the first season flowering stage were above the long-term average in May, while the second season recorded above-average temperatures in August - September, indicating warmer conditions during early crop establishment.

- **2024:** Temperatures during the first season growing period (April - June) were consistently above the long-term average, while the second season again recorded above-average temperatures in August - September, reflecting sustained warming across both agricultural seasons.

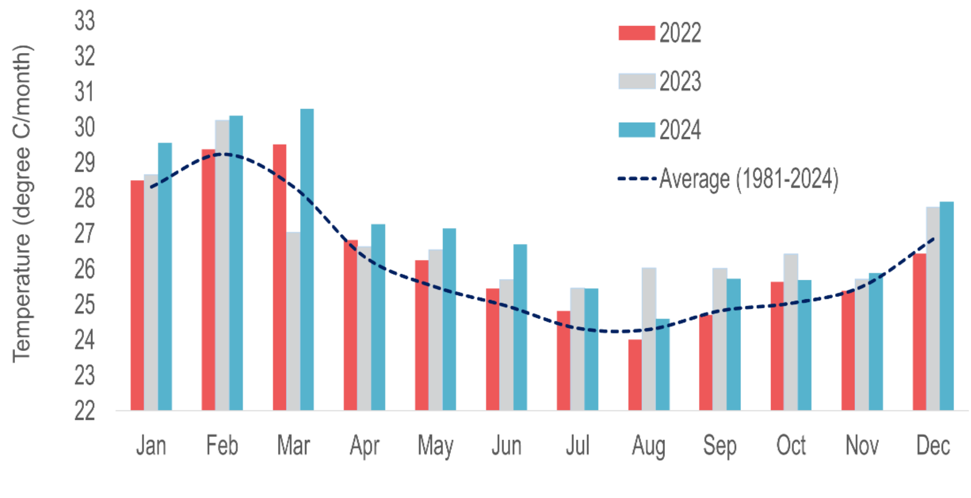


Figure 3: Graph showing average annual temperature (2022-2024) of Obongi District.

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, 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 pattern suggests that the **recent years are experiencing warmer conditions during key crop growth stages**, which may increase **heat stress on crops, accelerate soil moisture loss, and place additional pressure on rain-fed agricultural systems** in Obongi District.

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, 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 indices are expected to shift in coming decades, highlighting potential impacts on ecosystems, agriculture, and water resources under a moderately warming future.

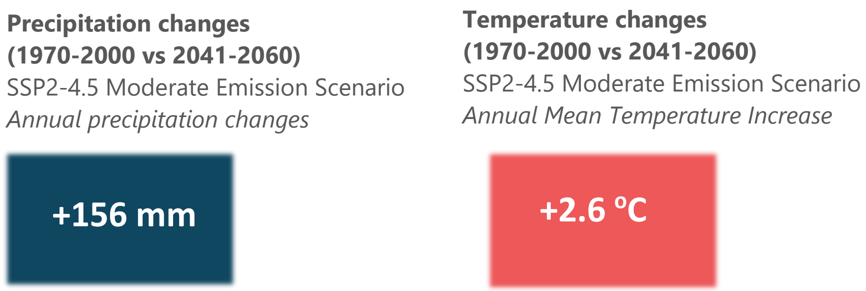


Figure 2: Annual precipitation and temperature changes in Obongi District.

Temperature

The mean annual temperature is projected to rise from **26.1°C** in the historical baseline to **28.7°C** by 2041-2060. Both minimum and maximum temperatures show substantial increases. The strongest warming **(up to 2.60-2.61°C)** is expected in the sub-counties of **Gimara, Itula (Palorinya Chinyi) and Itula (Palorinya Morobi)**. Sub-counties such as **Itula (basecamp, Belemaling, Dongo west and Budri)** are expected to experience slightly smaller increases **(~2.58°C**) but still exceed the districtwide warming trend.

An increase in mean temperature during both the **warmest month (+2.6°C)** and **driest quarter (+2.8°C)** indicates intensifying heat conditions during periods that are already hot and dry. This pattern points to heightened heat stress for people, crops, and livestock, increased evapotranspiration rates, and reduced soil moisture retention.

At the same time, mean temperatures are projected to rise in the **coldest month (+2.7 °C)** and the **wettest quarter (+2.7 °C)**, indicating pronounced warming during historically cooler and wetter periods. This suggests a reduction in seasonal cooling and persistently higher temperatures even during months that are traditionally cooler, contributing to overall warmer conditions throughout the year.

Together, these trends indicate year-round warming across both dry and wet seasons, with implications for heat exposure, evaporation, and pressure on climate-sensitive systems throughout the year.

