



UGANDA NATIONAL METEOROLOGICAL AUTHORITY

THE STATE OF CLIMATE OF UGANDA IN 2022

UGANDA NATIONAL METEOROLOGICAL AUTHORITY

HEAD OFFICE:
Luzira, Plot 22 -28
Port Bell Road, Kampala, Uganda

Tel: +256 414 251798
Fax: +256 414 251797
Email: info@unma.go.ug



Mandate

Uganda National Meteorological Authority (UNMA) is mandated to promote, monitor weather and climate as well as provide weather predictions and advisories to Government and other stakeholders for use in sustainable development.

Mission

To contribute to overall national development through provision of quality customer focused, cost effective and timely information for weather and climate services to all users.

Vision

To be a centre of excellence on Weather and Climate services for sustainable development of Uganda

FOREWORD

The Uganda National Meteorological Authority (UNMA) has a mandate to provide authoritative information about weather and climate over Uganda. The Authority, through its Directorate of Training and Research, conducts an annual assessment of the state of climate over Uganda.

The assessment of the annual state of climate revealed that the year 2022 was the fifth warmest on record over Uganda since 1950, after 2019 and 2009, 2021, and 2020 in that order. The rate of increase of temperature during the 1950 to 2022 period was found to be ~ 0.23 °C/decade. Considering the last thirty-two years alone, the rate of temperature rise is slightly higher, at a rate of ~ 0.25 °C/decade.

The observed extreme weather and climate events during 2022 led to flooding that affected thousands of people across the country. The impacts were so devastating and included loss of life and property, destruction of infrastructure, and landslides, among others.

Nearly 2,465 people lost their lives due to hunger/starvation as prolonged droughts caused crop failures in northeastern Uganda (Karamoja sub-region). And more than 26 people were killed, while 4000 persons displaced by landslides/mudslides in eastern and western Uganda as a results floods and, heavy storms in 2022.

Special thanks go to WMO for the continued support and the Ministry of Disaster Preparedness for the quick responses. UNMA's capability to provide timely and improved forecasts/predictions of such extreme events has gradually improved. This achievement may be reinforced with continued support from WMO, the Ministry of Water and Environment, other Government Ministries, and Development Partners.

UNMA welcomes suggestions from stakeholders to further improve the statement on the state of climate over Uganda to minimize the devastating impacts associated with extreme weather and climate occurrences.

.....
Bob Alex Ogwang (PhD.)
Ag. Executive Director, UNMA

THE HIGHLIGHTS FOR THE STATE OF CLIMATE OF UGANDA IN 2022

- ❖ The warming level in 2022 was $\sim 0.49^{\circ}\text{C}$ above the long-term mean value due to the base period: 1981 – 2010.
- ❖ Observed extreme weather and climate events during 2022 led to flooding that affected thousands of people across the country.
- ❖ The year 2022 was the fifth (5th) warmest on record over Uganda since 1950, after 2019, 2009, 2021, and 2020, in that order.
- ❖ The rate of increase of temperature during the period 1950-2022 was found to be $\sim 0.23^{\circ}\text{C/decade}$. Considering the last thirty-two years (1990-2022) alone, the rate of temperature rise is slightly higher, with a rate of $\sim 0.25^{\circ}\text{C/decade}$.
- ❖ Nearly 2,465 people were reported to have lost their lives due to hunger/starvation as prolonged droughts caused crop failures in northeastern Uganda (Karamoja sub-region). And more than 26 people were killed, while 4000 persons displaced by landslides/mudslides in eastern and western Uganda caused by floods and, heavy storms in 2022.

Prepared by:

Dr. Moses Ojara¹, and Dr. Godwin Ayesiga¹, et al

Supervised by:

Dr. Bob Alex Ogwang¹ (Ag. ED, UNMA).

¹Uganda National Meteorological Authority, Kampala, Uganda. Website: www.unma.go.ug

Correct Citation: UNMA, (2022). The State of Climate of Uganda in 2022.;
<https://unma.go.ug/resources/research-reports>

TABLE OF CONTENT

THE HIGHLIGHTS FOR THE STATE OF CLIMATE OF UGANDA IN 2022.....	iii
TABLE OF CONTENT	v
1. INTRODUCTION	1
2. KEY CLIMATE INDICATORS	2
2.1. National Temperature Assessment.....	2
2. 2. Regional Temperature Assessment	5
3. NATIONAL RAINFALL ASSESSMENT	17
3.1 The annual rainfall performance over Uganda in 2022	17
3.2. The Seasonal rainfall performance over Uganda in 2022	17
3.3 The annual percentage change in precipitation	20
3.5 Annual Rainfall Trends	22
3.6 Seasonal rainfall anomaly for 2022.....	23
3.7 Cross-section of the annual cycle of monthly precipitation	27
4.0 SAMPLED CLIMATE RISKS AND RELATED IMPACTS IN 2022	28
4..1 Extreme events and impacts in eastern Uganda	28
4.2 Extreme events and impacts in northeastern Uganda (Karamoja Sub-region)	30
4.3 Extreme events and impacts in western region.....	30
5.0 Summary and Conclusions	31
REFERENCES	32

1. INTRODUCTION

Uganda National Meteorological Authority (UNMA) is a semi-autonomous government institution under the Ministry of Water and Environment. It was established by an Act of Parliament (UNMA Act. 2012), and has a mandate to promote and monitor weather and climate as well as provide weather forecasts and advisories to Government and other stakeholders for use in sustainable development of Uganda.

UNMA's mission is to contribute to the overall national development through provision of quality customer focused, cost effective and timely information on weather and climate to all users contributing to the development of Uganda. This therefore requires that UNMA analyses and produces reliable weather and climate information, including warnings/advisories to support all sectors in the country.

The World Meteorological Organization (WMO) has been issuing the State of the Global Climate Report since 1993, where a document highlighting the main weather and climate events that occurred during a calendar year is published. At the regional level in Africa, WMO, African Centre of Meteorological Applications for Development (ACMAD) and the National Meteorological and Hydrological Services in Africa started the production of the State of the Climate Report for Africa in 2013 (WMO, 2015, 2017). ACMAD's State of Climate of Africa Report in 2018 was published based on datasets from the National Oceanic and Atmospheric Administration (NOAA) (Fan et. al, 2008 and Janowiak et. al, 1999, as well as Funk et. al, 2014). The publication has become a great contribution to the Global Framework for Climate Services (GFCS) and has become a useful document to support the African group of negotiators at Conference of Parties of the United Nations Framework Convention on Climate Change (UNFCCC-COPs).

UNMA started publishing the Annual State of the Climate of Uganda in 2017, 2018, 2019, 2020, and 2021 have been published. The document provides information to raise awareness and help in the formulation of plans and policies in the country since it reveals the extent of climate variability and climate change as of the year of interest compared to other years.

In this document, a summary of the main weather and climate events that occurred in Uganda during the calendar year of 2022 is provided. The major weather and climate events are documented using observed rainfall and temperature data in line with ACMAD and WMO, including reports from meteorological stations across the country.

2. KEY CLIMATE INDICATORS

2.1. National Temperature Assessment

The National Temperature Assessment reveals that 2022 was the fifth (5th) warmest year on record since 1950 over Uganda, after 2019, 2009, 2021, 2020 (Figure 1).

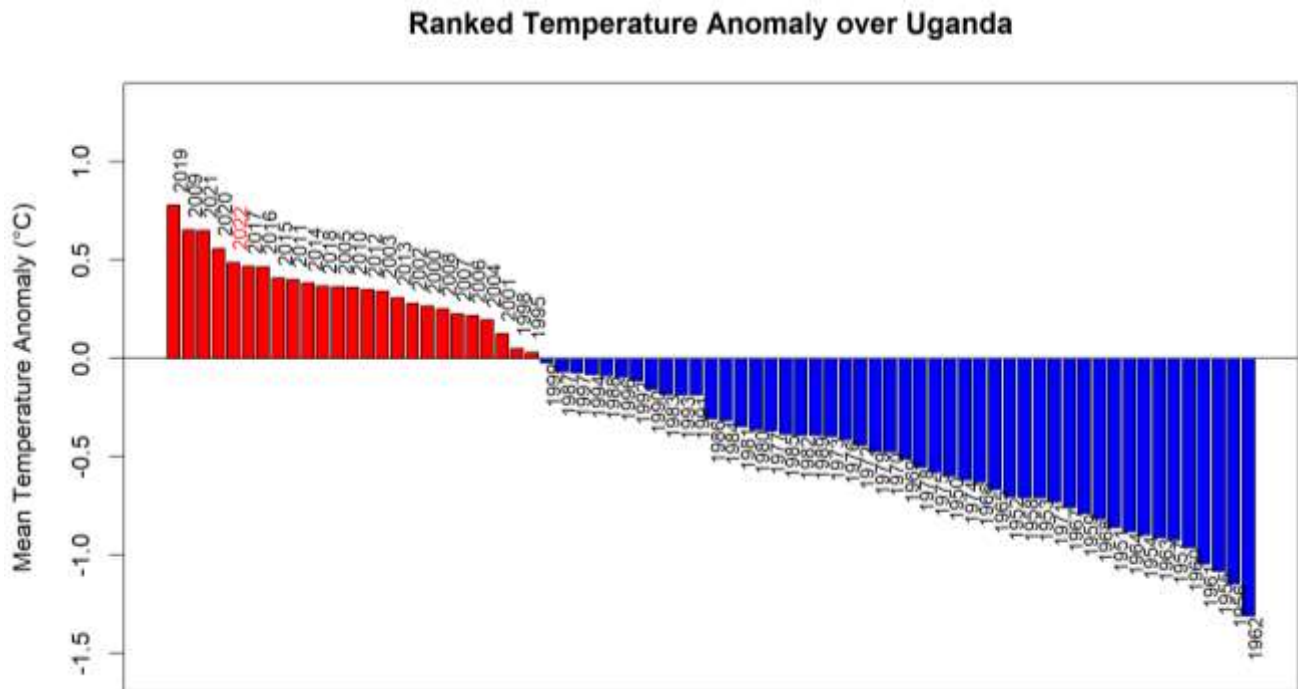


Figure 1: Ranked mean annual temperature anomalies (°C) over Uganda for the period 1950 - 2022 relative to climatology (1981-2010). Red color represents years with temperature anomalies more than the long-term mean value (climatology) and blue represents years with temperature anomalies less than the climatology.

Figure 2 reveals that there is a general warming trend over Uganda since 1950. The warming rate over the past 73 years was found to be about 0.23 °C/decade, compared to 0.25°C/decade over the recent 32 years (Figure 2).

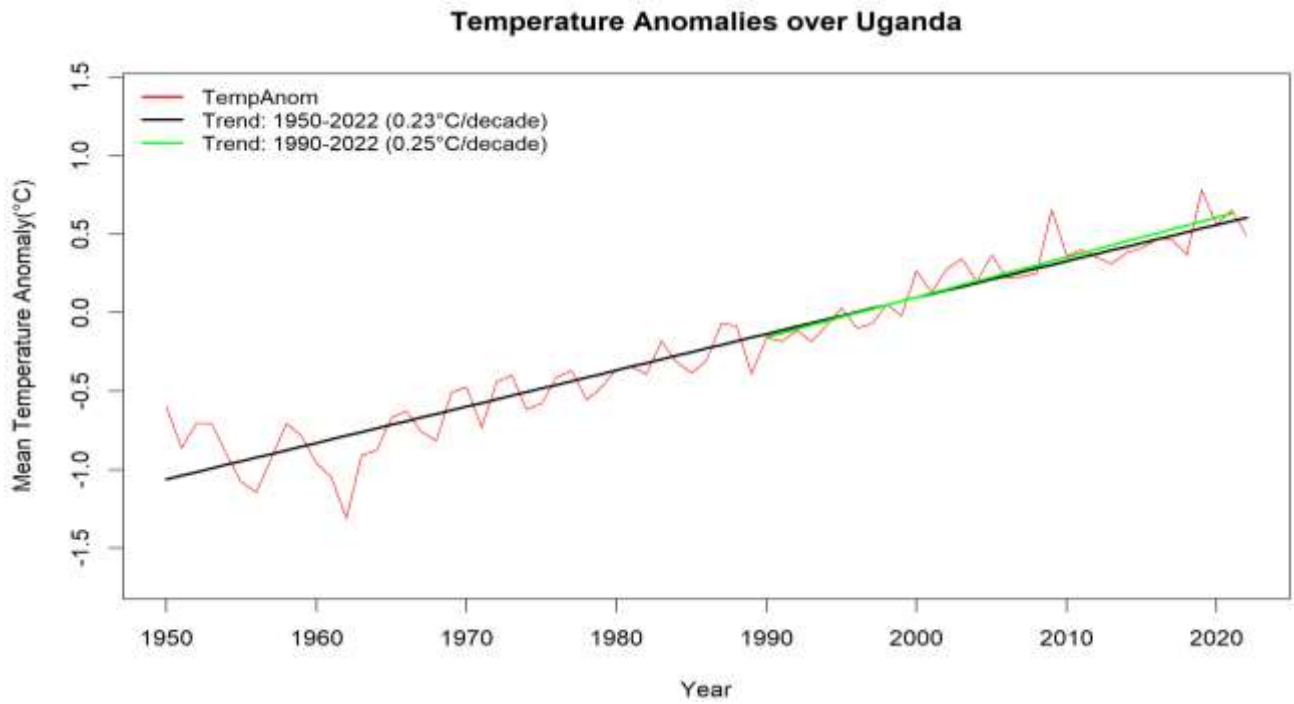


Figure 2: Trends in the mean annual temperature anomalies (°C) over Uganda for the period: 1950-2022 with respect to 1981-2010 reference period. Red color represents temperature anomalies, black color shows the trend line for the period: 1950-2022, and green represents the trend line for the period: 1990-2022.

Figure 3 reveals that all the 20 warmest years on record in Uganda were experienced in the last two decades. The increasing trends of temperature Uganda is associated with the frequent extreme events observed in the recent days.

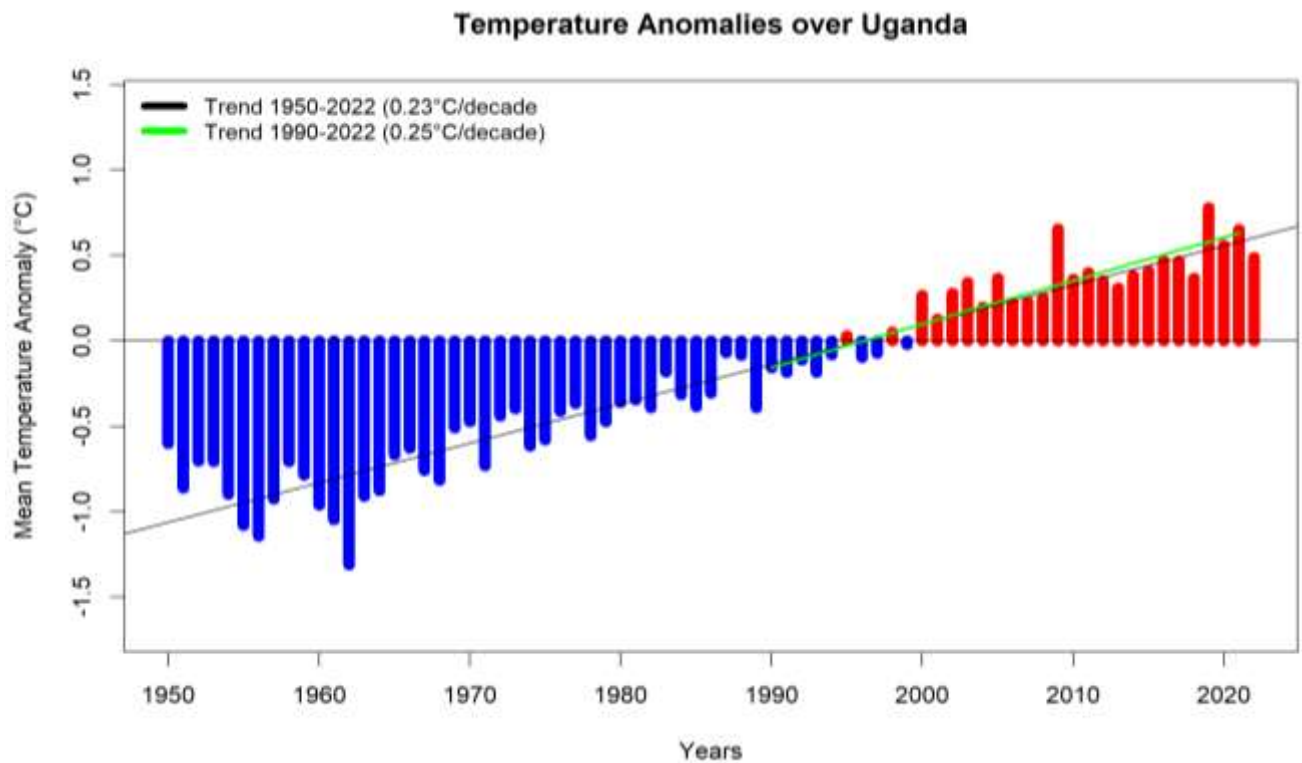


Figure 3: Temperature Anomalies (°C) over Uganda for period 1950-2022 and 1990-2022. Red color represents positive temperature anomalies, blue shows negative temperature anomalies, black color shows the trend line for the period: 1950-2022, and green represents the trend line for the period: 1990-2022.

