STATE OF THE CLIMATE GHANA

2022

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List of Acronyms

GMet	Ghana Meteorological Agency
LTM	Long-Term Mean
ITCZ	Inter-Tropical Convergence Zone
FMA	February March April
MAM	March April May
AMJ	April May June
MJJ	May June July
JJA	June July August
JAS	July August September
ASO	August September October
SON	September October November

PREFACE

The State of the Climate in Ghana 2022 represents a critical scientific endeavor by the Ghana Meteorological Agency (GMet) to systematically document, analyze, and interpret the climatic conditions experienced across Ghana during the year 2022. As a nation situated within the dynamic meteorological context of West Africa, Ghana's climate is subject to significant spatial and temporal variability, driven by both regional atmospheric circulation patterns and global climate change phenomena. This report, therefore, serves as an indispensable resource, not only for policymakers and climate scientists but also for stakeholders across agriculture, water resources, disaster management, and public health sectors.

The compilation of this report is grounded in the meticulous collection and analysis of meteorological data from an extensive network of observation stations spanning the length and breadth of the country. The data encompasses a wide array of climate variables, including maximum and minimum temperatures, precipitation totals, rainfall frequency, and the occurrence of extreme weather events such as floods and storms. The analytical approach adopted aligns with international best practices, utilizing standardized climatological baselines (1991–2020) to contextualize 2022 observations and employing anomaly detection to highlight deviations from the norm.

The year 2022 was marked by pronounced climatic anomalies, reflecting the ongoing influence of anthropogenic climate change as documented by the Intergovernmental Panel on Climate Change (IPCC, 2013). These anomalies manifested in both temperature and precipitation regimes, with significant implications for Ghana's socio-economic development and environmental sustainability. The report's structure is designed to provide a comprehensive overview, beginning with an introduction to the climatological context of Ghana, followed by detailed chapters on temperature and precipitation patterns, and culminating in an assessment of extreme events and their impacts.

This report intends to inform the government and the broader public on the current state of Ghana's climate, thereby facilitating evidence-based decision-making and the formulation of robust adaptation and mitigation strategies. The findings underscore the urgency of integrating climate science into national planning processes, particularly considering the increasing frequency and intensity of extreme weather events. As climate variability and

change continue to challenge the resilience of Ghanaian communities, the role of timely, accurate, and accessible climate information cannot be overstated.

In conclusion, the State of the Climate in Ghana 2022 stands as a testament to the Ghana Meteorological Agency's commitment to advancing climate science in Ghana. It is hoped that this report will catalyze further research, foster across-sectoral collaboration, and ultimately contribute to the sustainable development of the nation in the face of a changing climate.

FOREWORD

The publication of the State of the Climate in Ghana 2022 by the Ghana Meteorological Agency marks a significant milestone in the nation's ongoing efforts to monitor, understand, and respond to the multifaceted challenges posed by climate variability and change. I have witnessed firsthand the profound transformation of Ghana's climate system, characterized by increasing temperature extremes, shifting precipitation patterns, and the heightened occurrence of hydrometeorological hazards.

Mr. Eric Asuman

This report is both timely and essential. It provides a data-driven account of the climatic conditions that prevailed in Ghana during the year 2022, situating these observations within the broader context of historical trends and global climate change. The documentation of temperature and rainfall anomalies, as well as the detailed analysis of seasonal and regional variations, offers valuable insights into the evolving nature of Ghana's climate. Such information is critical for the development of targeted adaptation and mitigation strategies, particularly in sectors that are highly sensitive to climatic fluctuations, such as agriculture, water resources, and disaster risk management.

The 2022 climate year was notable for several reasons. Temperature records indicate a continuation of the warming trend observed over recent decades, consistent with projections from the IPCC (2013) and corroborated by regional climate models. The spatial analysis of maximum and minimum temperatures reveals significant departures from climatological norms, with implications for heat stress, crop yields, and public health. Precipitation patterns were similarly anomalous, with certain regions experiencing above-average rainfall and others facing deficits, leading to both flooding and drought conditions at different times of the year.

Perhaps most concerning is the increasing frequency and severity of extreme weather events, as documented in the latter sections of the report. Floods, storms, and coastal inundations have exacted a heavy toll on communities, infrastructure, and livelihoods, highlighting the urgent need for enhanced early warning systems and climate-resilient

infrastructure. The report's comprehensive analysis of these events provides a solid foundation for future risk assessments and underscores the importance of integrating climate information into disaster preparedness and response frameworks.

The State of the Climate in Ghana 2022 is more than a scientific report; it is a call to action. It challenges us to recognize the reality of climate change, to invest in climate science and services, and to prioritize the well-being of vulnerable populations. The Ghana Meteorological Agency is to be commended for its leadership and dedication to advancing climate knowledge in Ghana. I am confident that this report will serve as a catalyst for informed decision-making and sustained action at all levels of society.

SUMMARY

The State of the Climate in Ghana 2022 provides a comprehensive assessment of the climatic conditions experienced across the country during the reporting year, with a particular focus on temperature and precipitation patterns, their anomalies, and associated extreme events. The report is structured to offer both a macro-level overview and detailed sectoral analyses, drawing on a robust dataset spanning multiple decades and utilizing internationally recognized climatological baselines.