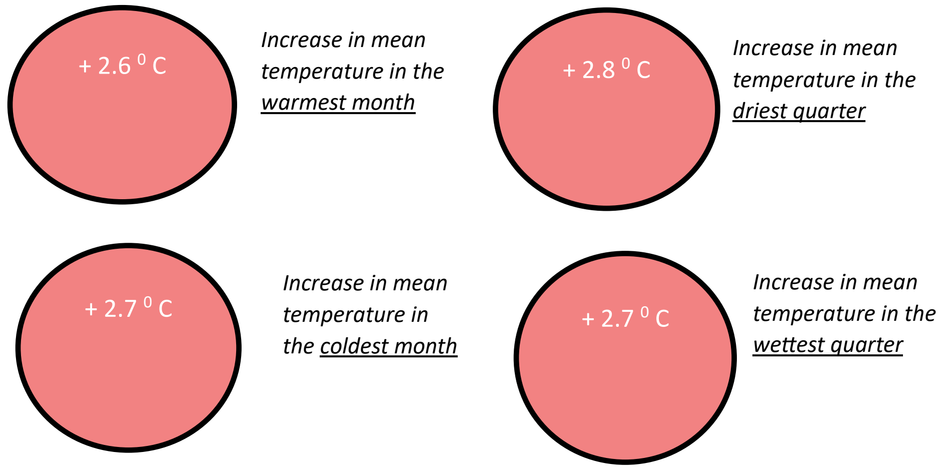


Figure 5: Projected changes in temperature in bioclimatic variables of Obongi District

Precipitation

Mean annual rainfall is projected to increase from **1,156 mm to 1,312 mm** by mid-century. However, the distribution of rainfall gains is uneven across the district. The largest precipitation increases **(156-157 mm**) are expected in **Itula, Obongi town council and Gimara**, while areas such **as Palorinya Ibakwe (basecamp), Aliba and Palorinya Belemaling** show smaller increases **(153-154 mm).**

An increase in precipitation during both the **wettest month (+39 mm)** and the **warmest quarter (+17.6 mm)** indicates more intense rainfall during periods that are already wet and hot. This pattern suggests a higher risk of flooding, increased surface runoff, and potential soil erosion, which can affect crops, infrastructure, and water.

At the same time, an increase in precipitation during both the **driest month (+2.5 mm)** and the **coldest quarter (+58.5 mm)** indicates more rainfall during periods that are typically dry and cooler. This pattern suggests a potential reduction in seasonal water scarcity, improved soil moisture availability, and enhanced water resources even during historically low-rainfall periods. Together, these patterns indicate both an intensification of peak rainfall and a redistribution of rainfall across the year, reflecting increasing intra-annual variability in precipitation and changing seasonal dynamics.