The mean annual cycle of temperature provides the monthly evolution of temperature over Uganda in 2022 (Figure 4). A comparison is made between year 2019, 2020, 2022 and the long-term mean (Climatology -1981-2010), reveals that the observed temperature in 2019 over Uganda was well above average in except in October-December. The year 2022 recorded warmer temperature than the climatology in March, April and May. Similarly, all the three recent years, 2019, 2020 and 2022 recorded higher temperatures than the climatological period 2018-2022.

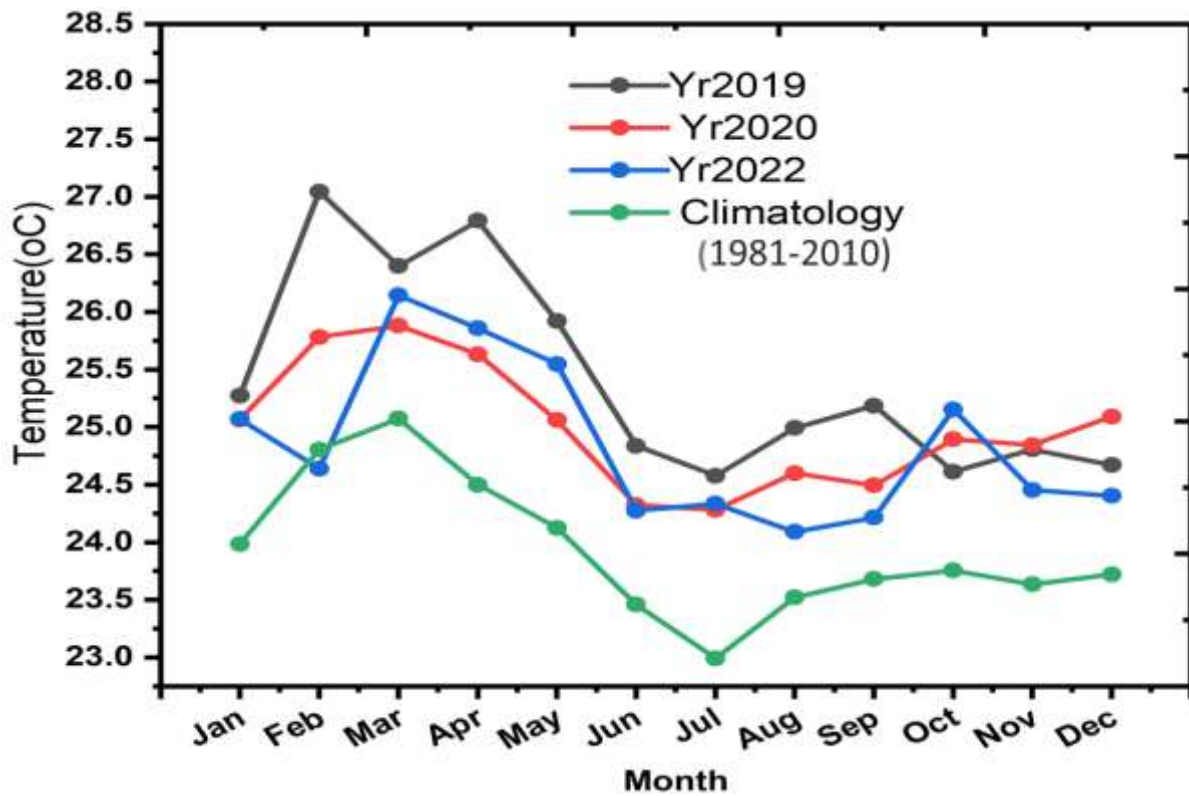


Figure 4. Mean annual cycle of temperature (°C) for year 2022 (blue) and the climatology (green) based on the reference period 1981-2010.

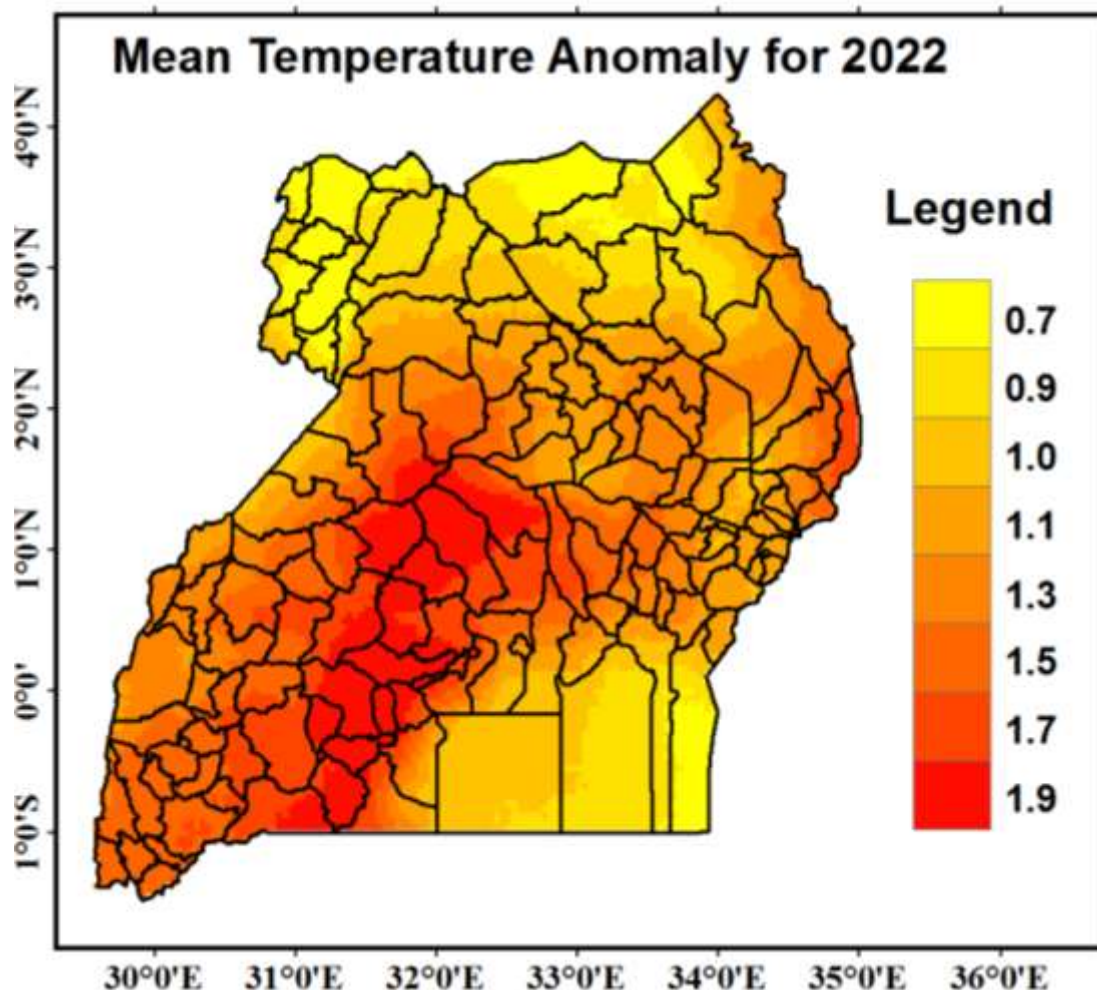


Figure 5 Mean annual temperature anomalies (°C) over Uganda in 2022 relative to 1981-2010 reference period.

2. 2. Regional Temperature Assessment

As in the previous reports of State of climate of Uganda; 2017, 2018 and 2019, 2020, 2021, temperature anomalies exhibited varying warming levels over the different sub-regions of Uganda. In this report, seven different sub-regions (Figure 6) were considered so as to capture localized climate variability and change; West Nile Region; Northern region; Karamoja region; Eastern Uganda; Central Uganda; Western Region; and Southwestern Region.

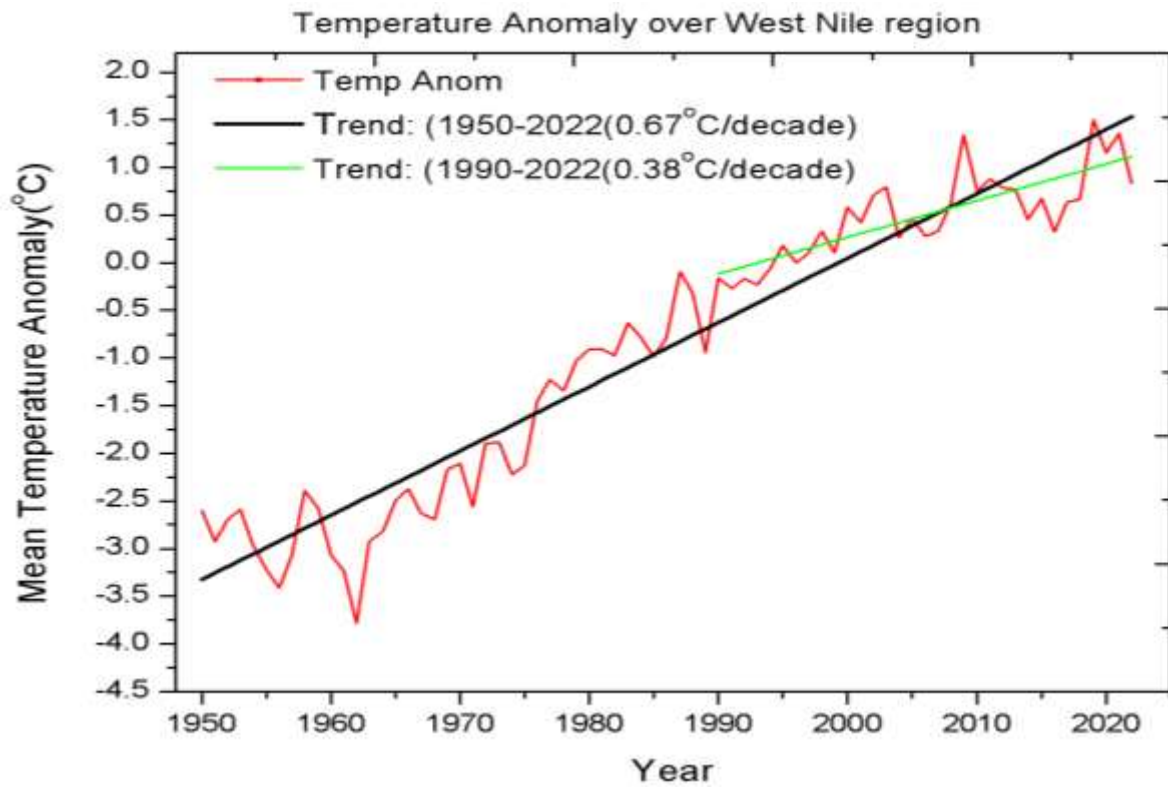


Figure 7: Trends in the mean annual temperature anomalies (°C) over West Nile Region for the period: 1950-2022 with respect to 1981-2010 reference period. Red color represents temperature anomalies, black color shows the trend line for the period: 1950-2022, and green represents the trend line for the period: 1990-2022.

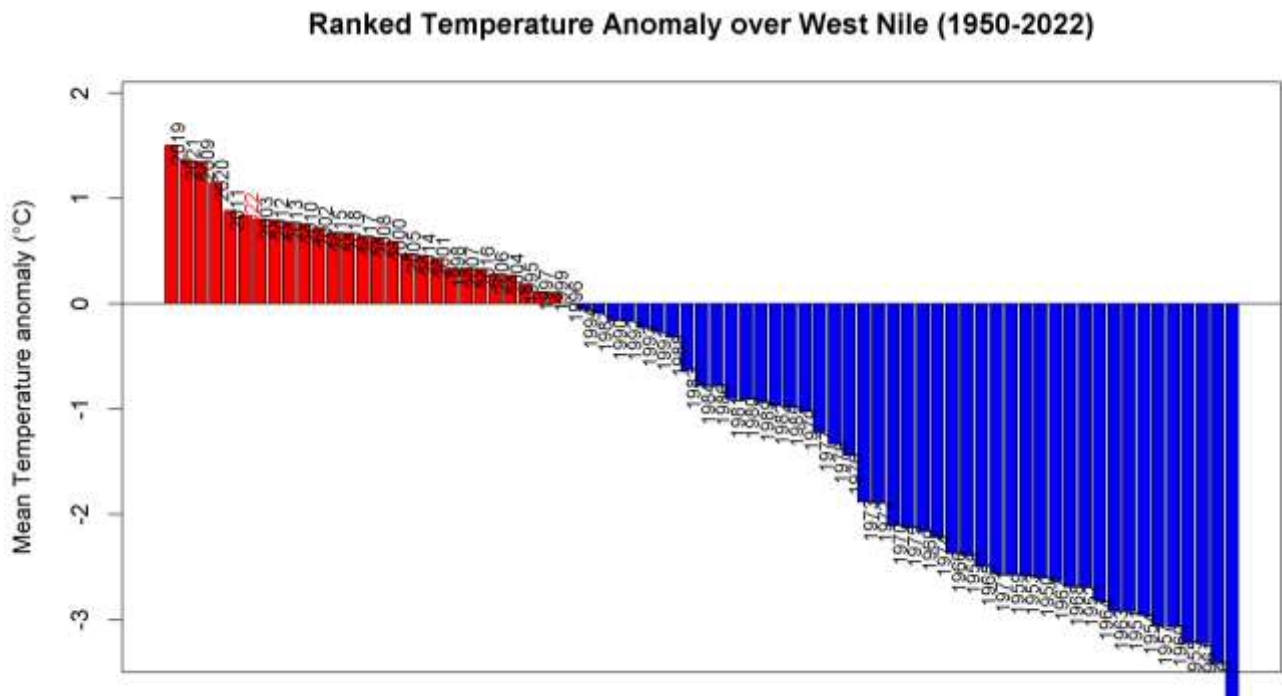


Figure 8: Ranked mean annual temperature anomalies (°C) over Uganda for the period 1950 - 2022 relative to climatology (1981-2010). Red color represents years with temperature anomalies more than the long-term mean value (climatology) and blue represents years with temperature anomalies less than the climatology. The year 2022 was the sixth warmest year on record after 2019, 2021, 2009, and 2011 in that order.

2.2.2 Northern region

The northern region covers the geographical latitudes; 2.3°N-3.8°N and longitudes 32.3°E-33.5°E, and districts such as Gulu, Kitgum, Pader, Lamwo, Agago, Lira, Kole, Kwanja, Nwoya, Oyam, Apac, Dokolo, among others (Figure 5). The rate at which temperature has been increasing in this region over the period 1950 to 2022 and 1990 to 2022 were found to be 0.54 °C and 0.46°C per decade, respectively (Figure 6).

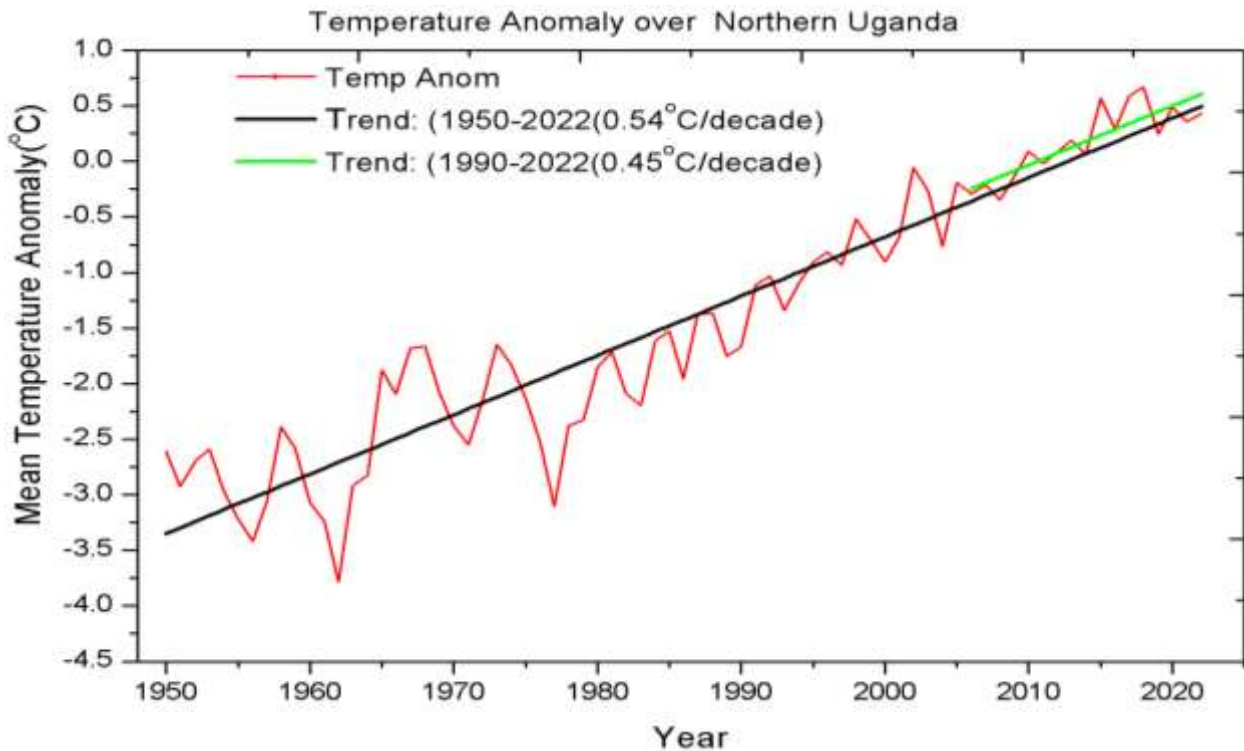


Figure 9: Trends in the mean annual temperature anomalies (°C) over Northern region for the period: 1950-2022 with respect to 1981-2010 reference period. Red color represents temperature anomalies, black color shows the trend line for the period: 1950-2022, and green represents the trend line for the period: 1990-2022.