Mrs. Francisca Martey

The analysis of temperature data reveals a continuation of the warming trend that has characterized Ghana's climate over the past four decades. Maximum and minimum temperatures recorded in 2022 were, in many instances, significantly higher than the 1991–2020 climatological averages. The spatial distribution of temperature anomalies indicates that both the northern and southern sectors experienced elevated temperatures, with the highest recorded values surpassing historical records in several locations. These findings are consistent with global observations of increasing surface temperatures, as documented by the IPCC (2013), and underscore the influence of anthropogenic greenhouse gas emissions on regional climate dynamics.

Precipitation patterns in 2022 were marked by considerable variability, both temporally and spatially. The report documents significant deviations from the long-term average in annual and seasonal rainfall totals, with certain regions experiencing above-normal precipitation while others faced deficits. The analysis of rainfall frequency and intensity further highlights the occurrence of extreme precipitation events, which contributed to widespread flooding in urban and rural areas alike. The seasonal breakdown of rainfall-covering major and minor rainy seasons in the south and the unimodal regime in the north, provides a nuanced understanding of the intra-annual variability that characterizes Ghana's climate.

The report also documents the impacts of extreme weather events, including floods, storms, and coastal inundations. Photographic evidence and case studies illustrate the human and economic costs of these events, which were exacerbated by the underlying climatic

anomalies. The occurrence of such events in 2022 aligns with broader trends observed across West Africa, where climate change is amplifying the frequency and intensity of hydrometeorological hazards.

In synthesizing these findings, the report emphasizes the interconnectedness of climate variables and their cumulative impact on Ghanaian society. The observed anomalies in temperature and precipitation are not isolated phenomena but are indicative of broader shifts in the regional climate system. The implications for agriculture, water resources, public health, and disaster risk management are profound, necessitating a coordinated and science-based response.

The “State of the Climate in Ghana 2022” thus provides a vital reference point for understanding the current state of the nation’s climate, identifying emerging risks, and informing the development of adaptive strategies. The report’s rigorous analysis and clear presentation of data make it an essential tool for policymakers, researchers, and practitioners working to build climate resilience in Ghana.

CHAPTER 1: INTRODUCTION

Climate change is a global threat with severe, cross-sectoral, long-term, and, in some cases, irreversible impacts. The impact of climate change, especially on life and property, is still continuous on increasing trend, hence placing additional burden on poverty alleviation efforts, thereby significantly hampering growth in prosperity. The State of the Climate in Ghana report will inform the Government regularly, hence provide critical science-based information for climate policy and decision-making about the status of the climate and its associated annual variability. The climate of Ghana in time and space, like any region in parts of the tropics, is prone to extreme climatic episodes such as frequent floods and recurring rainfall variability. Ghana's weather and climate are changing in response to global warming that is currently being experienced globally (IPCC, 2013). To deal with this, proper adaptation and mitigation measures should be put in place to cushion the population against the current and future negative climate change impacts.

Ghana is located between latitudes 4°N to 12°N and longitudes 1.5°E to 3.5°W in West Africa with a monsoonal climate dominated by wet and dry seasons. The Northern sector of the country experiences unimodal rainfall (April to October) whilst the Southern sector experiences bimodal; a Major rainy season (March to July) and a Minor season (September to November). The month of August experiences a break in the rainy season for the south, known as the little dry season. The dry season, referred to as Harmattan, occurs from December to February and is mainly dominated by dry north easterly winds which carry dust into the country, hence affecting visibility. Ghana's average minimum and maximum temperatures are 22 °C and 32°C respectively, with long-term mean annual rainfall between 700 mm and 2030 mm. Main weather phenomena are rainfall, fog, mist, haze, thunderstorm, lightning, gusty winds, hail, and the climate phenomena include floods, drought, high temperatures, and coastal inundation. The forecast of rains and its performance are of great significance to the agricultural sector as well as to the overall performance of the economy. The annual north and south migration of the overhead sun across the equator, which influences the position of the Intertropical Convergence Zone (ITCZ), is the main driver of weather in Ghana.

CHAPTER 2: TEMPERATURE

2.1 Maximum Temperature

Analysis of the annual mean (i.e., climatology (1991 – 2020)) maximum temperature (i.e., day time temperature) reveals that Navrongo and its environs in the upper east region of the country is characterized by more warmer conditions with values above 35°C hence the hottest and warmest region (Figure 1(a)). The area with the lowest climatological record is Abetifi and its environs in the eastern region, with a record value of 26°C as this is due to its relatively high elevation.