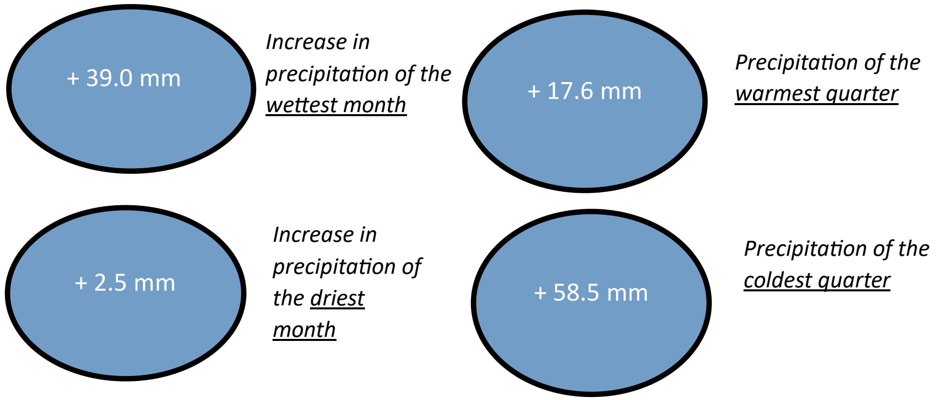
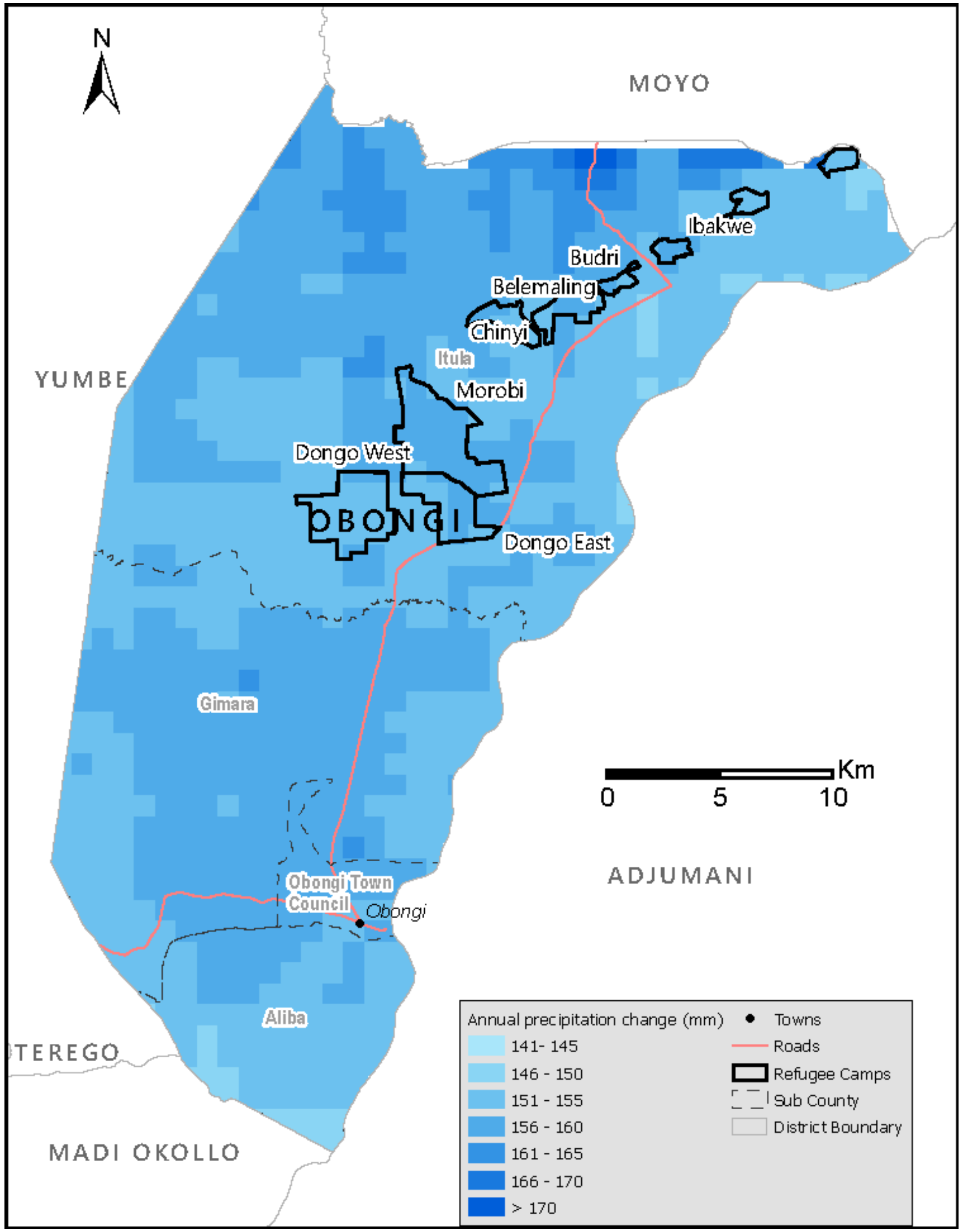


Figure 6: Projected changes in precipitation in bioclimatic variables of Obongi District



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

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Implications

The combination of rising temperatures, changes in seasonal rainfall patterns and moderate increases in annual precipitation creates a complex climate-hazard profile for Obongi District. Higher temperatures during both hot and dry periods are likely to increase **evapotranspiration**, which may offset the benefits of additional rainfall, limiting gains in **soil moisture and water availability**. Sub-counties with fragile or limited vegetation cover, such as **Gimara and Itula (Palorinya Chinyi)**, are likely to face rising exposure to **heat stress, seasonal drought, and water scarcity**. Northern sub-counties, which historically experience drier conditions, may become more vulnerable to **climate-related shocks** compared to southern sub-counties that receive larger rainfall gains. These changes have important implications for **agriculture, livestock production, water resources, and overall community resilience**, highlighting the need for targeted **climate adaptation strategies** across the district.

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 Obongi District fall within these ranges, indicating that the district is experiencing climate shifts. consistent with regional trends. This comparison reinforces the need for targeted adaptation measures, as increased rainfall intensity, elevated flood risk, and intensified heat stress may further affect agriculture, water resources, and overall livelihood resilience.