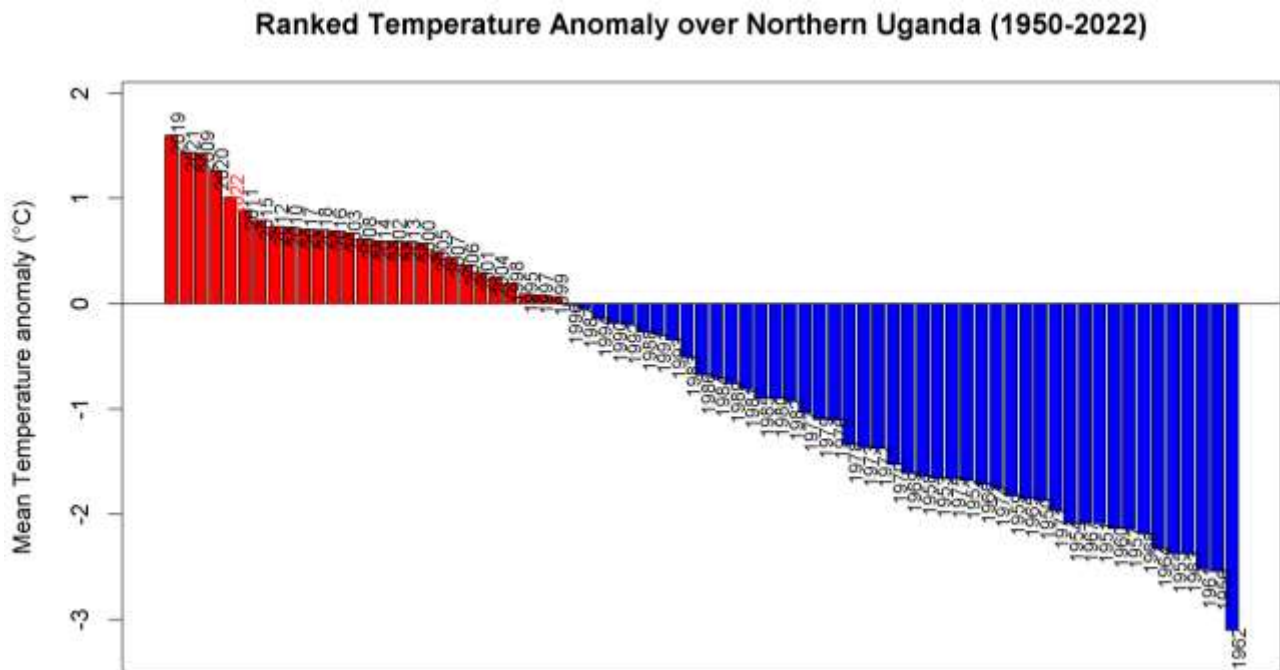


Figure 10: Ranked mean annual temperature anomalies (°C) over Uganda for the period 1950 - 2022 relative to climatology (1981-2010). Red color represents years with temperature anomalies more than the long-term mean value (climatology) and blue represents years with temperature anomalies less than the climatology. The year 2022 was the fifth warmest year on record after 2019, 2021, 2009, 2020 in that order.

2.2.3 Karamoja region

Karamoja region lies within the geographical latitude 2.5-4.2°N and longitude 33.5-35°E (Figure 6), and covers the districts such as Karenga, Kabong, Kotido, Moroto, Napak, Abim, Nakapiripirit, and Amudat. The rate at which temperature has been increasing in this region over the period 1950 to 2022 and 1990 to 2022 were found to be 0.37°C and 0.35°C per decade, respectively.

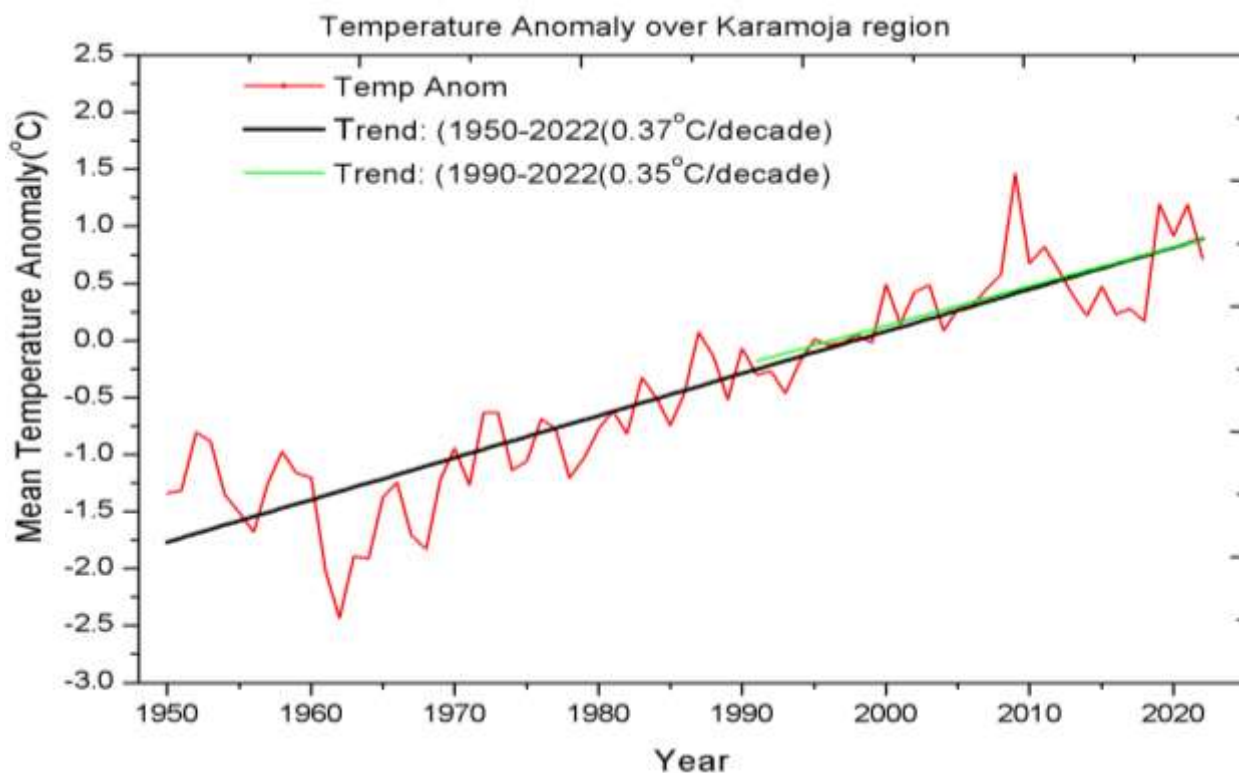


Figure 11: Trends in the mean annual temperature anomalies (°C) over Karamoja region for the period: 1950-2022 with respect to 1981-2010 reference period. Red color represents temperature anomalies, black color shows the trend line for the period: 1950-2022, and green represents the trend line for the period: 1990-2022

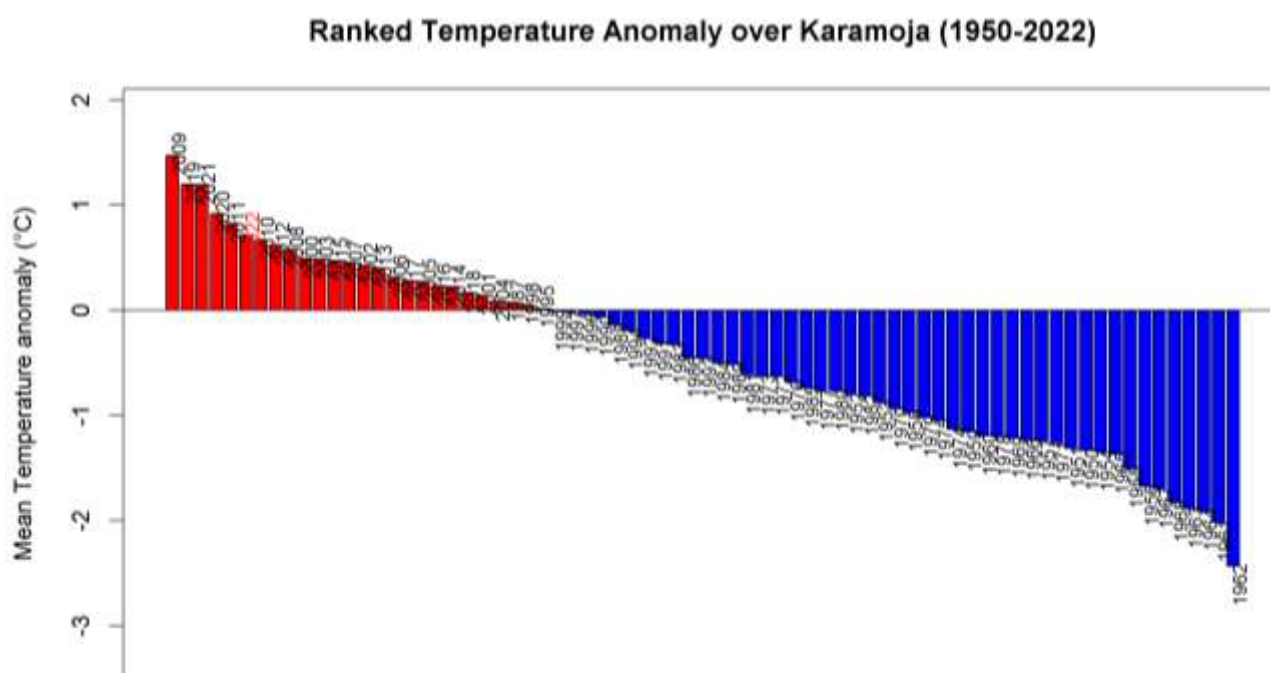


Figure 12: Ranked mean annual temperature anomalies (°C) over Karamoja for the period 1950 - 2022 relative to climatology (1981-2010). Red color represents years with temperature anomalies more than the long-term mean value (climatology) and blue represents years with temperature anomalies less than the climatology. The year 2022 was the sixth warmest year on record after 2009, 2019, 2021, 2020 and 2011 in that order.

2.2.4 Eastern Uganda

Eastern region is situated along the geographical latitudes; 0.25-1.5°N and longitudes 32.5-34.5°E. The region covers districts such as Soroti, Serere, Kumi, Pallisa, Kalaki, Katakwi, Tororo, Sironko, Budaka, Bududa Kween, Bukwo, and Ngoro, etc. (Figure 6). It is one of the most disaster-prone areas in Uganda, with a number of landslides, floods and droughts happening over the recent years. The rate at which temperature has been increasing in this region over the period 1950 to 2022 and 1990 to 2022 were found to be 0.20°C and 0.44°C per decade, respectively.

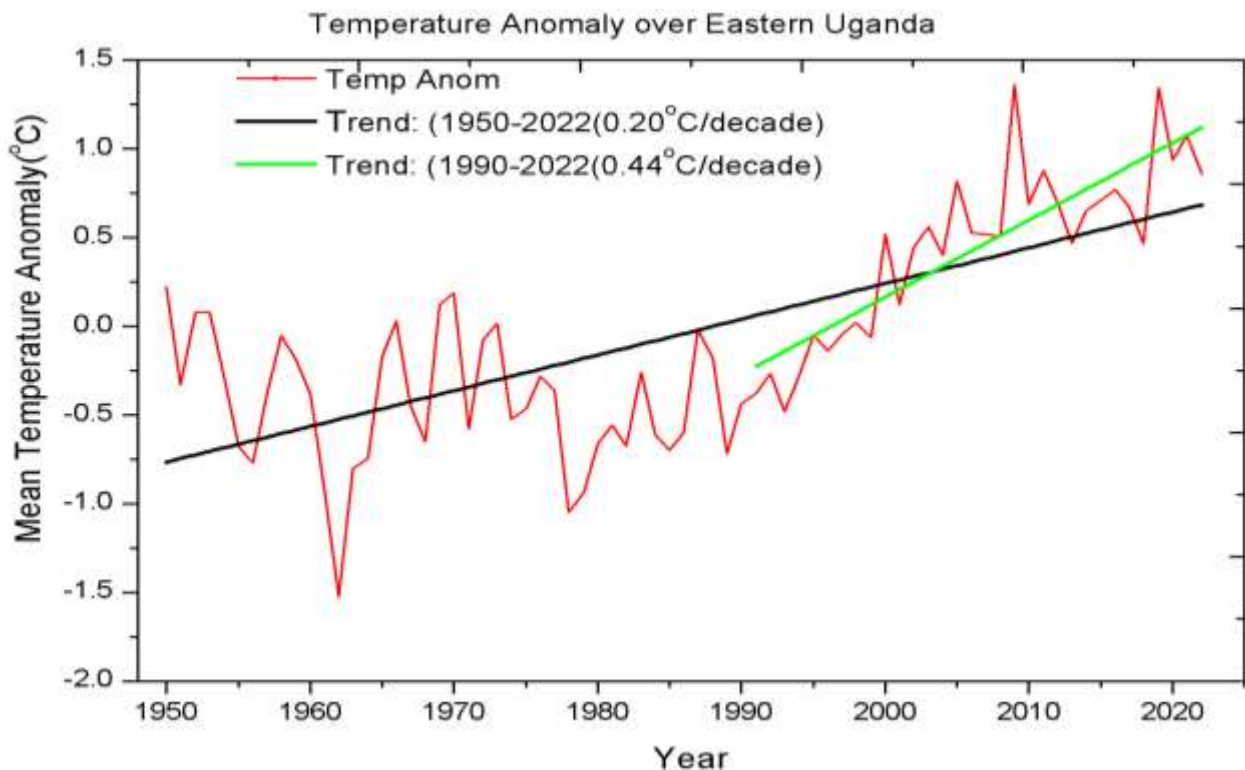


Figure 13: Trends in the mean annual temperature anomalies (°C) over Eastern region for the period: 1950-2022 with respect to 1981-2010 reference period. Red color represents temperature anomalies, black color shows the trend line for the period: 1950-2022, and green represents the trend line for the period: 1990-2022

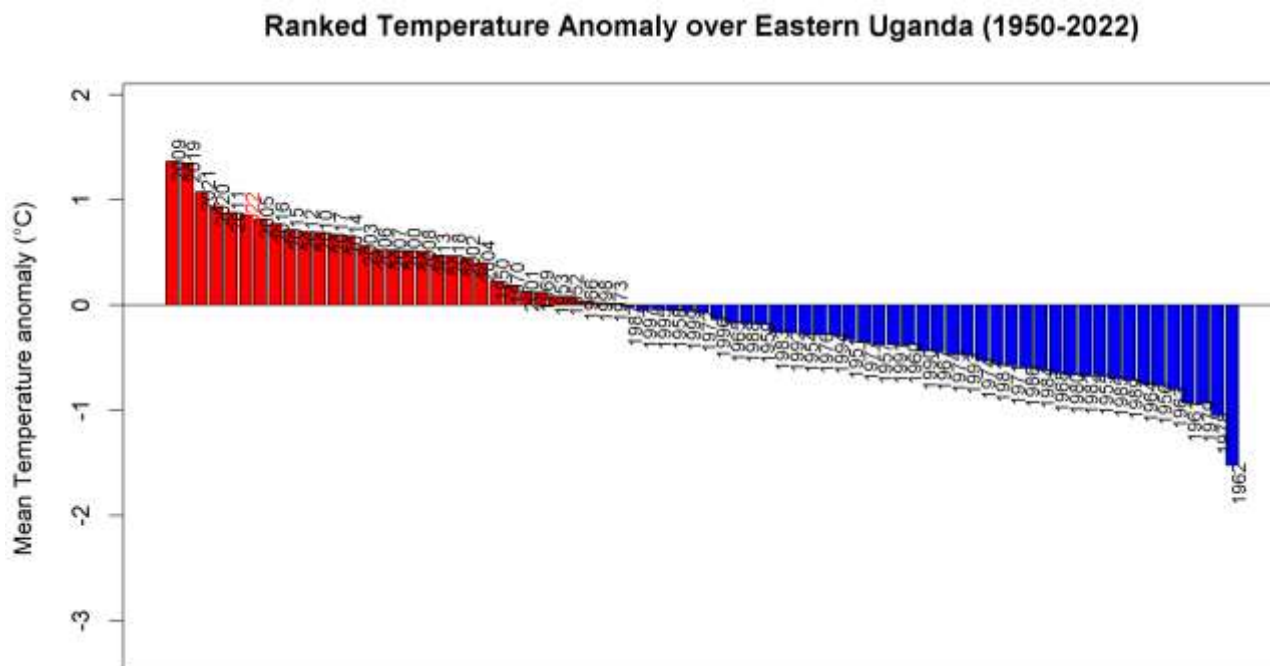


Figure 14: Ranked mean annual temperature anomalies ($^{\circ}\text{C}$) over Eastern region for the period 1950 - 2022 relative to climatology (1981-2010). Red color represents years with temperature anomalies more than the long-term mean value (climatology) and blue represents years with temperature anomalies less than the climatology. The year 2022 was the sixth warmest year on record after 2009, 2019, 2021, 2020 and 2011 in that order.