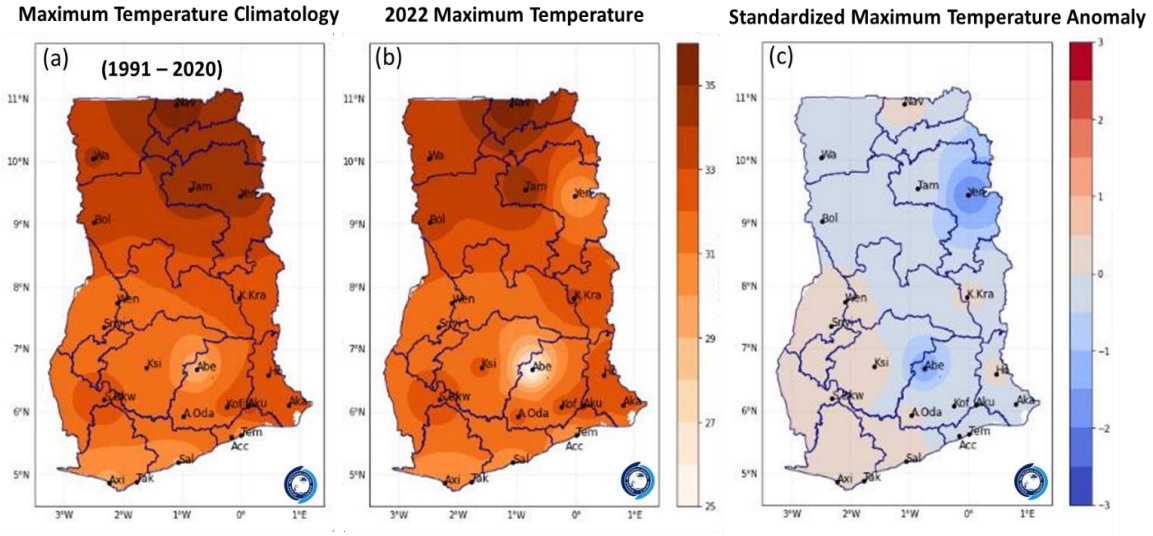

Figure 11: Climatology, Maximum Temperature and anomalies for 2022.

According to the data for 2022 (Figure 1(a)), Navrongo exhibited a slight increase above the climatic value however, Abetifi which is relatively cool due to its altitude experienced a decrease as shown in (Figure 1(c)). The 2022 standardized maximum temperature anomaly in general revealed slight increasing trend over the southwestern portions of the country and slight decreasing trend from the eastern coast through to the nnortheastern sector. Analysis of the average maximum temperature over the northern part of the country indicates that this part of the country records the highest daytime temperatures. Generally, across all the sectors, the month of march has the highest temperature ranging between 31°C and 39°C whilst August has the lowest maximum temperature between 27°C and 32°C according to the new climate normal with a clear seasonality (Figure 2(a)).

A similar characteristic was realized for the year 2022 however the range between both hottest and coolest months reduced. March record ranged between 32°C and 39°C with August also ranging between 28°C and 31°C (Figure2(b)).

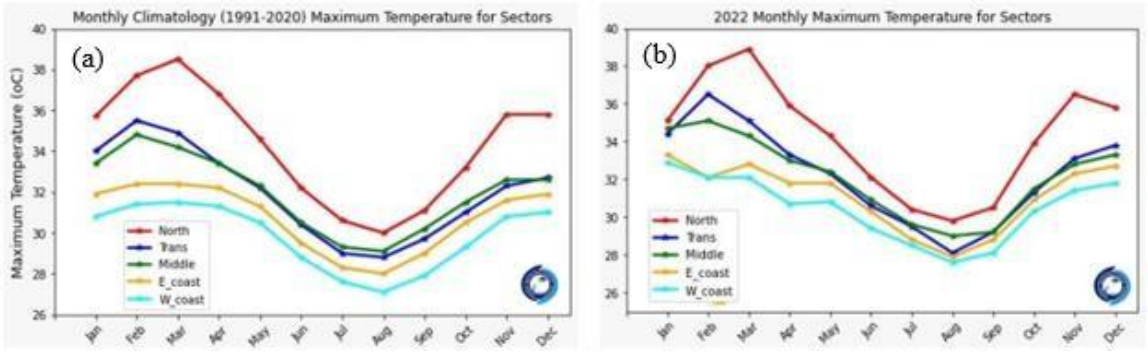

Figure 22: Monthly climatology and 2022 maximum temperature across sectors

2.2 Highest Recorded Temperature

Temperature record over Ghana generally depicts an increasing trend according to an interannual analysis of the standardized anomaly which spans from 1981 – 2022 as shown in (Figure 3).

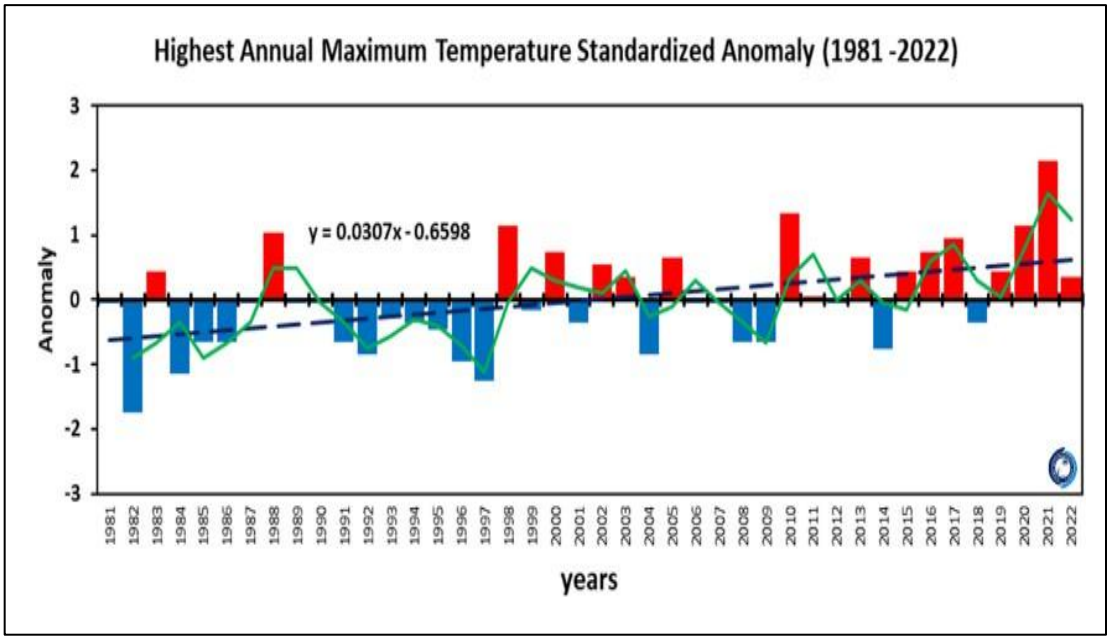

Figure 33: Annual Maximum Temperature Anomaly 1981 2022 over Ghana with a two (2) year moving average

From the analysis a positive slope of 0.031 confirms the general warming trend observed across the globe. In further analysis, a two-year moving average was overlayed on the interannual variability and this revealed an increasing trend and also the seasonality within the period. An annual ranking showed that the year with the highest temperature from 1981 – 2022 was 2021 with the highest temperature value of 45°C specifically over Navrongo. The year 2022 was ranked 16th warmest comparably as shown in (figure 4).