SEASONAL DROUGHT HAZARD ASSESSMENT

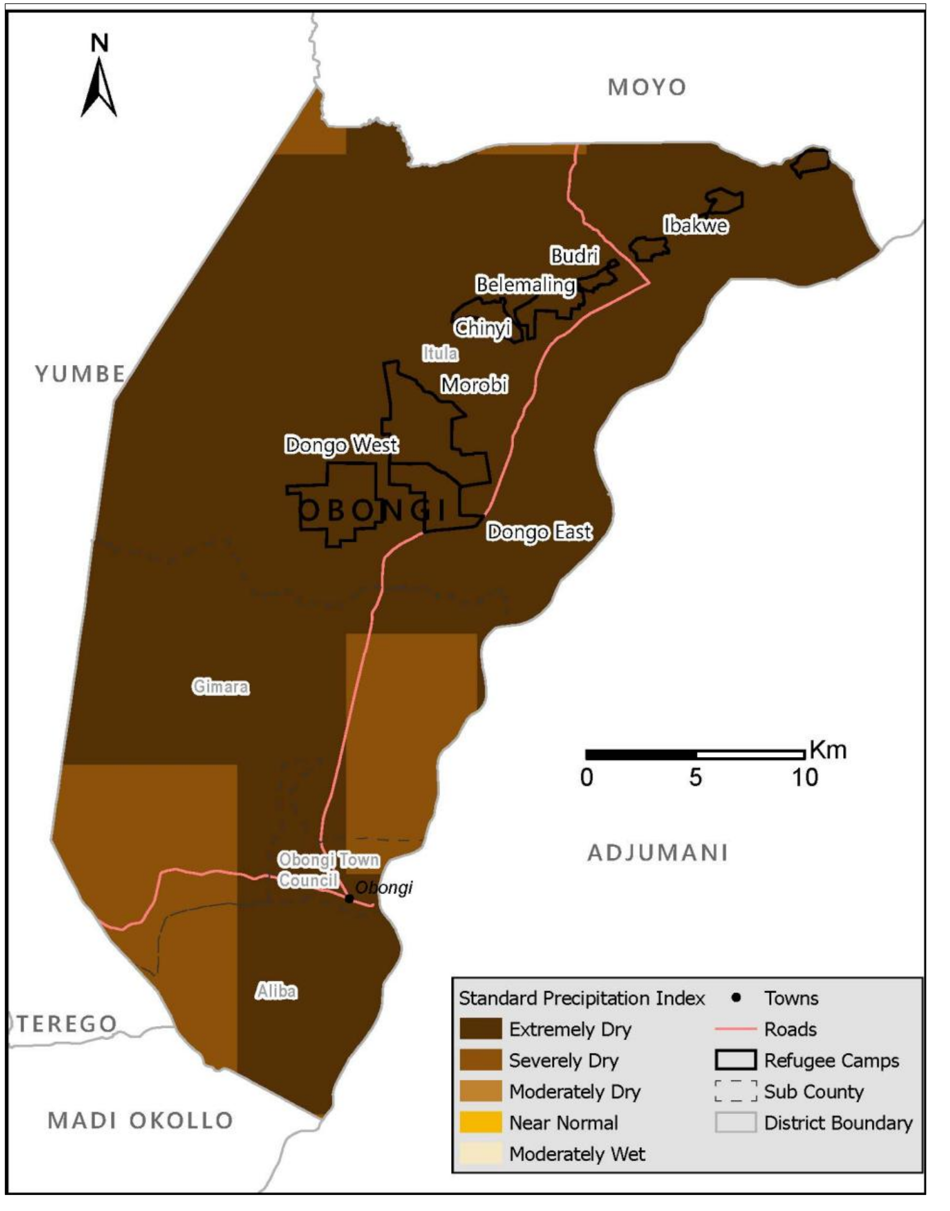
Obongi District has been experiencing increasing changes in climate, where rainfall patterns have become unpredictable. Prolonged dry spells and rising temperatures have grossly affected the first planting season, undermining agricultural production and household livelihoods in this predominantly rain-fed system.[33] Both host and refugee communities, including those in Lobule Settlement, 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). These conditions disrupt planting seasons, reduce yields, and intensify food insecurity.[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[3] 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 2023, when severe seasonal drought conditions hit Lobule Sub-county, resulting in crop failure, water shortages, and heightened humanitarian needs. 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.[35]

SPI Findings

The *Standardized Precipitation Index (SPI)* analysis shows that March-May 2024 was a critical month for measuring seasonal drought because this is the flowering season for first season crops. Much of the district recorded **extremely dry precipitation conditions**. Parts of the southern sub-counties like **Aliba, Gimara and Obongi town council** experienced severe dry precipitation conditions.[36] **Palorinya Refugee Settlement**, as shown in *Map 6*, **experienced extremely dry precipitation**



Map 6: Map showing the SPI Index.