2.2.4 Central Uganda

The central region is located within the geographical latitudes; 0°N - 1°N and longitudes; 31.0 - 33.0°E . It covers most districts in the Lake Victoria basin such as Kampala, Mukono, Jinja, Gomba, Kaliro, Mayuge, etc and parts of the region including Nakasongola and Nakaseke lie in the cattle corridor of Uganda (Figure 6). Over Central Uganda (Figure 10), the average temperature anomaly was about 0.59°C , warmer than the long term mean value. The rate at which temperature has been increasing in this region over the period 1950 to 2022 and 1990 to 2022 was found to be 0.41°C and 0.55°C per decade, respectively. The three warmest years over this region since 1950 are 2009, 2019, and 2021 in that order.

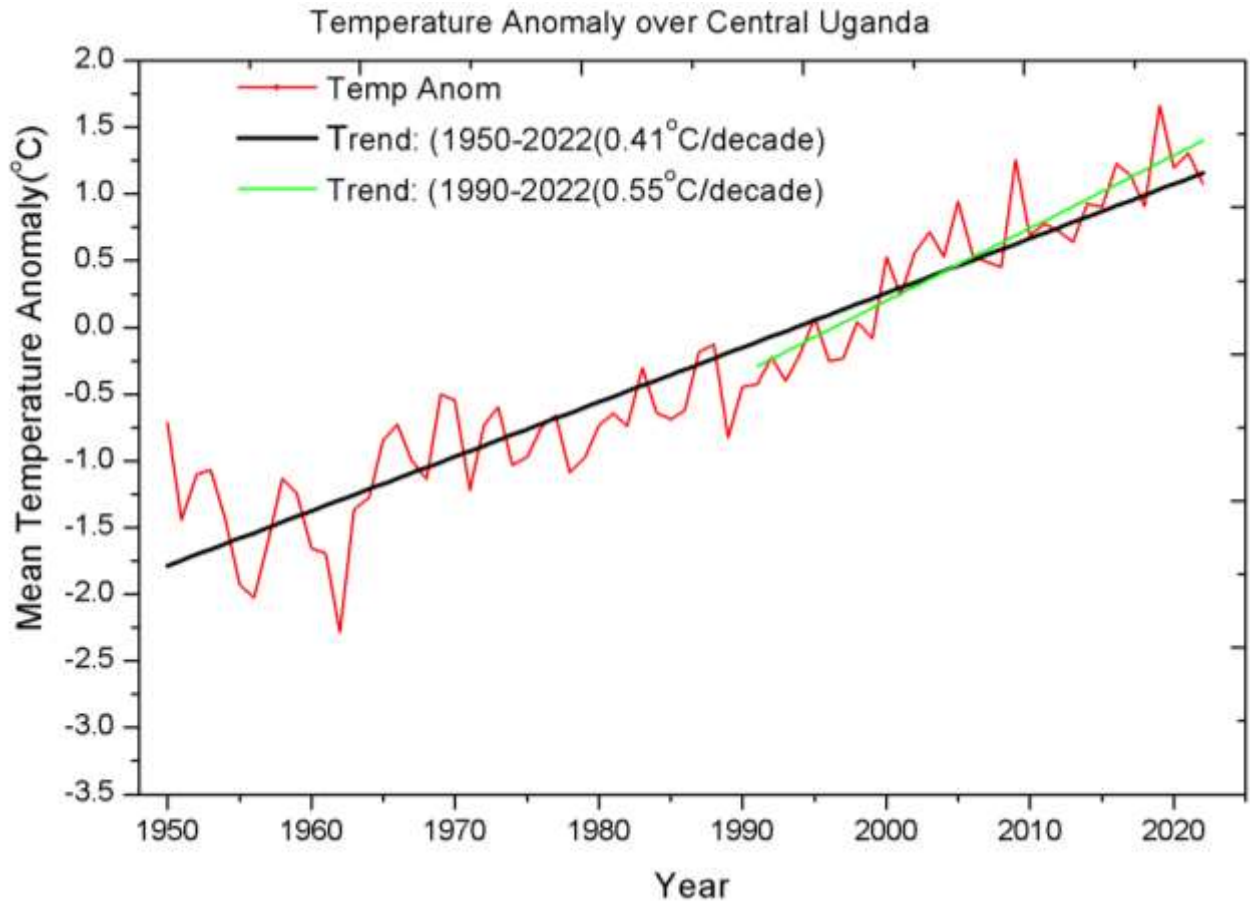


Figure 15: Trends in the mean annual temperature anomalies (°C) over Central Uganda for the period: 1950-2022 with respect to 1981-2010 reference period. Red color represents temperature anomalies, black color shows the trend line for the period: 1950-2022, and green represents the trend line for the period: 1990-2022

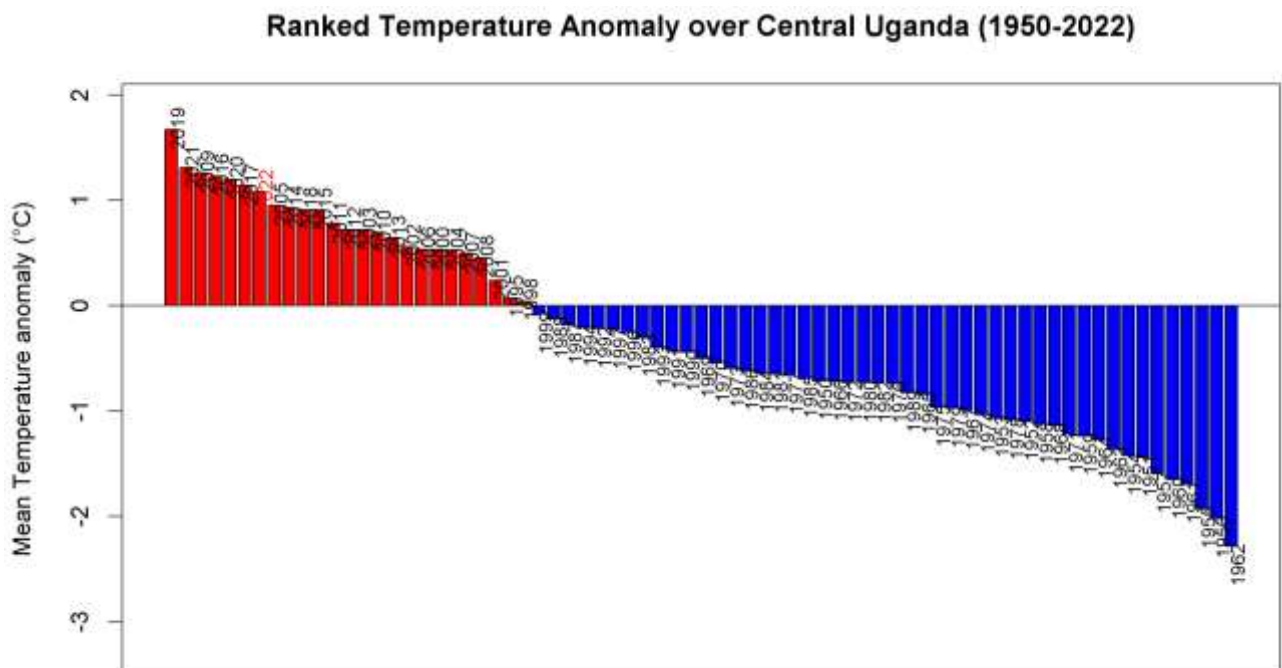


Figure 16: Ranked mean annual temperature anomalies (°C) over Central Uganda for the period 1950 - 2022 relative to climatology (1981-2010). Red color represents years with temperature anomalies more than the long-term mean value (climatology) and blue represents years with temperature anomalies less than the climatology.

The year 2022 was the sixth warmest year on record after 2009, 2019, 2021, 2020 and 2011 in that order.

2.2.5 Western Region

The western region, lies within the geographical latitudes; 0°N-2°N and longitudes; 29.8-31.0°E. It stretches from lake Albert to mount Rwenzori, implying that it covers most of the oil rich districts of Buliisa, Hoima, Kikuube, Kakumiro, Ntoroko, Kyenjojo, Kyegegwa, Kabarole, Kasese, Kamwenje etc, (Figure 6). The average temperature anomaly was about 0.61°C warmer than the long term mean value. The rate at which temperature has been increasing in the region over the period 1950 to 2022 and 1990 to 2022 was found to be 0.60°C and 0.58°C per decade, respectively. Over the last decade, the region has been affected by some of the most devastating floods especially caused by the overflow on river Nyamwamba due to occasional heavy rainfall in the region.

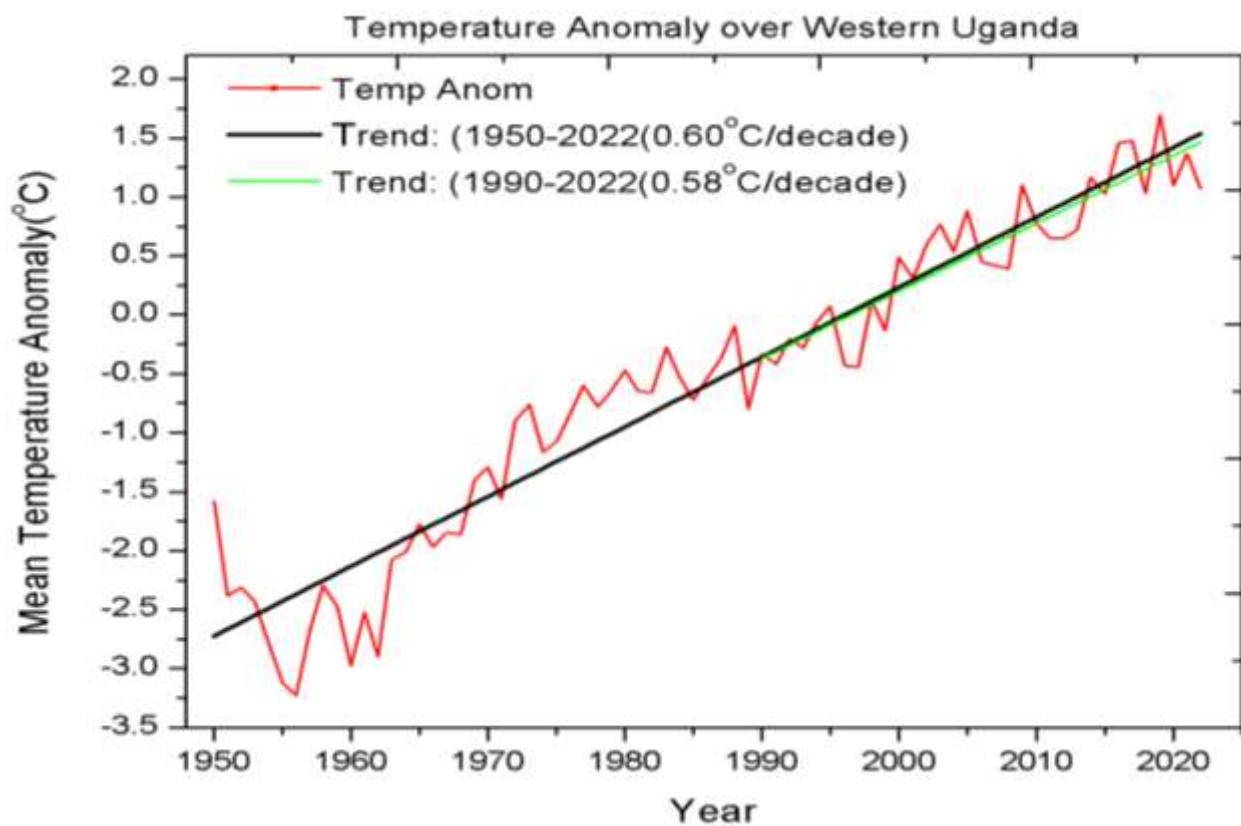


Figure 17: Trends in the mean annual temperature anomalies (°C) over western region for the period: 1950-2022 with respect to 1981-2010 reference period. Red color represents temperature anomalies, black color shows the trend line for the period: 1950-2022, and green represents the trend line for the period: 1990-2022

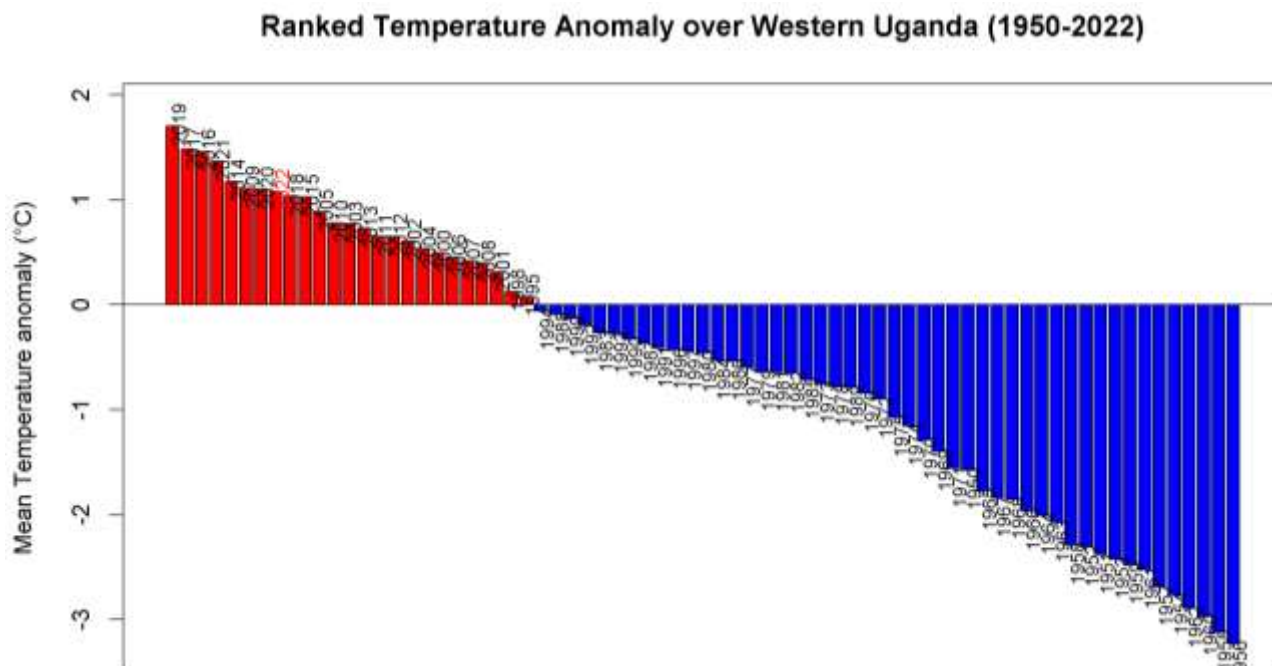


Figure 18: Ranked mean annual temperature anomalies (°C) over western region for the period 1950 - 2022 relative to climatology (1981-2010). Red color represents years with temperature anomalies more than the long-term mean value (climatology) and blue represents years with temperature anomalies less than the climatology. The year 2022 was the eighth warmest year on record after 2019, 2017, 2016, 2021, 2014, 2009, and 2020 in that order.