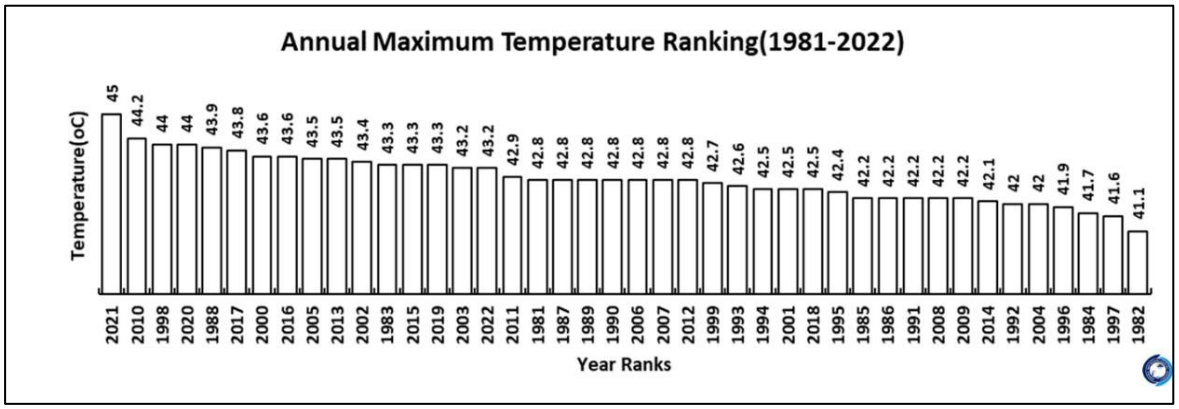

Figure 44: Ranking for Highest Annual Maximum Temperature from 1981 to 2022

2.3 Minimum Temperature

The long term (1991 – 2020) annual minimum temperature in Ghana ranges from 20°C to 26°C as shown in Figure 5(a). From the analysis, cool night time temperatures are mostly recorded over the mid central portions (eastern region) of the country stretching to the western part of the transitional zone (savanna region) whilst the remaining regions remain warm especially along the coastal regions and the eastern corridors.

The minimum temperature for the year 2022 (Figure 5(b)) exhibited a similar pattern as the long term mean however there was slight warming over most places comparably. The standardized anomaly (Figure 5(c)) revealed specific areas of deficits and above normal in detail.

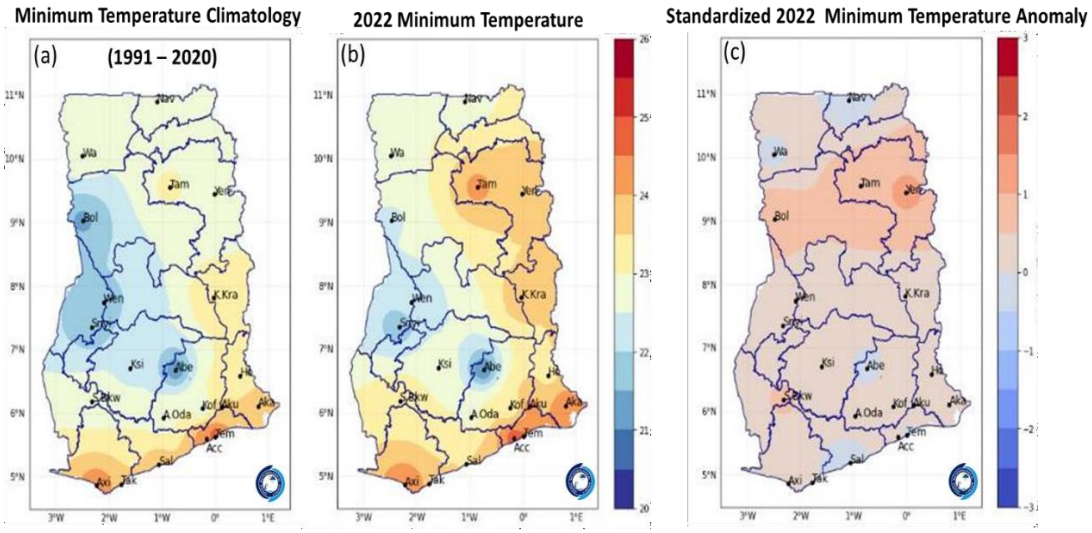

Figure 55: Climatology, Minimum Temperature and Standardized Anomaly for 2022

The monthly minimum temperature as shown in figure 6 (a) indicates that the lowest temperature in the year during the night is January and December.

The northern sector records the least temperature during these months per the records. On the contrary, the coastal sector records relatively warm temperatures climatologically. In the year 2022 (Figure 6(b)) the coolest months identified by the long-term mean became warm with closer ranges across all the sectors throughout the year.