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

conditions. These extremely dry precipitation conditions indicate substantial impacts on soil moisture availability, crop performance, rangeland conditions, and water access, particularly in areas overlapping with Palorinya Refugee Settlement, where livelihood systems are already highly sensitive to rainfall variability.

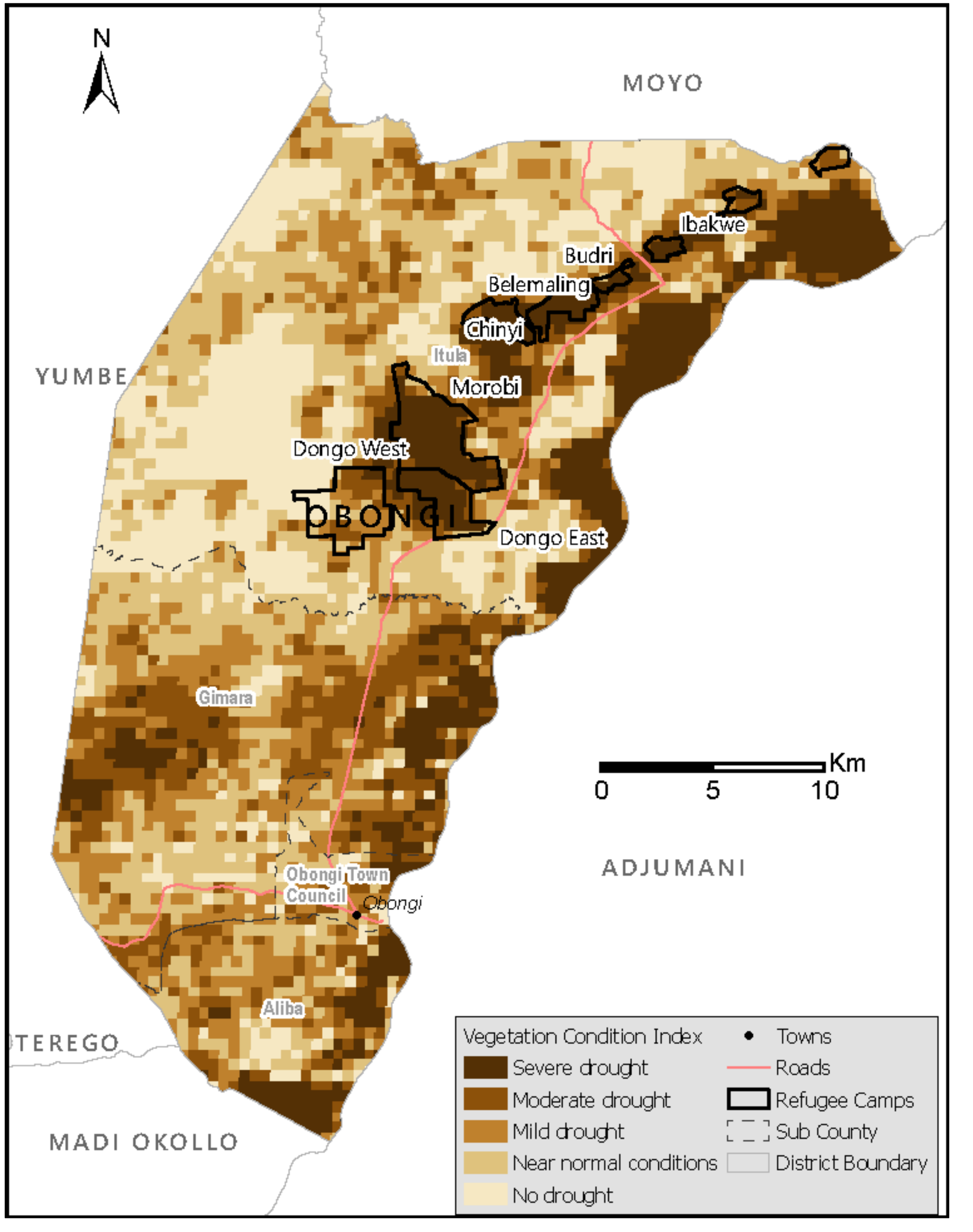
VCI Findings

The *Vegetation Condition Index (VCI)* results confirm widespread vegetation stress across Obongi District in March-May 2024, corresponding closely with the SPI-detected rainfall deficits. 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 Eastern and Southwestern parts of Obongi show moderate to severe vegetation drought, as represented by the darker brown tones on *Map 7*. **The Eastern and Southwestern parts of Obongi** show moderate to severe vegetation drought The **northeastern half of the district, including Itula Sub-county**, experienced extreme dry precipitation (*Map 6*). Containing cropland, grassland and built-up areas, this may reflect near true vegetation of severe drought as those areas are not far from wetland at lower elevations. In contrast, **the southern counties of Obongi, Aliba and Gimara** Sub counties, which had severe dry precipitation and contain scattered cropland and grassland, may show true variation of mild, moderate to severe vegetation droughts.