2.2.6 Southwestern Region

Southwestern region, is located within the geographical latitudes ; 1°S - 0°N and longitudes ; 29.7 - 31.5° E. It is one of the regions characterised by heterogenous terrain and also prone of natural disaster such as landslides. The region covers districts such as ; Kisoro, Kabale, Ntungamo, Rukungiri, Mitooma Bushe-nyi, Rubirizi, Rubanda, Rukiga etc., (Figure 6).

Over the region; the average temperature anomaly was about 0.59°C warmer than the long term mean value. The rate at which temperature has been increasing in this region over the period 1950 to 2022 and 1990 to 2022 was found to be 0.55°C and 0.56°C per decade, respectively.

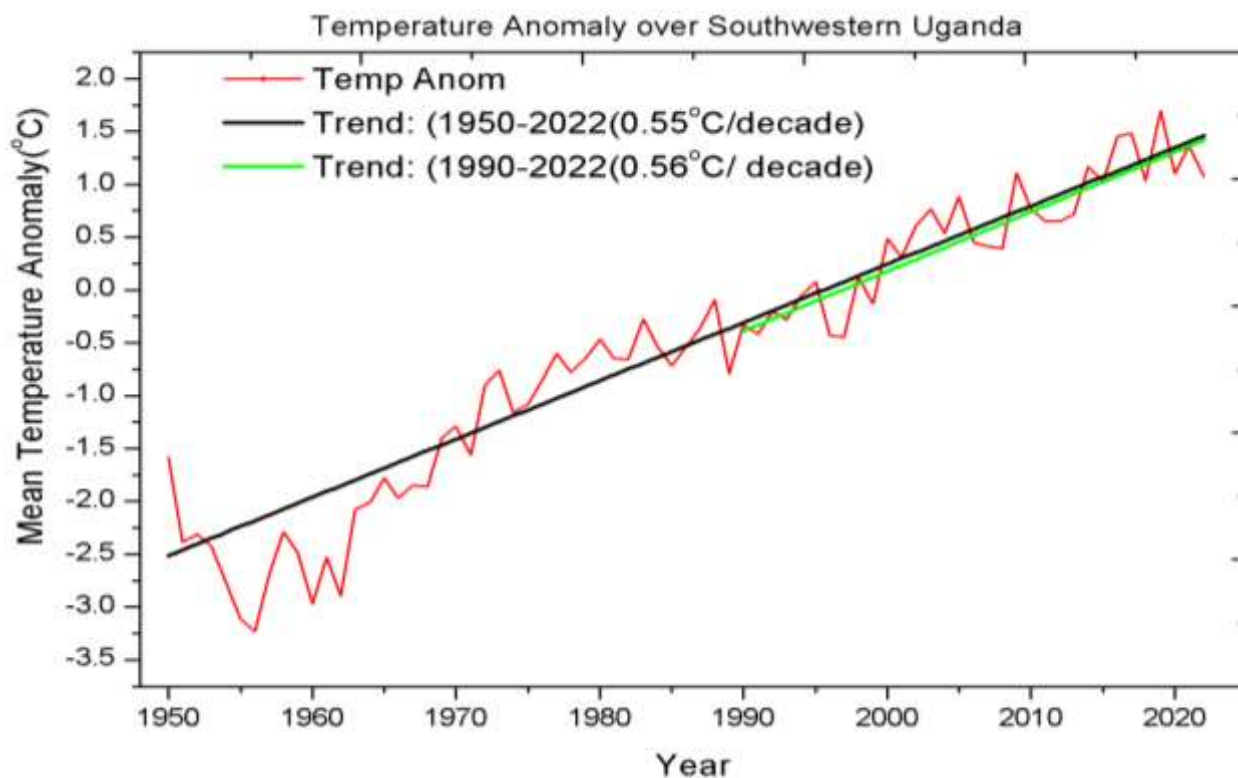


Figure 19: Trends in the mean annual temperature anomalies (°C) over Southwestern region for the period: 1950-2022 with respect to 1981-2010 reference period. Red color represents temperature anomalies, black color shows the trend line for the period: 1950-2022, and green represents the trend line for the period: 1990-2022

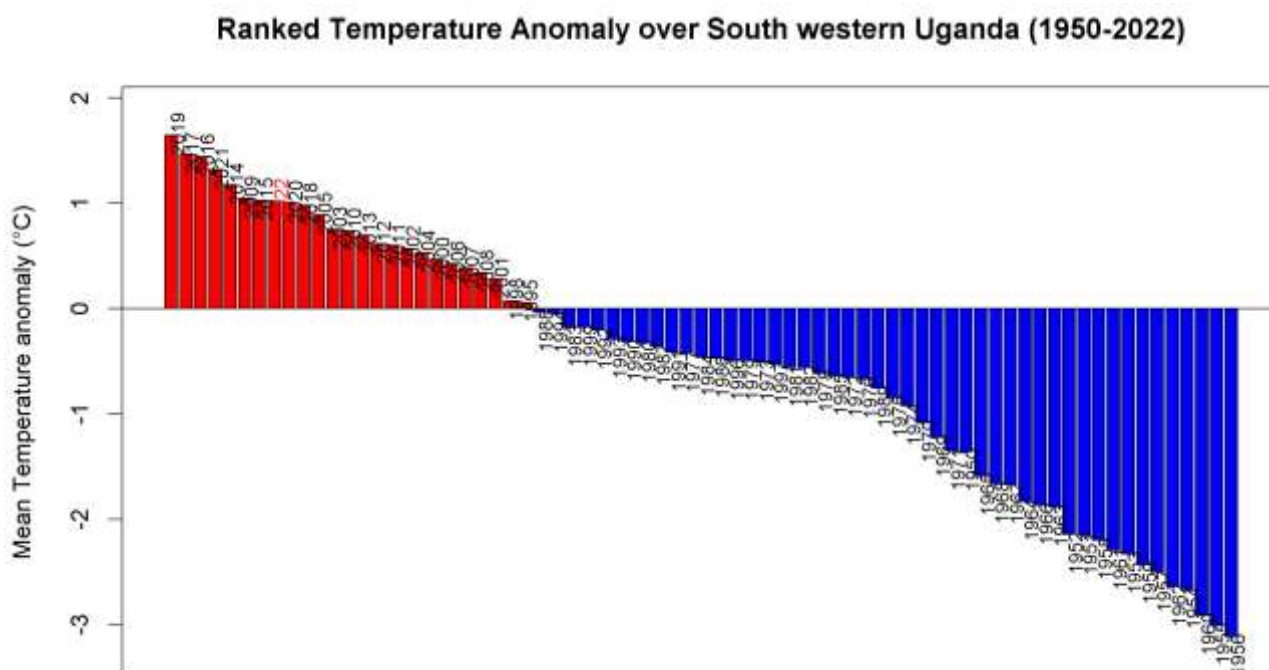


Figure 20: Ranked mean annual temperature anomalies (°C) over Southwestern region for the period 1950 - 2022 relative to 1981-2010. Red color represents years with temperature anomalies more than the long-term mean value (climatology) and blue represents years with temperature anomalies less than the climatology. The year 2022 was the eighth warmest year on record after 2019, 2017, 2016, 2021, 2014, 2009, and 2015 in that order.

3. NATIONAL RAINFALL ASSESSMENT

3.1 The annual rainfall performance over Uganda in 2022

Figure 21 shows the annual rainfall for Uganda in 2022. Generally, the year 2022, is one of the wettest years. The highest rainfall amount total of 2250.6 mm was recorded in the Lake Victoria sub-region, and Mount Elgon sub-region, while the Karamoja sub-region received lowest amount of rainfall of 448.3 mm. Patches of central region around Nakasongola district, Southern region in the districts of Mbarara, Kyotera, Ssembabule, and parts of Albertine sub-region received between 884.0 to 1034.9 mm.

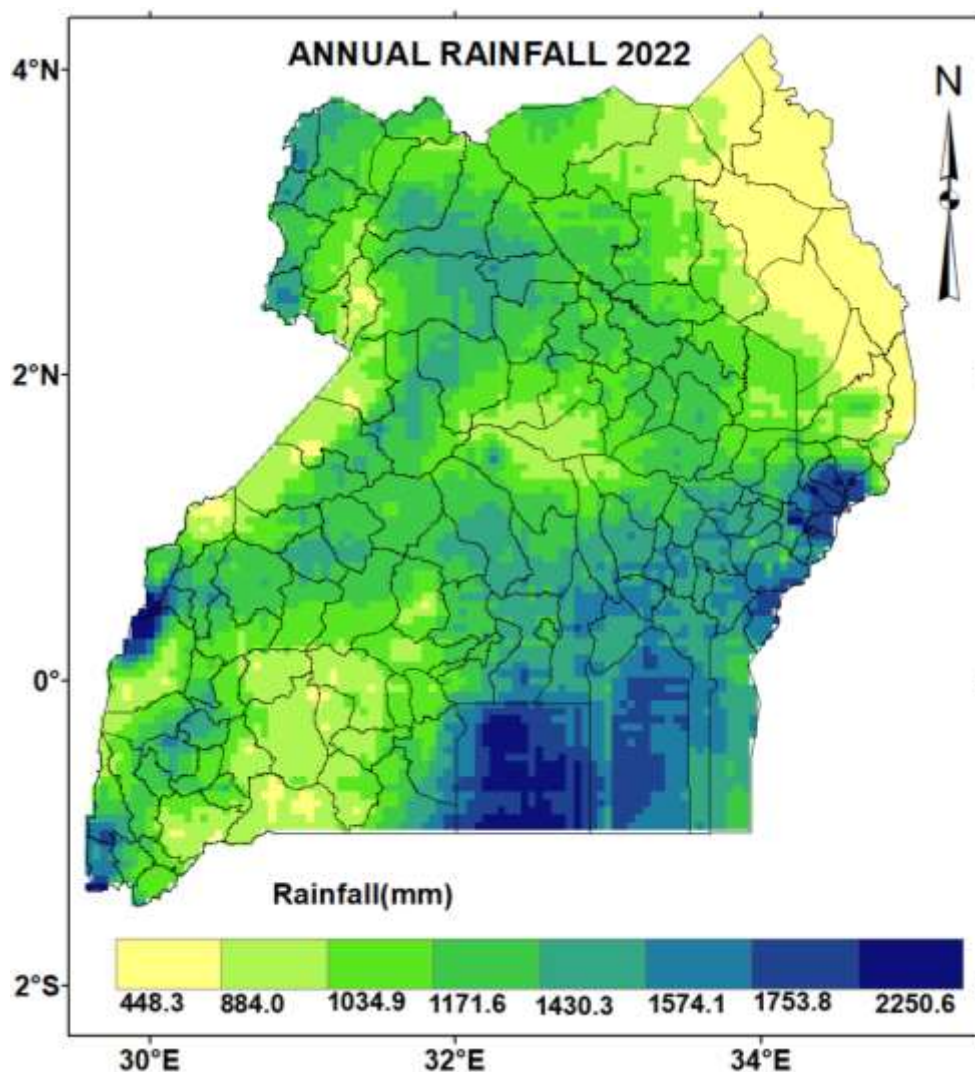


Figure 21: Shows the performance of annual precipitation (mm) over Uganda in 2022

3.2. The Seasonal rainfall performance over Uganda in 2022

3.2.1 The March-May (MAM) rainfall Season

During the first rainfall season March-May (MAM) 2022, Lake Victoria sub-region and eastern region received the highest rainfall ranging between 435.6 to 965.6 mm. Most of the remaining areas

including central, northern, west Nile, western and parts of southwestern Uganda received between 294.4 to 434.6 mm. The lowest rainfall amount of 173.8 mm was recorded in the most of the Karamoja sub-region, patches of southwestern and Albertine sub-region (Fig.22).

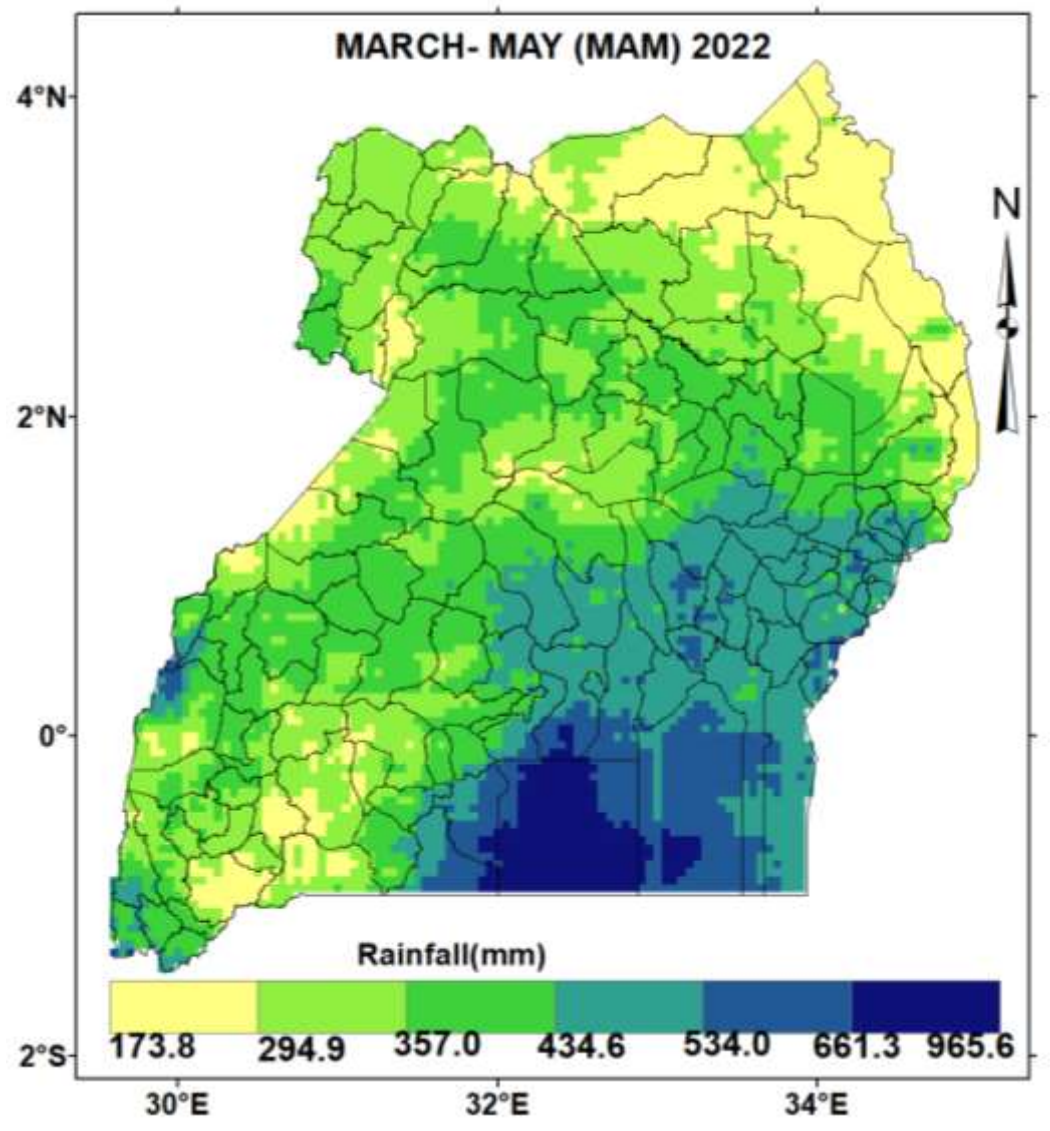


Figure 22: Show the performance of March-May (MAM) seasonal rainfall (mm) over Uganda in 2022.

3.2.2 The June-August (JJA) Season

Figure 23 shows the performance of the second season of the year (JJA), west Nile, northern Uganda, most of eastern Uganda, and mount Elgon areas received the highest rainfall in the range of 260.5 to 537.6 mm. This is followed by central region, most of Lake Victoria region, western region with 134.7 to 260.5 mm. The lowest rainfall of 36.3 to 134.7mm was recorded in the southern and southwestern Uganda.