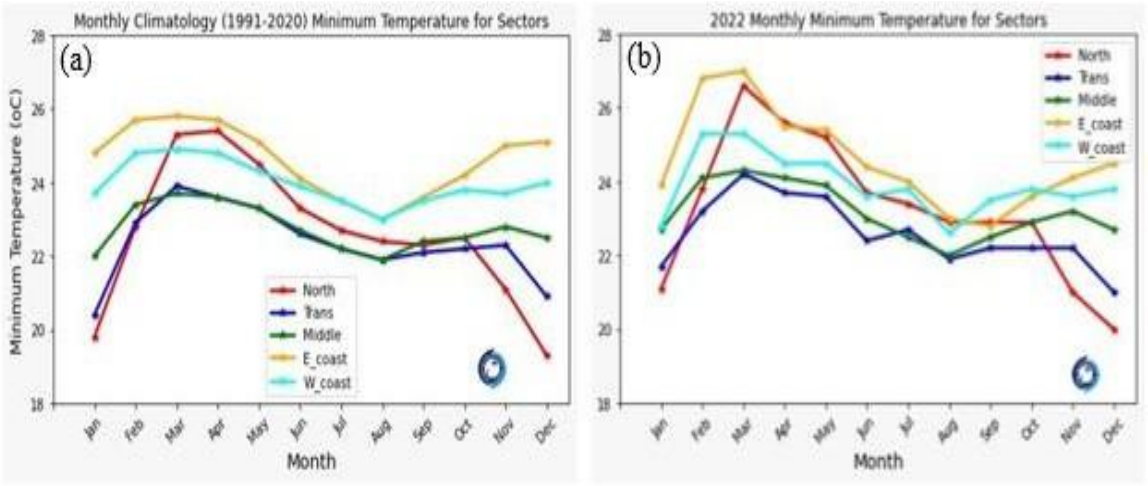

Figure 66: Monthly climatology and Monthly minimum temperature across sectors for 2022

2.4 Lowest Recorded Temperature

The rank of the lowest annual temperature from 1981 - 2022 showed that 1982 ranked 1st and 2022 ranked 6th per records (Figure 7). In general, the standardized anomaly indicates a warming trend with a positive gradient of 0.0534 (Figure 8). A two-year moving average overlay conforms with a uniform increasing pattern.