The **northeastern part** of the district, where the **Palorinya Refugee settlement** is located *(Map 7),* shows a **severe vegetation drought** because of more built-up area cover and extreme dry precipitations. 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 reveal that Obongi District is experiencing seasonal drought conditions that extend beyond short term rainfall deficits with implications across agriculture, food security, water resources, public health and socio-economic stability. The simultaneous occurrence of extremely dry SPI conditions and moderate to severe VCI stress across areas such **as Aliba, Gimara, Obongi Town Council and parts of Itula Sub County, including Palorinya Refugee Settlement, suggests heightened vulnerability during periods of rainfall deficit.**

These climatic stressors have observable real-world consequences. In **2021**, farmers in **Obongi District** reported that **unreliable rainfall patterns and short dry spells during key planting and flowering periods** disrupted crop growth and reduced expected yields for both **host communities and refugees**. Reports from the wider **West Nile sub-region**, which includes Obongi, have also documented **dry spells that withered staple crops, such as maize, beans, ground nuts, and cassava before maturity**. Farmers identified **unpredictable rainfall and prolonged dry conditions** as major constraints on agricultural production and harvest outcomes.[37] Reports from the wider **West Nile sub-region**, which includes Obongi, have also documented **dry spells that withered staple crops such as maize, beans, ground nuts, and cassava before maturity**. Farmers identified **unpredictable rainfall and prolonged dry conditions** as major constraints on agricultural production and harvest outcomes.[38]

Water scarcity linked to seasonal drought has far-reaching implications for **household welfare, public health, and community resilience**. Limited access to reliable water sources can constrain **domestic use, hygiene, and sanitation practices**, increase the risk of **water-related illnesses and place additional pressure on local health systems**. Evidence from the **West Nile sub-region** indicates that many households rely on **distant or unprotected water sources**, a challenge that becomes more acute during dry periods when water availability declines. [39]At the same time, **rainfall deficits and prolonged dry spells** have been shown to contribute to **soil moisture stress and crop losses**, reducing food production and weakening households' livelihoods across northwestern Uganda.[40] Together, these dynamics highlight how seasonal drought conditions can simultaneously affect **water access, health outcomes, and livelihood stability.**

Photo 1: West Nile Locals Face Starvation as Drought hits Crops and Animals. Photo Credit: Africa Press.

A prolonged **dry spell in 2022** severely affected communities across the **West Nile sub-region**, including **Obongi District**, leading to widespread crop failure and food insecurity. The drought caused key staple crops such as **maize, groundnuts, sim-sim, beans, and cassava** to wither before maturity, leaving many farmers without a harvest. Residents reported that rainfall patterns had become increasingly **unpredictable**, disrupting normal farming seasons. As crops failed, many households faced **food shortages and rising hunger**, with some families forced to rely on loans or sell livestock to survive. The drought also reduced the availability of **pasture and water for animals**, affecting livestock production and household income. Farmers and local leaders called for the establishment of **irrigation schemes in low-lying areas such as Obongi and Rhino Camp** to reduce dependence on unreliable rainfall and strengthen resilience to future droughts. **Source:** Africa Press - West Nile locals face starvation as drought hits crops, animals - Uganda

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 seasonal drought episodes, and improve resource allocation for both immediate response and long-term climate resilience across Obongi District.

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.