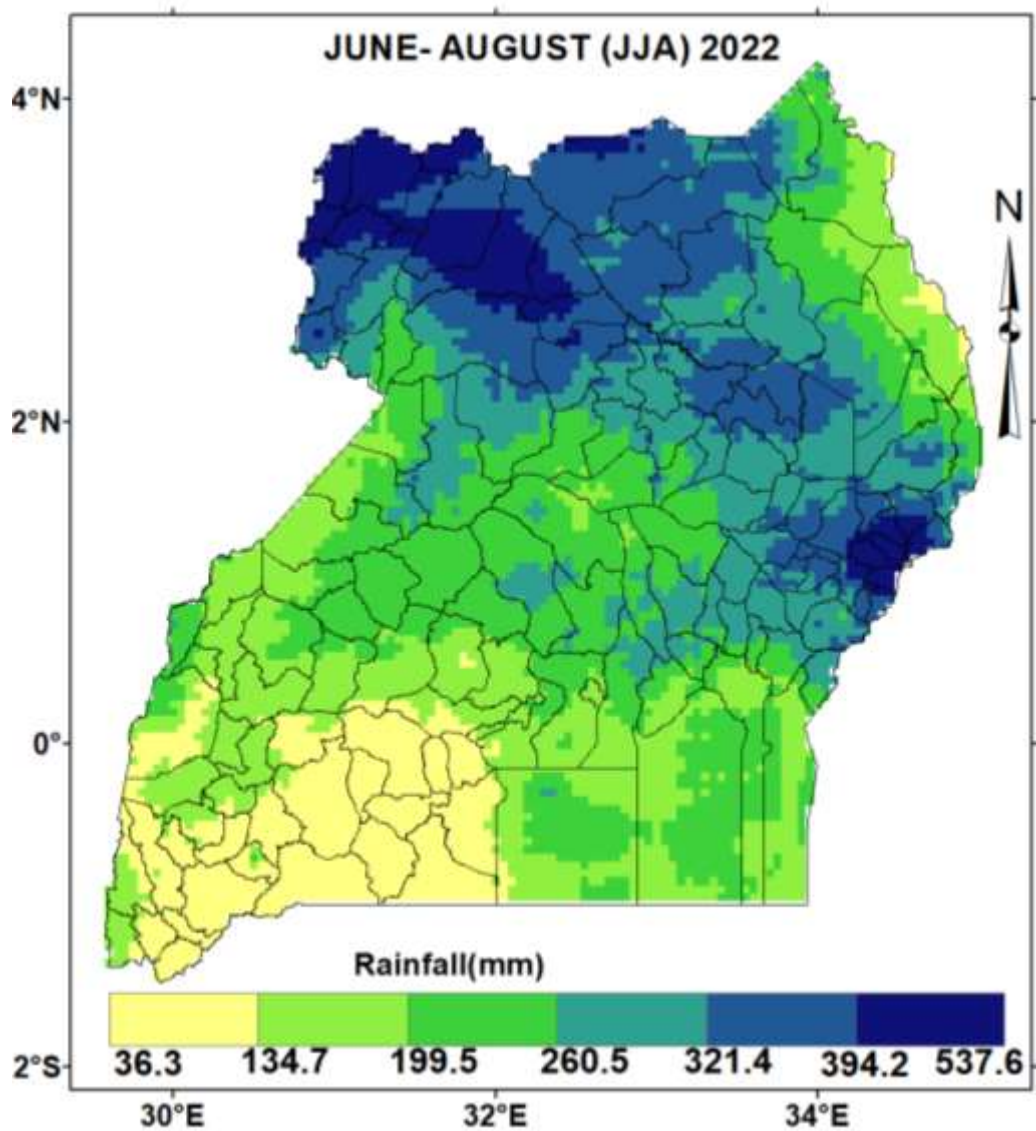


Figure 23: Show the performance of June-August (JJA) seasonal rainfall (mm) over Uganda during the year 2022.

3.2.3 The September-December season (SOND)

Figure 24 show greatly enhanced rainfall performance during the September-December rainfall season where a bigger part of the western sector, Lake Victoria basin, and top of mount Elgon experienced between 530.3 to 937.4mm. Most parts of the country received between 339.9 to 471.2 mm. Karamoja sub-region received the lowest rainfall amount of 100.2 to 339.9 mm. The persistent dry conditions in the Karamoja sub-region during SOND, negatively affected crop production and livestock rearing resulting into severe food insecurity, both livestock and human death.

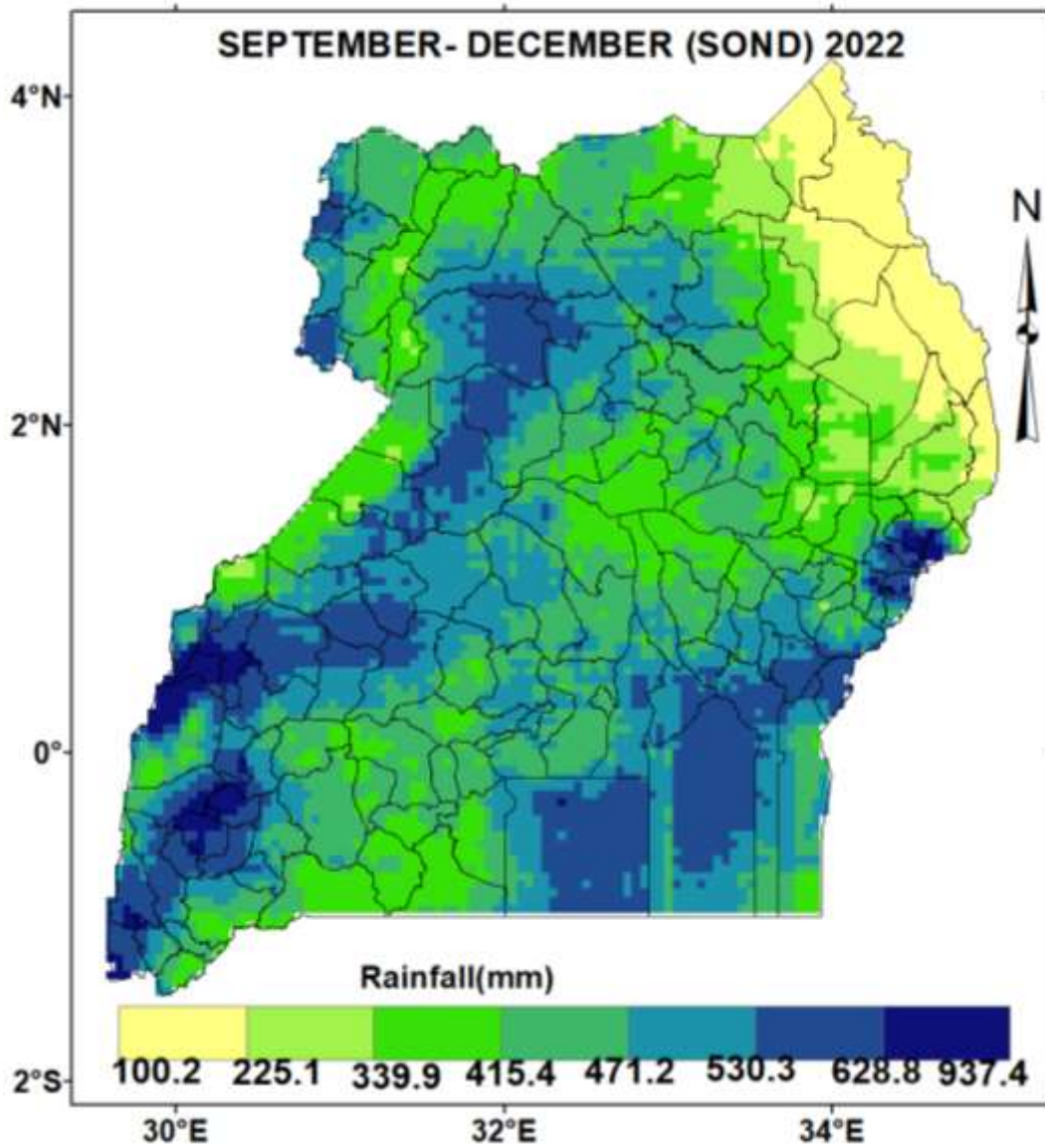


Figure 24: Show the performance of September-December (SOND) seasonal rainfall (mm) over Uganda in 2022

3.3 The annual percentage change in precipitation

The mean annual rainfall expressed as a percentage of the long-term mean over Uganda in the year 2022 is presented in Figure 8. Compared to the reference period of 1991-2020, above-average rainfall was observed over a small portion of Lake Victoria basin. Patches of northern Uganda received below normal rainfall (Cream to brown). The rest of the country recorded on average, near-normal rainfall conditions during 2022 (White) The recorded extreme rainfall events during 2022 led to flooding and landslides that affected thousands of people across the country.

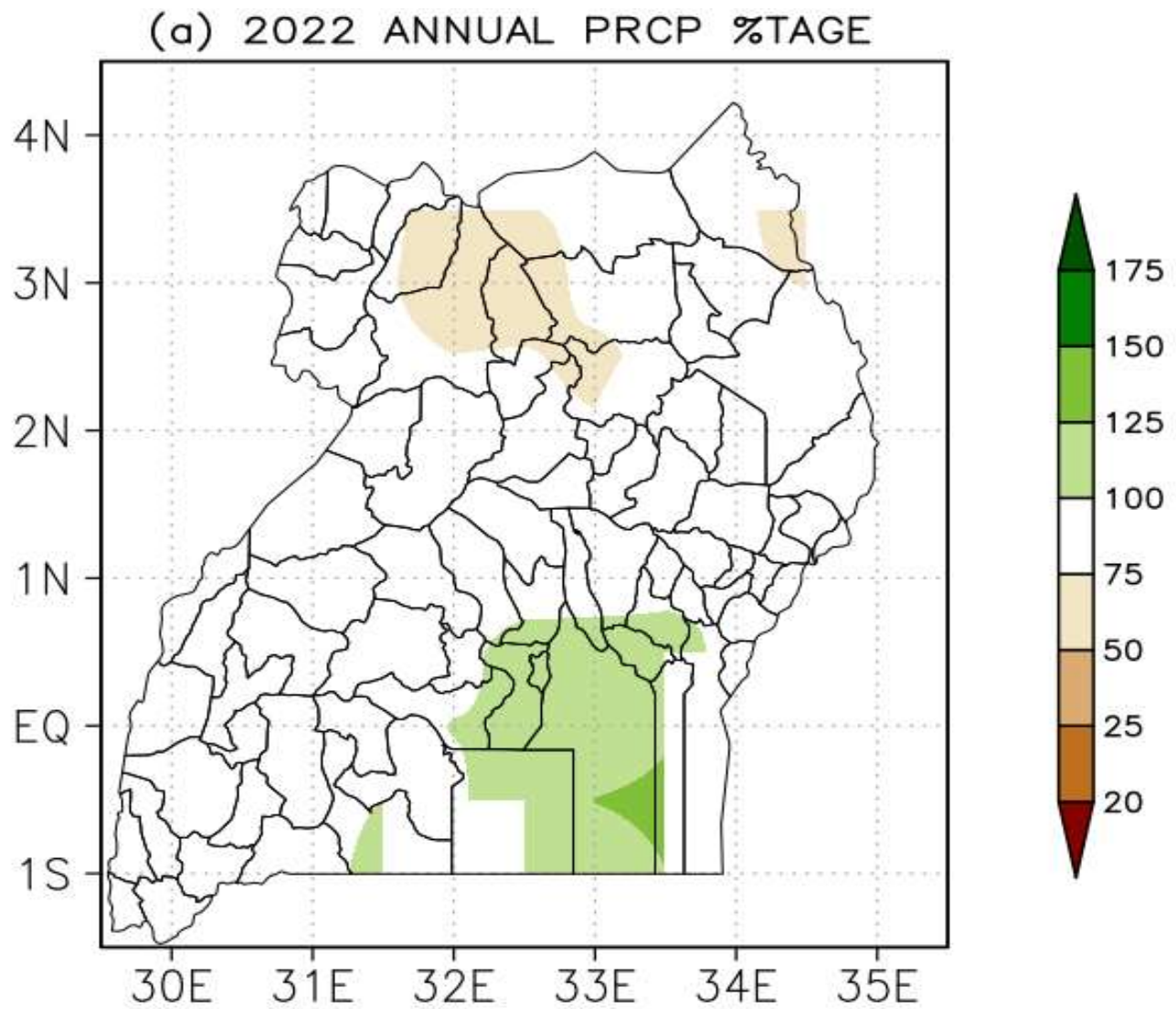


Figure 25: Mean annual rainfall over Uganda in 2022, expressed as a percentage of average based on the 1991-2020 reference period.

3.4 Annual cycle of rainfall

The mean annual cycle of rainfall provides the monthly evolution of rainfall over Uganda in 2022 (Figure 25). A comparison is made between the year previous year 2021, and the long-term mean (LTM: Climatology 1991-2020). The Figure reveals a similar pattern observed rainfall in 2022 over Uganda, starting from January to December. However, the year 2022 received more rainfall during the month of December-February (DJF) compared to the LTM and the previous year 2021. Conversely, the year 2022 also received less rainfall during June-July months compared to LTM. The heavy rainfall during the first seasons especially the month of April led to the record-breaking rise in the Lake Victoria water level that caused flooding of most commercial areas around the lakes.

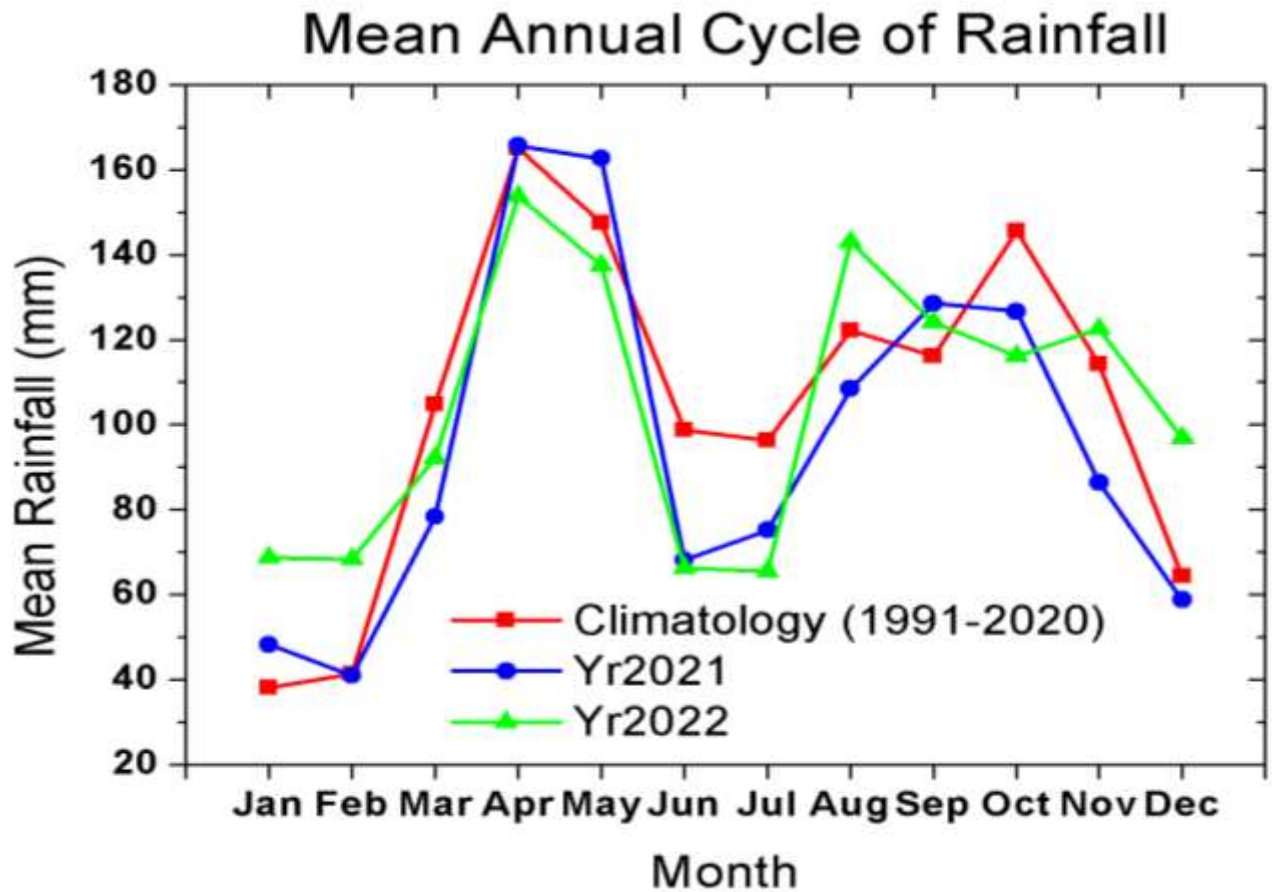


Figure 25: Mean annual cycle of rainfall (mm) for the year 2022 (green) and the climatology (red) based on the reference period 1991-2020.

3.5 Annual Rainfall Trends

Further examination of the annual rainfall trend over the country reveals that the mean annual rainfall (Figure 26) exhibits significant increasing trends at a 95% level of confidence over parts of the eastern, and in small patch over southwestern regions of Uganda. The remaining parts of the country shows near normal to insignificant decrease in rainfall over the period 1981-2022.