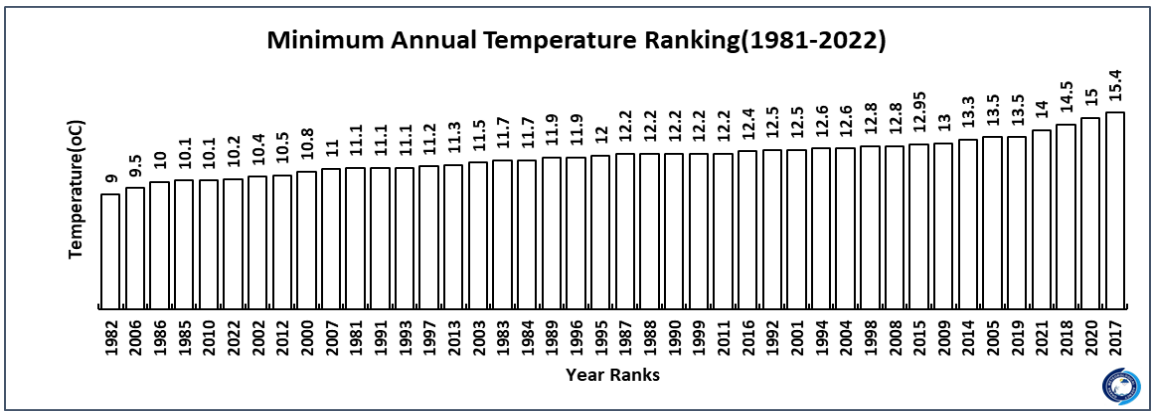

Figure 77: Ranking of Annual Minimum Temperature over Ghana from 1981 to 2022

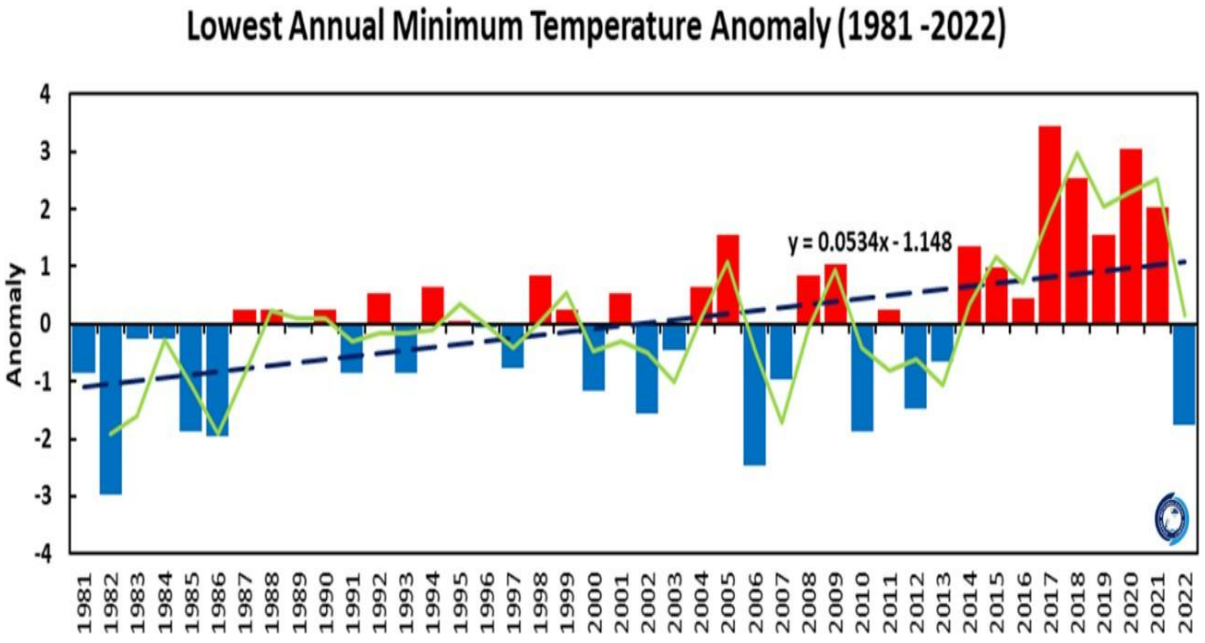

Figure 88: Lowest Annual Minimum Temperature Anomaly 1981 to 2022 with 2-year moving average

2.5 Extreme Maximum and Minimum Temperature for 2022

In 2022, analysis of the extreme maximum (Figure 9(a)) and minimum (Figure 9(b)) temperatures revealed that the sector with the extreme record was the northern sector. Although these records occurred in different months the extreme maximum specifically occurred over upper east whilst that of the minimum occurred in upper west. In reference to the climatology, the year 2022 was ranked the 16th warmest since 1981 and when it comes to the coolest ranked year, the year 2022 was also ranked 6th in position.

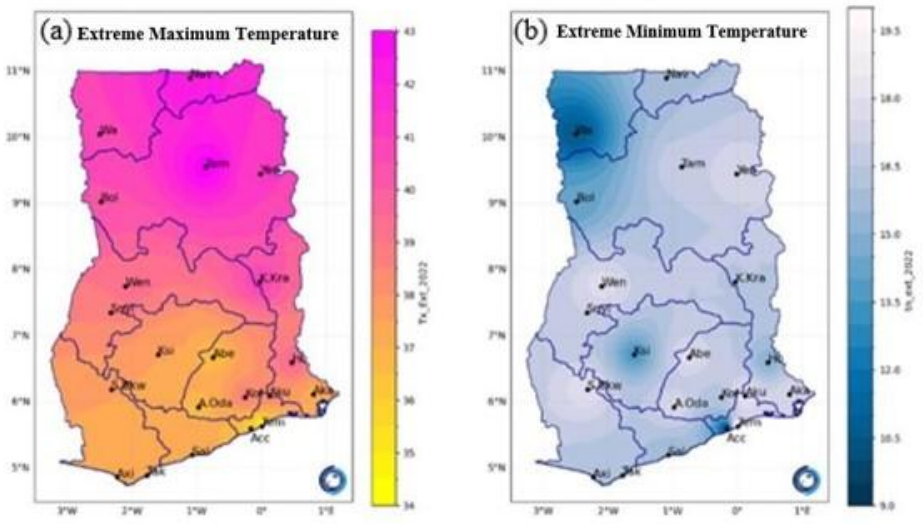

Figure 99: Extreme Maximum and Minimum Temperature in 2022

CHAPTER 3: RAINFALL

3.1 Annual Total Rainfall

The climatological rainfall map for Ghana from 1991-2020 depicts; the west coast and the forest zone receives rainfall amount of over 1800mm while the east coast and the north receives less rainfall ranging between 700mm-1000mm. Axim and Half Assini, around the west coast, receives an annual average of about 1800mm and 1900mm respectively (Figure 10(a)). The year 2022 experienced enhanced annual rainfall around the west coast (Axim-2803.1mm, Half Assini-2464.3mm and Takoradi-1314.9mm) and the extreme portion of the east coast (Accra-1077.5mm and Tema- 821.6mm). Highest annual values of over 1700mm were recorded around the western portion of the country, while most parts of the forest zone received annual rainfall values between 1200mm to 1800mm. The northern portions and part of the east coast received relatively low annual total values between 900mm to 1200mm with Salaga, over the north, recording the highest of 1263.1mm.

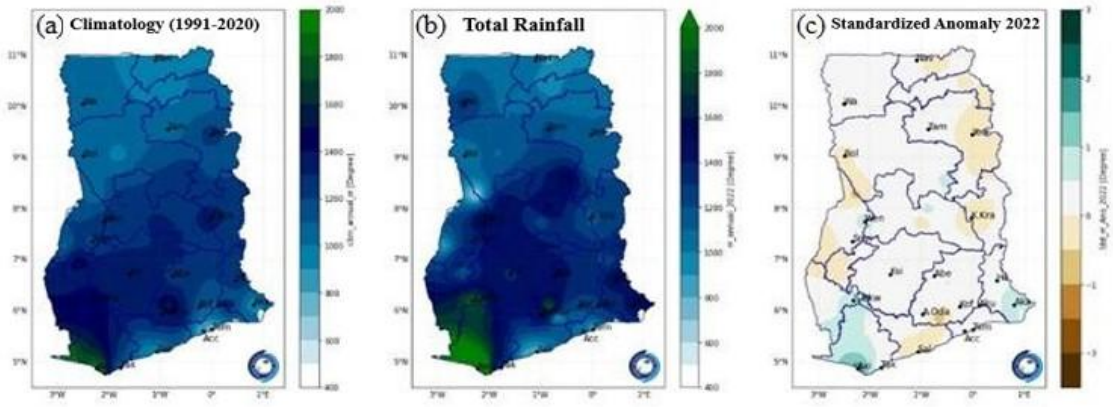

Figure 1010: Climatology, total rainfall amount and Standardized Anomaly 2022

The annual rainfall anomaly distribution for 2022 (Figure 10(b)) across the entire country, generally depicted normal rains for most portions of the country. Places such as Axim and Half Assini, around the extreme west coast, and Akatsi around the extreme eastern portion of the country, recorded some surplus rains. Axim recorded positive anomaly as shown in Figure 10(c). There were also some pockets of below normal rains across various portions of the country. Places such as Saltpond (828.1mm- LTM of 965.6mm), Dormaa Ahenkro (885.5mm-LTM of 1089.0mm) and Yendi (1108.5mm-LTM of 1231.4mm) recorded some deficit rains for the year 2022.