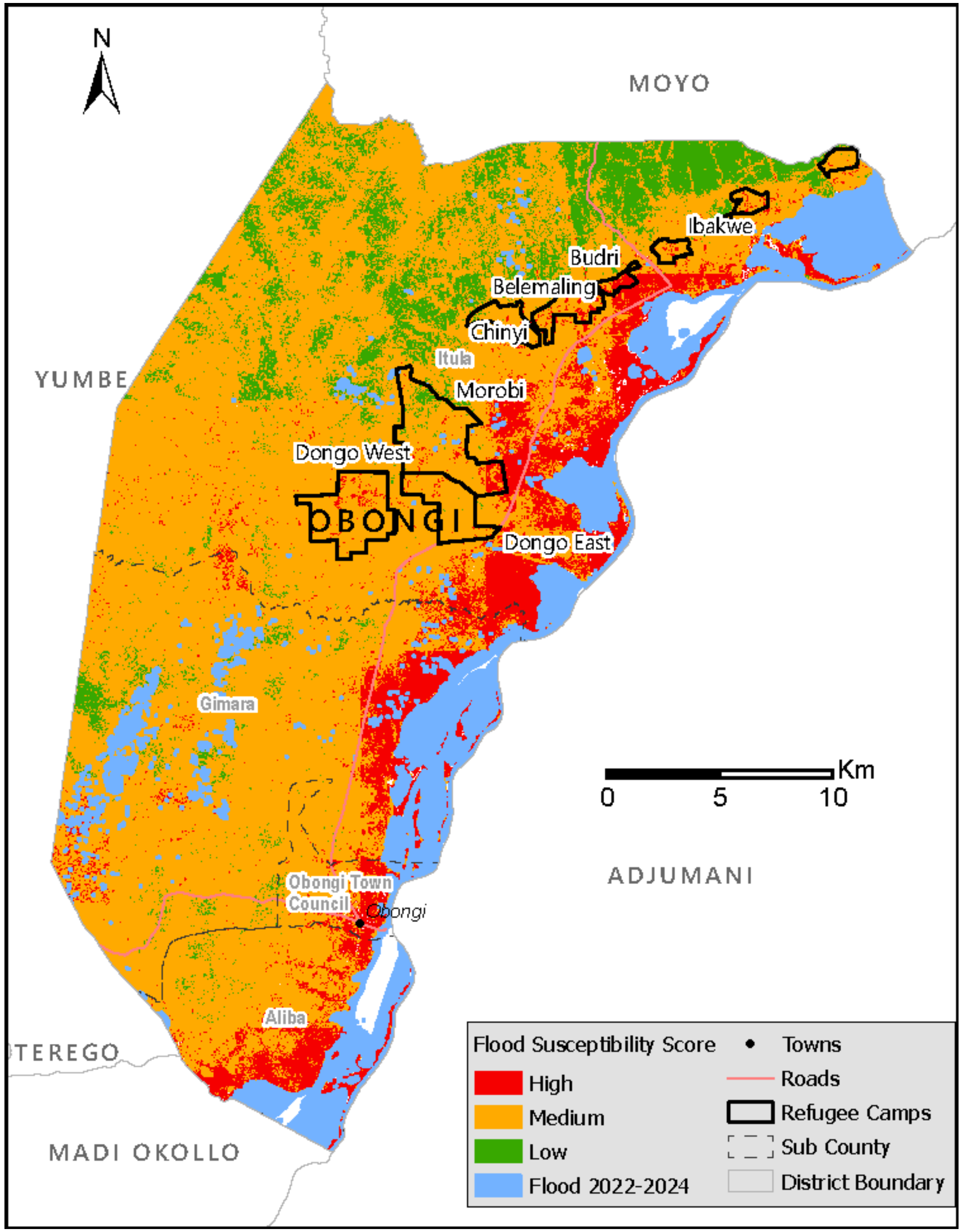
Hydro-climatic indicators such as rainfall intensity, frequency of continuous rainfall days, and flood return periods are equally vital in flood risk assessment. Literature shows that extreme rainfall events, particularly when sustained over consecutive days, significantly increase flood hazards. Soil 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. More specifically, Obongi's landscape is a mix of flat plains and hills sloping towards the east, unstable clayey soils in slopy areas, and insufficient drainage infrastructure with limited water infiltration and increased surface runoff, particularly in low-lying areas and along seasonal streams.

Satellite-based assessments reveal that less than **19 % of Obongi District fall into high-risk flood areas**. Half of the western parts of Obongi District are **areas with higher risk to riverine flood**.[53] Their vulnerability stems from low elevation and proximity to seasonal river channels. Within the Palorinya Refugee Settlement, Dongo East, Morobi, Belemaling, Budri and Ibakwe in the western part are especially susceptible to flooding due to closeness to river Nile and lower elevation. These zones are situated on terrain that accumulates runoff during peak rainfall periods and overflowing of the Nile River, resulting in damage to shelters, latrines, and access roads. Such events disrupt humanitarian operations and pose significant public health risks, including water contamination.[54]

Flood risk is highest 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 around Kochi River (**Catchment covers 1640 km^2 across Obongi, Yumbe, and Moyo districts; originates in Obongi and Yumbe, flows to lowlands in Moyo**)** 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.[55] These conditions reduce infiltration and increase the likelihood of rapid accumulation of surface water following intense rainfall events.



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

Risk on Cropland and Settlement

The land cover analysis revealed that **grassland covers 30.6%, forest 52.8%, and built-up areas 3.2%, while cropland only covers 0.8 %.** Less than**19% of cropland falls within the high-risk flood zone**. For built-up areas, this figure rises to 26%. 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 can therefore conceal substantial spatial concentration of impacts at local levels.