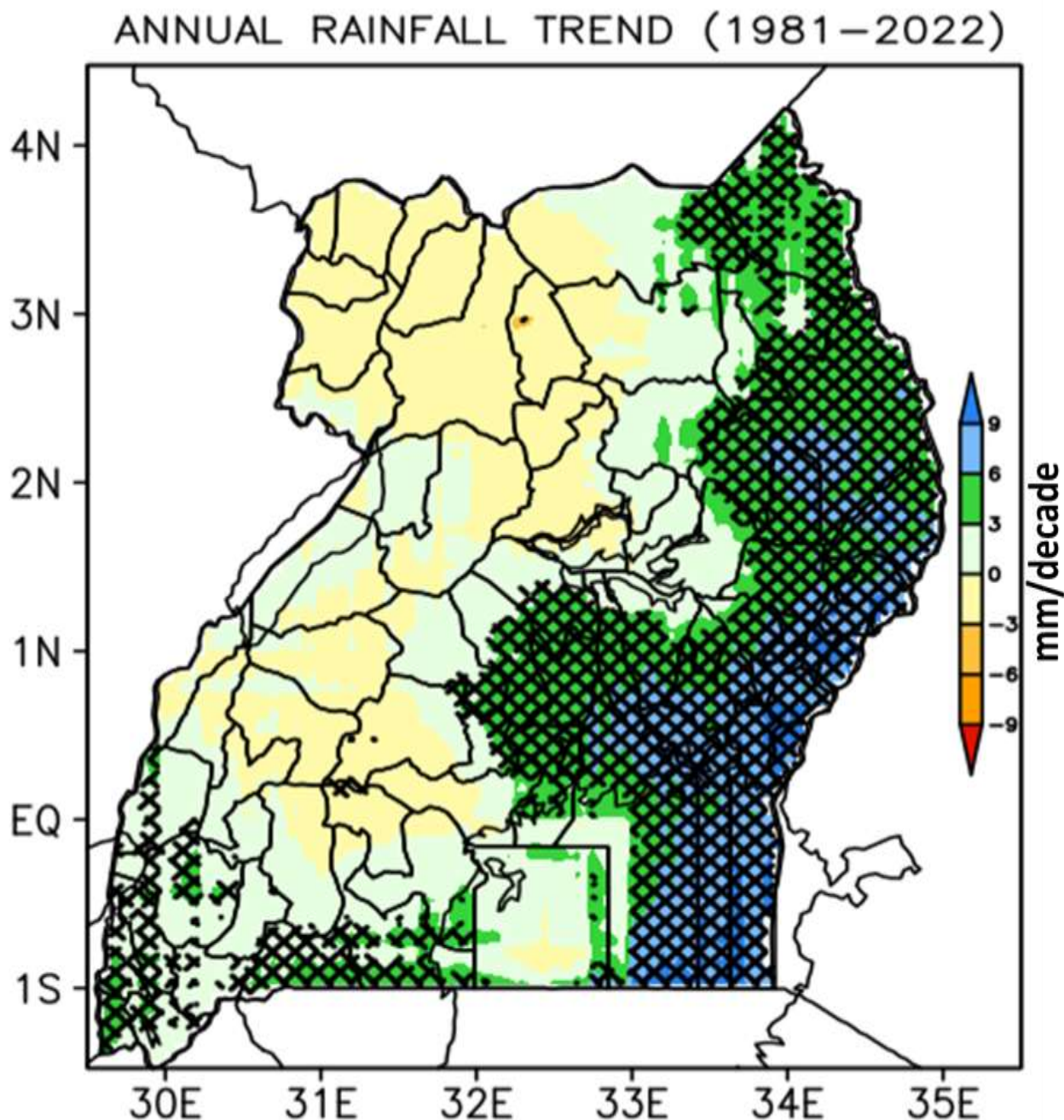


Figure 26: Mean Annual rainfall over Uganda. The shaded areas indicate an increasing trend (positive) or decreasing trend (negative). The hatched regions show a significant increase or decrease at 95% confidence level.

3.6 Seasonal rainfall anomaly for 2022

Seasonal performance of 2022 rainfall during the dry period of January- February (JF) revealed near normal rainfall for most parts of West Nile, Northern, and most parts of Karamoja (white color), while parts of southwestern and central Lake Victoria received above normal rainfall (green color) (Figure 27a). Further, in the first season of March-May 2022, most parts of West Nile, Northern, Central, Western, South-western and Karamoja sub-region received near normal to below normal rainfall (white to brown color). Meanwhile, parts of western Lake Victoria, experienced normal to above normal rainfall (light green to green) (Figure 27b). For June-July period, nearly all regions of Uganda received near normal to below

normal (white-brown color) (Figure 27c); Likewise, in the SOND rainfall season, most parts of the country experienced near normal to below normal rainfall (white-brown), with only patches of north eastern Uganda. Parts of western Uganda and Lake Victoria n experienced above normal rainfall (light green to green) (Figure 27c)

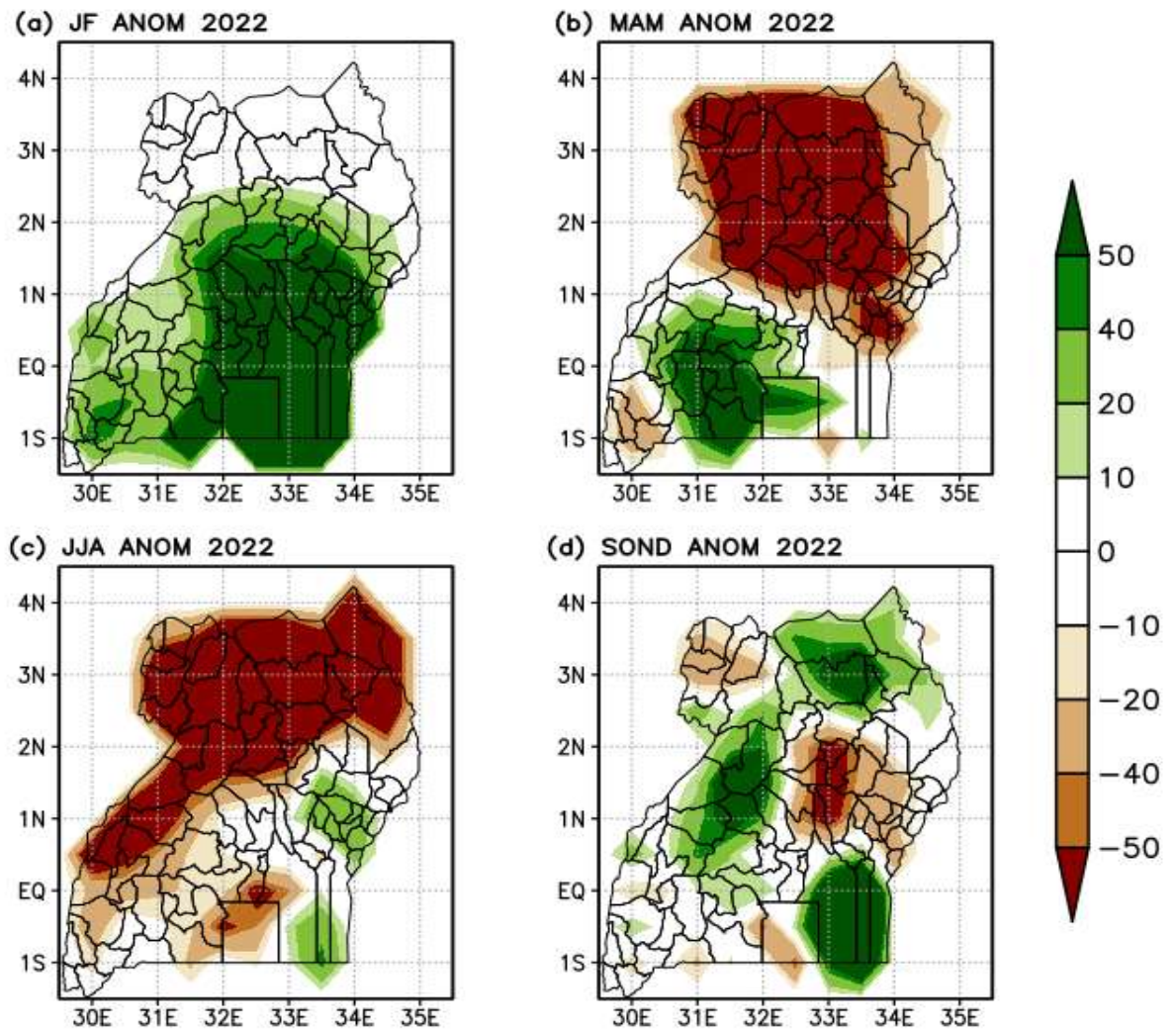


Figure 27 Shows the seasonal rainfall anomalies for 2022 January-February (JF), March-May (MAM), June-August (JJA) and September-December (SOND) compared to the climatological period 1991-2020

In light of the monthly performance, the year 2022 showed varied results compared to the climatological period of 1991-2020. For example, the month of February-March, June-July, and October-November all presented with near normal to below normal rainfall (white-brown color) (Figure 28a, c, f, g, J, K).

Prominent positive rainfall anomaly was exhibited in January covering parts of eastern and south-western Uganda. While in April it covered eastern region and Lake Victoria basin. In May, above normal rainfall is experienced in the northern and eastern sector of the country. And for September and December (Green color) above normal rainfall occurred in the eastern sector and Lake Victoria and respectively.

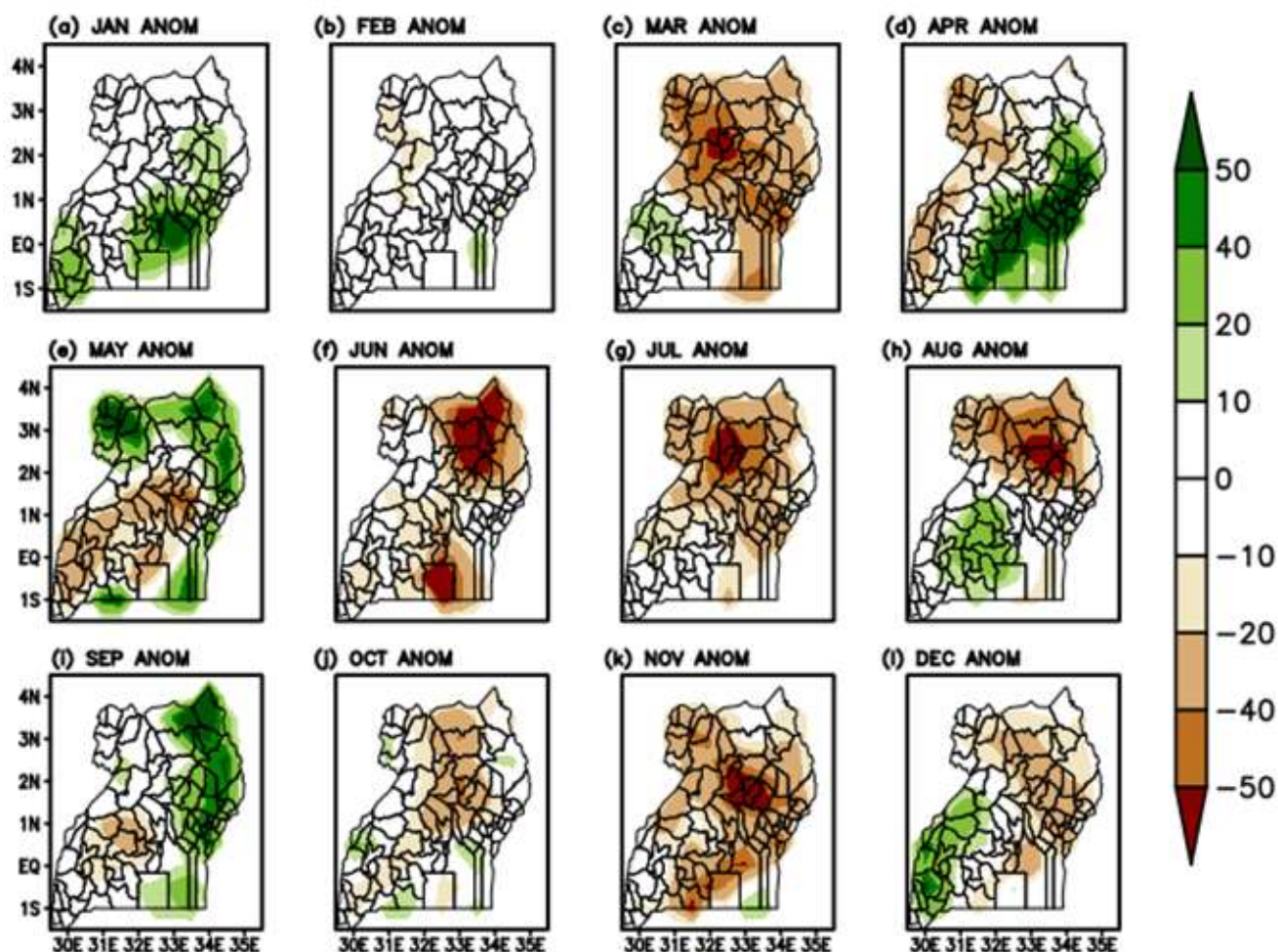


Figure 28 Shows the monthly rainfall anomalies for 2022 January-December compared with the climatological period 1991-2020

Figure 29 Shows the trend of March to May (MAM) seasonal rainfall over Uganda during the period 1981-2022. MAM seasons is the first rainfall periods over Uganda and it follows the northward movement of the intertropical convergence zone on the East Africa region. In most part of the country, the first rainfall season (MAM) is very important for agricultural activities especially when the country emerges through the dry season of December- February (DJF).

Results showed that the eastern sector of the country, including Karamoja sub-region, Mount Elgon Sub-region, part of Busoga sub-region, and Eastern Lake Victoria, parts of western and southwestern Uganda have experienced an increasing trend in MAM seasonal rainfall (Light green to Blue) on Figure 29. The trends are statistically significant in few areas mark (xxx) on the map. Conversely, West Nile, Northern Uganda, Central Uganda, most parts of Western Uganda, and patches of Lake Victoria, revealed a decreasing trends in MAM season rainfall. The decreasing trends is statistically significant in the mid-northern region covering mainly, Dokolo, Oyam, and Amolatar.

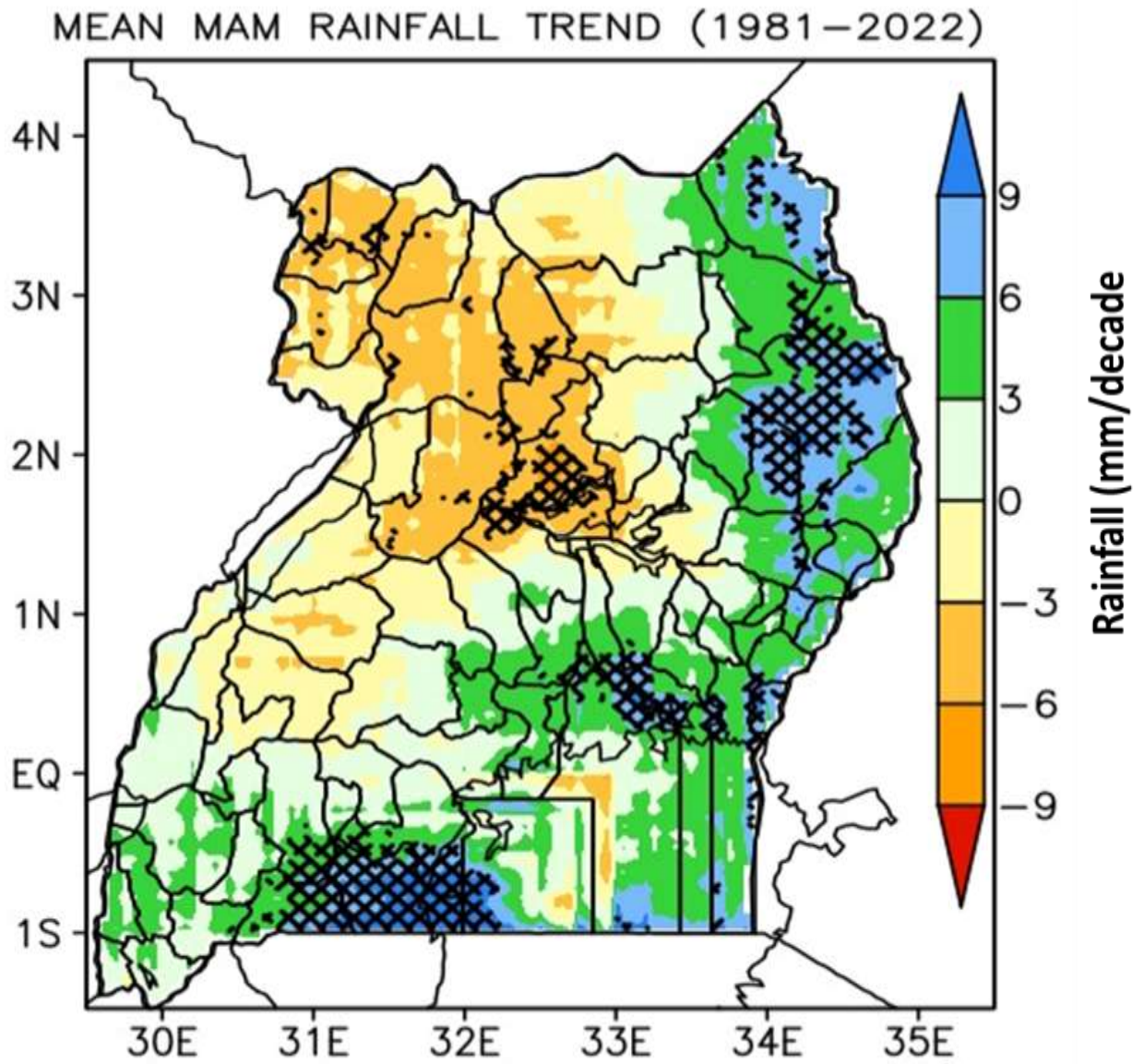


Figure 29 Shows the trends of mean MAM seasonal rainfall over Uganda during the period 1981-2022

The trends for SON seasonal rainfall follows similar pattern, as those of MAM, but nearly all eastern sector of Uganda showed statistically significant trends. Like for MAM, the western sector of the country revealed a decreasing trends in SON rainfall and only statistically significant trends in an isolated region, covering Ssembabule, Mbarara, Mubende, and parts of Kyenjoja.