3.2 Annual Total Rainfall Ranking

Out of the 44 rainfall stations used to compute this analysis, an annual accumulated total rainfall climatology from 1991 to 2020 was ranked and result indicated that Half Assini recorded the highest amount of 1938.2mm followed by Axim with 1895.8mm (Figure 11). Both stations are located near the western coastline of the country where vegetation cover is highest hence supporting such rainfall amounts.

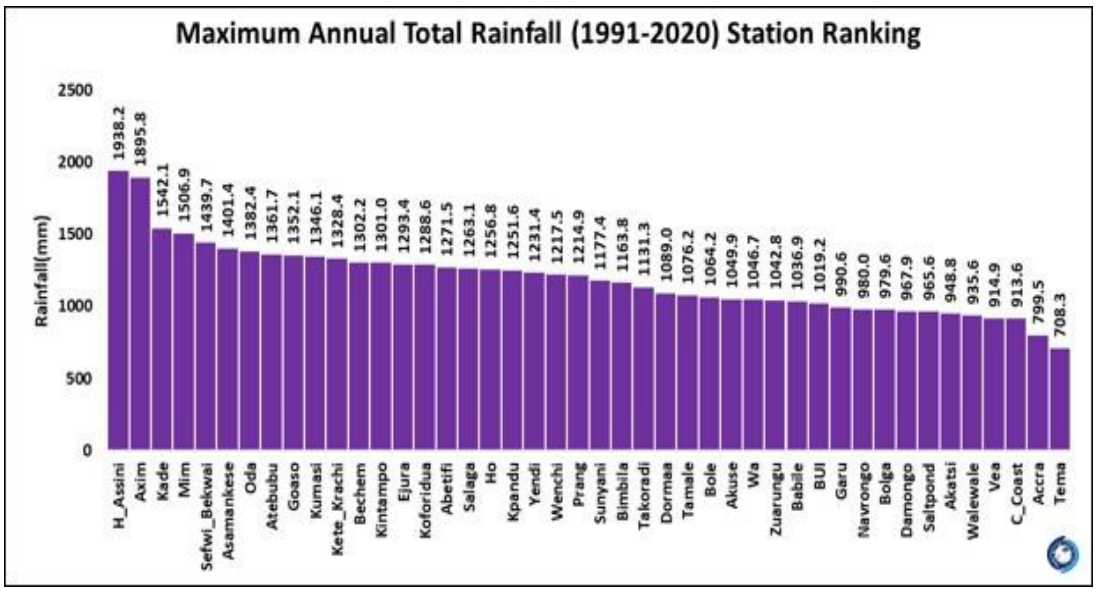

Figure 1111: Station Ranking of Maximum Annual Rainfall Total 1991 to 2020

3.3 Highest Annual Daily Maximum Rainfall (1991 – 2020)

Analysis to extract the extreme annual daily maximum rainfall over the entire country revealed Prang as the station with the highest record of 270.5mm followed by Half Assini also with an amount of 265.4mm (Figure 12). These daily records are not surprising because the stations that recorded them are in the forest zone in the south western portion of the country where vegetation cover is high hence more evapotranspiration aiding convective activities. The ranking reveals the fact that maximum annual daily rainfall is seen mostly in stations located in the southern half of the country other than the northern half. This may be attributed to the fact that; vegetative cover over the southern sector contributes greatly to this effect.