The *Land Use and Landcover Map* (*Map 3)* shows that most cropland cells are around Obongi Town, Palorinya Refugee Settlement and within the southern parts of the district. The *Land Use and Landcover Map* shows that most cropland cells are around Obongi Town, Palorinya Refugee Settlement and within the southern parts of the district. They fall within the medium- to high-risk flood zones, pointing to exposure for households cultivating around floodplains and poorly drained depressions. For these households, 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 Obongi Town and Palorinya Refugee Settlement, tend to be within the range of medium to high-risk flood zones.

Overall, the findings indicate that flood risk in Obongi is spatially concentrated in specific terrain and soil types and closely linked to settlement patterns. Urban expansion occurred without a structured and adequate plan to manage stormwater, leaving the concentrated runoff to carve out large gullies. Effective flood risk management will require targeted interventions around the Kochi Catchment, such as planting of trees, buffer zone demarcation, improved drainage infrastructure, and viable alternatives for income-generating activities like **apiary (beekeeping), aquaculture (fish farming), and fruit farming**. This is specifically targeted at those engaged in sand mining along the riverbanks. Integrating flood hazard information and unstable soil management **to reduce landslide** into land-use planning and settlement management is essential for reducing vulnerability, particularly in flood-affected sections of the Palorinya Refugee Settlement. 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-related landslides.

Flood Impacts

Flooding in Obongi District has had multidimensional socio-economic and environmental impacts. Flash flood and hailstones inundation has led to damage of crops and agricultural land, disrupting food production and household income for both host and refugee communities.[56] Access roads, especially the Sinyanya-Adjumani road and footpaths in flood-prone areas, become impassable during heavy rainfall, affecting mobility and access to markets, schools, and health facilities.[57] Floods have also killed livestock, contaminated water sources and damaged sanitation facilities, increasing the risk of waterborne diseases particularly within the built-up areas affected by landslides.[58]-up areas affected by landslides.[59]Access roads, especially the Sinyanya-Adjumani road and footpaths in flood-prone areas, become impassable during heavy rainfall, affecting mobility and access to markets, schools, and health facilities.[60] Floods have also killed livestock, contaminated water sources and damaged sanitation facilities, increasing the risk of waterborne diseases particularly within the built-up areas affected by landslides.[61]

Photo 2: Flooded River Nile displace locals in Obongi district. Photo Credit: Newsflare.

In 2020, severe flooding along the **River Nile** caused widespread disruption in communities across **Obongi District**, particularly in areas such as **Aliba, Ewafa, Gimara, Itula, Palorinya, and Obongi Town Council**. The floods, triggered by prolonged heavy rains and rising Nile water levels, **submerged large areas of farmland and settlements**, forcing many households to abandon their homes. In Obongi alone, about **1,734 households (13,083 people)** were affected by the disaster. The flooding destroyed crops, cut off transport routes, and damaged infrastructure, limiting access to markets, schools, and health facilities. Many families lost their **farmland and livelihoods**, forcing them to seek shelter on higher ground or depend on relatives and humanitarian support. The disaster highlighted the growing vulnerability of riverine communities in the **Madi sub-region** to recurrent flooding and climate variability

Source: Monitor UG - Madi's vanishing lands: How 2020 floods disrupted life along the Nile

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

Conclusion

The findings of this geospatial analysis highlight the influence of climate-related hazards on both refugee and host communities in Obongi District. Over the assessment period, **the district has experienced seasonal drought conditions and localized flooding, which together pose major risks to agricultural productivity, water availability, and settlement infrastructure**. The SPI and VCI analyses reveal spatially spread vegetation stress and rainfall deficits controlled by elevation and landcover type, especially during the 2023 crop flowering for first season. Flood mapping indicates high exposure in low-lying sub-counties, such as Obongi Town. Within the **Palorinya Refugee Settlement, Dongo East, Morobi, Belemaling, Budri and Ibakwe** are especially susceptible to flooding due to proximity to River Nile and lower elevation compared to the western parts of the district. These findings underscore the need for targeted adaptation measures including improved water resource management, resilient agricultural practices, and settlement planning to avoid encroachment into wetland, safeguard livelihoods and enhance resilience for both refugee and host populations

Methodology Overview

The climate hazard assessment for Obongi 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[62] under the SSP2-4.5 scenario, processed using the same bioclimatic variables to ensure comparability with the historical baseline.[63]

Drought assessment followed UN-SPIDER protocols[64], using SPI calculated in Google Earth Engine (GEE)[65,66] from CHIRPS rainfall data[67] (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.[68] 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.[69] 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 Lobule Refugee Settlement in Obongi 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 Obongi (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.[70]

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.[71]

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.[72]

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.[73]

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[74]

Exposure: The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.[75]

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 risk capacity.[76]

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).[77]

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

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