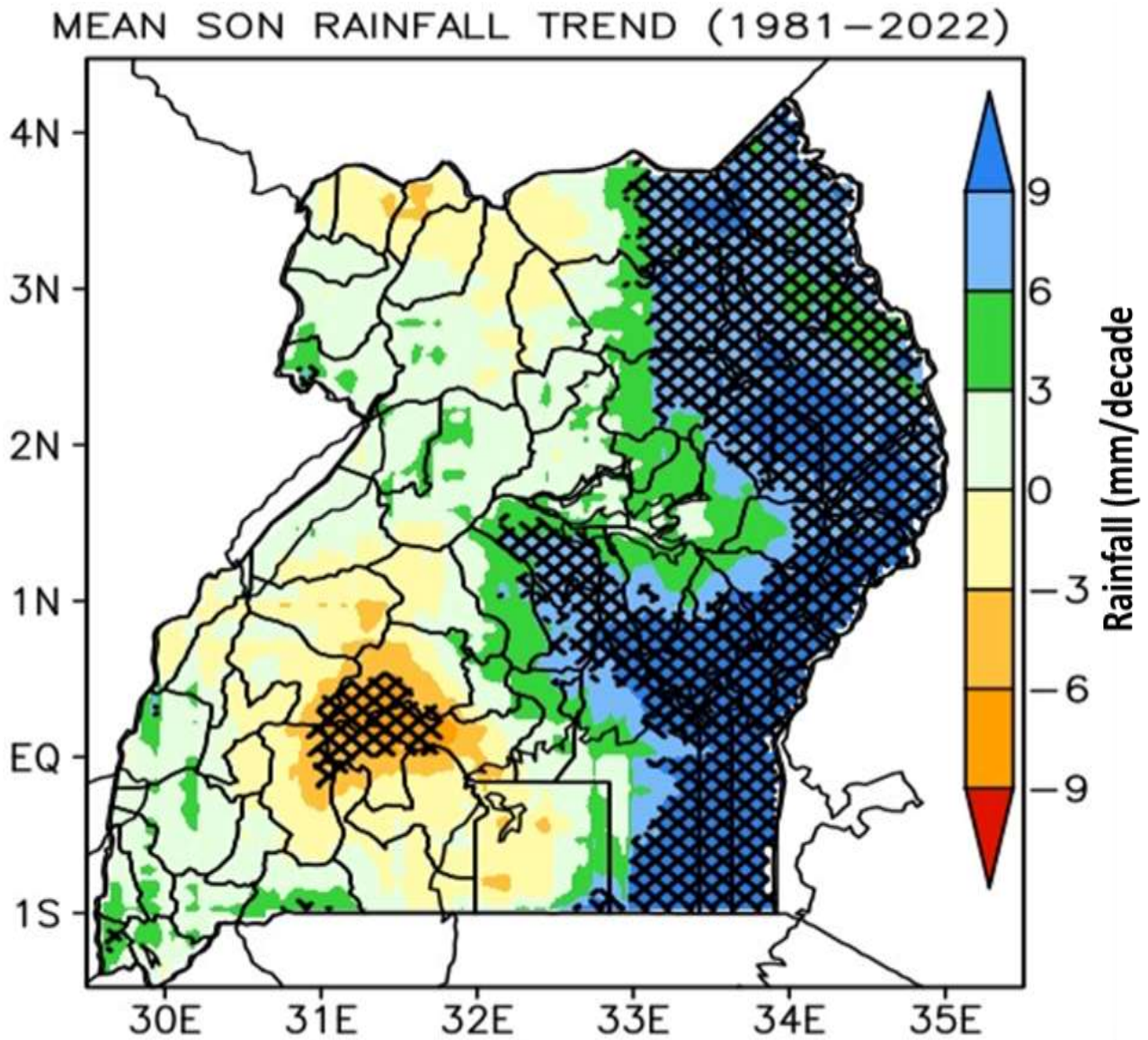


Figure 14 Shows the trends of mean SON seasonal rainfall over Uganda during the period 1981-2022

3.7 Cross-section of the annual cycle of monthly precipitation

Figure 30 present a cross-sectional view of annual monthly rainfall cycle for climatological period 1991-2020 and for the year 2022 taken at longitude 33° in Uganda (Figure 13a, b). Climatologically, more rainfall is received during the months of March-June with April and May being the peak (Yellow-Red), which progressively decreases to the northern region in the higher latitudes (2- 4°N). The month of June-July-August-September are relatively dry for areas below 1°N as indicated by light blue to blue color (Figure 30a, b).

Similar pattern is exhibited in the year 2022, but more rainfall was concentrated between latitude 1.5°S to 1.0°N and above this received less rainfall compared to the climatological period (Green to Blue color). This is clearly reflected in Figure 13c, as a percentage change showing that between the months of February-March and April, June-July areas situated above 1° N received less rainfall compared to the climatological period (whitist-brown color). For the month of June-July-August-September rainfall received was entirely less in all location across the dissected latitude (whitist-brown color).

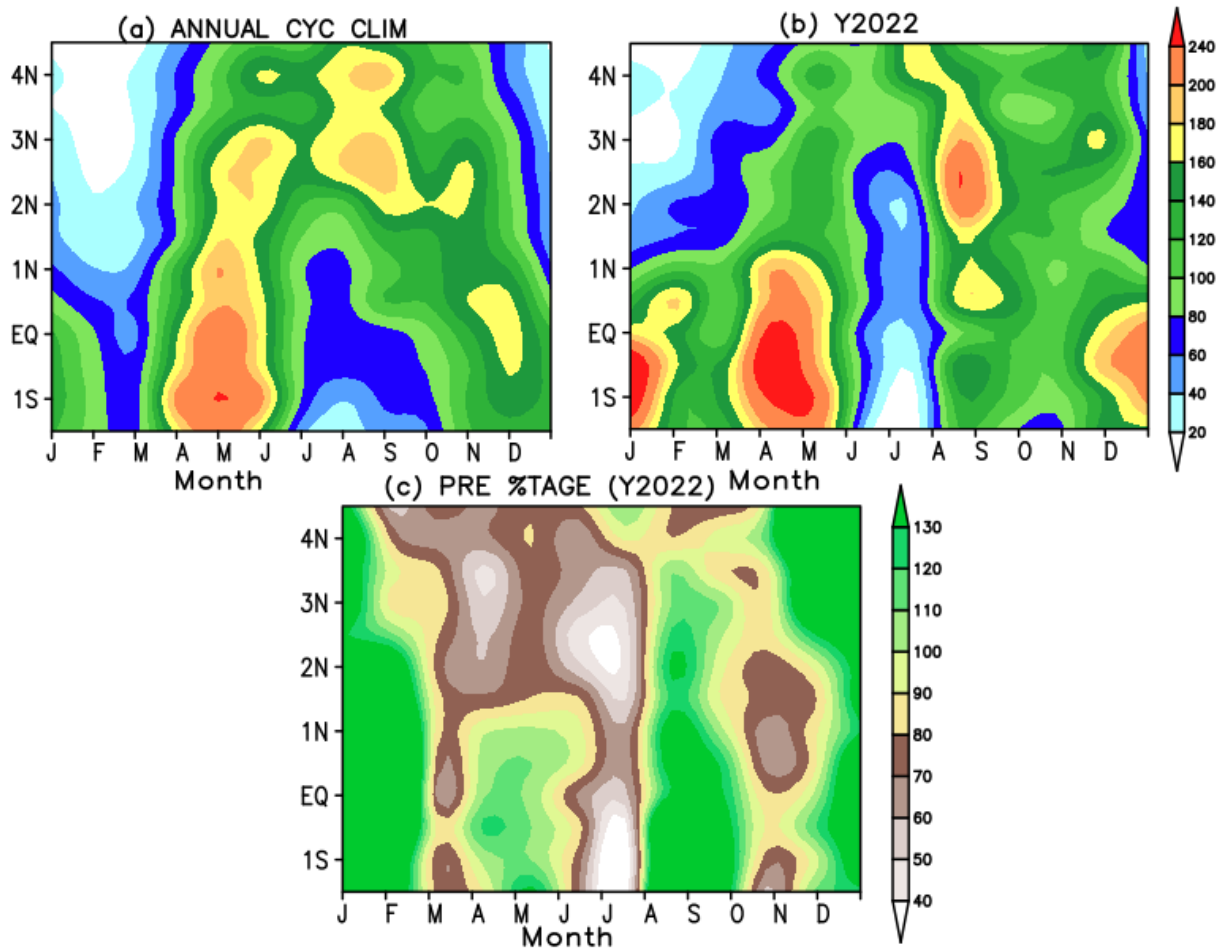


Figure30. shows the cross-section of the annual cycle of monthly precipitation climatology (a), and for 2022 (b), with the percentage change for 2022 compared with climatology (c)

Meanwhile, for the second main rainfall season of September-December (SOND) nearly all areas above equator (1.5S.-2.0 N^o), also received less rainfall compared to the climatological period of 1991-2020 (whitist-brown color). Drier conditions in the northern parts of Uganda and Karamoja sub-region during the year 2022 were mainly contributed by the long dry spells that occurred in the first season and droughts in the second period covering the district of around lake Kyoga basin including; Dokolo, Kwania, Amolatar, Lira, Apac, Kiryandongo, and all the Karamoja districts as reported by (DRR, 2021, UNMA, 2022).

4.0 SAMPLED CLIMATE RISKS AND RELATED IMPACTS IN 2022

4.1 Extreme events and impacts in eastern Uganda

At least 26 people were killed after flooding occurred Mbale Kween and surrounding districts (Uganda Red Cross). The Uganda Red Cross estimates that over 4,000 homes were affected in the region, and thousands displaced by the flood induced landslides that wreaked havoc in the region. Several crop fields were washed away by floods in Bumbobi subcounty in Kween district in Eastern Uganda on 29 August 2022 (Uganda Red Cross)



Figure 30: Unseasonal flooding and landslides washed away crops in Bumbobi sub-county in Eastern Region of Uganda after days of heavy rainfall causing rivers to overflow.

<https://trees.org/2022/11/28/uganda-floods-update/>

Following torrential rains experienced in area, parts of eastern Uganda experienced floods and landslides, specifically the districts around the Mt. Elgon region including Kween, Mbale, Kapchorwa, Bulambuli, Namisindwa, Sironko, Manafwa and the surrounding areas (Uganda Red Cross)



Figure 31: People look on as divers search for bodies from River Nabuvonga after the floods in Mbale district, eastern Uganda Floods (UN-IOM). <https://storyteller.iom.int/stories/ugandas-perennial-floods-cast-spotlight-regions-climate-change-related-disasters> (August 29/2022

4.2 Extreme events and impacts in northeastern Uganda (Karamoja Sub-region)

The northeastern Uganda (Karamoja Sub-region) experienced prolonged drought events and rampant food insecurity which left more than two million facing starvation. The categories of people affected mainly included the elderly, lactating mothers and children.

The statistic from international humanitarian organizations such as the Famine Early Warning Systems Network (FEWS NET) and World Food Programme (WFP) reported that about 518,000 faced critical food insecurity, and of these, 428,000 people experienced crisis levels of food insecurity. As of late July 2022, the United Nations Office for Coordination of Humanitarian Affairs (UN OCHA) reported the number of fatalities in Karamoja due to the “food insecurity crisis” to be 2,465 (USAID, 2022).

4.3 Extreme events and impacts in western region

At least 15 people died in western Uganda after their homes were buried in a landslide triggered by torrential rains (Uganda Red Cross). More than 8 homes were destroyed and several lives lost after heavy rain caused flash floods on 02 September 2022 triggering landslides in villages near Rubuguri in Kisoro Dis-

trict. Meanwhile, heavy rains also affected Bundibugyo District, where 3 children were reported killed after severe flooding struck in villages near Ntandi town on same day (Uganda Red Cross).



Figure 32: Shows the community members digging out the Landslides buried homes in Kisoro, Uganda, September 2022. (Uganda Red Cross)

5.0 Summary and Conclusions

Temperature continues to rise over Uganda with the year 2022 being the 5th warmest year on record since 1950. It fell behind 2019, 2009, 2021, and 2020, in that order.

The warming level in 2022 was ~ 0.49 °C above the WMO's operational base period of 1981-2010, and the rate of warming over the period 1950-2022 was 0.23 °C/decade and for the period 1990-2022 was 0.25 °C/decade.

Nearly 2,465 people were reported to have lost their lives due to hunger/starvation as prolonged droughts caused crop failures in northeastern Uganda (Karamoja sub-region). And more than 26 people were killed, while 4000 persons displaced by landslides/mudslides in eastern and western Uganda caused by floods and, heavy storms in 2022.

Uganda National Meteorological Authority will continue to provides up-to-date weather and climate information to help and minimize the effects of extreme event in the country.

REFERENCES

- Annual State of Disaster Report (ASDR) 2020, Office of the Prime Minister. Kampala Uganda
- Fan, Y., and Dool, H. V. D. (2008). A global monthly land surface air temperature analysis for 1948-present, J. Geophys. Res., 113, D01103, doi:10.1029/2007JD008470.
- Flood List (2018, November 20). Uganda – Deadly Floods in Central Region. Retrieved from <http://floodlist.com/africa/uganda-floods-november-2018>
- Flood List (2018, October 12). Uganda – Dozens Killed in Landslides and Floods in Eastern Region. Retrieved from <http://floodlist.com/africa/uganda-floods-november-2018>
- Floodlist News (17 DECEMBER, 2019) Uganda – More Fatalities after Floods in Central and Eastern Regions, <http://floodlist.com/africa/uganda-floods-central-eastern-region-december-2019>
- Funk, C. C., Peterson, P. J., Landsfeld, M. F., Pedreros, D. H., Verdin, J. P., Rowland, J. D., Romero, B. E., Husak, G. J. Michaelsen, J. C., and Verdin, A. P. (2014). A quasi-global precipitation time series for drought monitoring: U. S. Geological Survey Data Series 832, 4 p., <http://dx.doi.org/110.3133/ds832>
- Janowiak, J. E. and P. Xie. (1999). CAMS_OPI: A Global Satellite-Rain Gauge Merged Product for Real-Time Precipitation Monitoring Applications. J. Climate, vol. 12, 3335-3342.
- Reliefweb (2018, August 24). Over 10,000 floods and landslides survivors in Eastern Uganda get relief support from Uganda Red Cross society. Retrieved from <https://reliefweb.int/report/uganda/over-10000-floods-and-landslides-survivors-eastern-uganda-get-relief-support-uganda>
- ReliefWeb (18 Jun 2019) Uganda: Floods and Landslides - Jun 2019 <https://reliefweb.int/disaster/fl-2019-000067-uga>
- ReliefWeb (October 2019) Uganda: Floods and Landslides - Oct 2019 <https://reliefweb.int/disaster/fl-2019-000163-uga>
- UNMA. (2018). The Annual State of Climate of Uganda in 2017. Available at <https://www.unma.go.ug/research-reports/>
- UNMA. (2019). The Annual State of Climate of Uganda in 2018. Available at: <https://www.unma.go.ug/research-reports/>
- WMO, 2015. The Climate in Africa: 2013. WMO publication. ISBN 978-92-63-11147-0 . Pg: 1-29.
- WMO, 2017. WMO Statement on the State of the Global Climate in 2017. Retrieved from http://www.wmo.int/pages/prog/wcp/wcdmp/documents/2017_provisional_statement_text_-_updated_04Nov2017.pdf
- USAID (2022). https://karamojaresilience.org/wp-content/uploads/2022/12/TUFTS_2261_KRSU_Humanitarian_Crisis_V2_P19_adjust_online.pdf.
- <https://www.reuters.com/world/africa/more-than-200-people-die-drought-ravages-northeast-uganda-2022-07-19/>