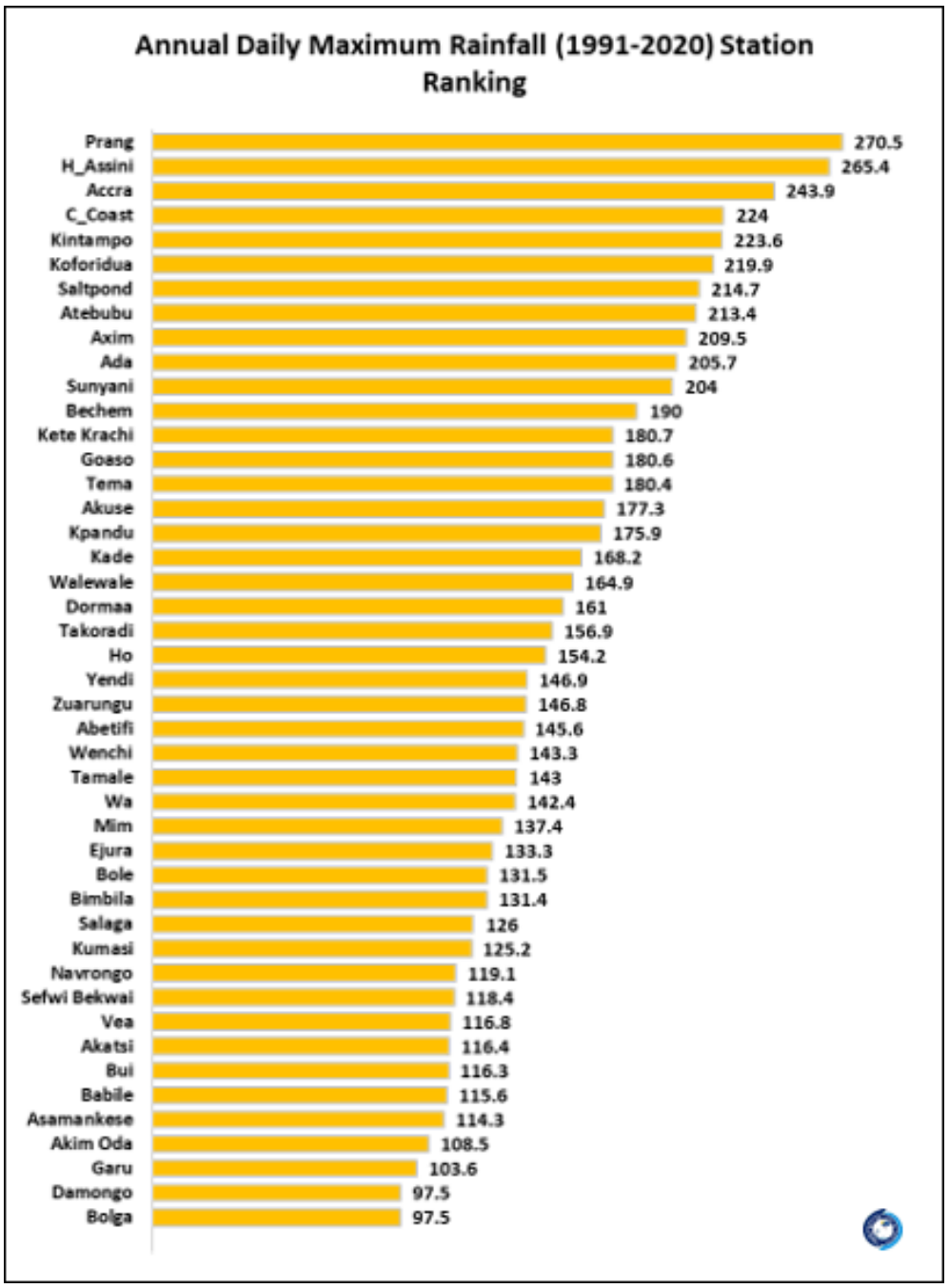

Figure 1212: Ranking of Highest Annual Daily Maximum Rainfall 1991 to 2020

3.4 Annual Rainfall Frequency

The number of rainy days or rainfall frequency per annum plays very important role in the agricultural sector as it aids annual planning. It is known that the long term mean rainfall frequency reveals the southwestern portions of the country through to the eastern region as the areas with high frequency of rainfall ranging between 100 and 140 days per annum.

Figure 13(a) is the climatological (1991 – 2020) frequency and Figure 13(b) is the annual rainfall frequency for 2022. The standardized anomaly for 2022 annual rainfall frequency (Figure 13(c)) generally indicates that there was deficit all over the entire country with only few exceptions over Western North, Ashanti West and the southern portions of the Volta region as well as Greater Accra region.

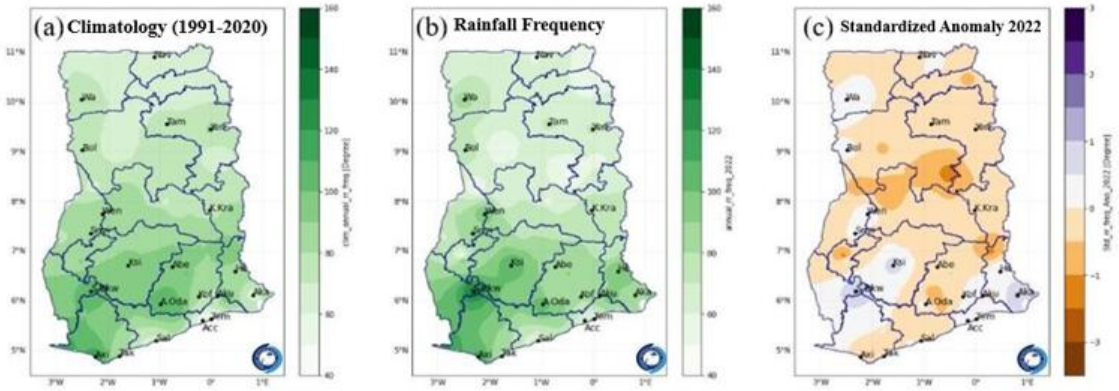

Figure 1313: Climatology, rainfall frequency,2022 and Standardized Anomaly.

3.5 Monthly Total Rainfall, Frequency and 2022 Anomaly

As alluded earlier, 45 stations were used in this analysis to understand the monthly pattern of rainfall at various zones. The zones include Coastal, Forest, Transition as well as North and represented by Axim, Accra, Ho, Kumasi, Wenchi, Kete Krachi, Navrongo and Wa respectively. The frequency of the rainfall has been analyzed for these stations to reveal the patterns. A further analysis on the 2022 total monthly rainfall anomaly also describes the performance of the rainfall over all the zones with eight stations representing each.

3.5.1 West Coast

Axim is known to be a station that experiences lots of rainfall throughout the season and also has the highest amount of rainfall records. Averagely in 2022, rainfall was in surplus for both major and minor seasons across all months except February and March which recorded deficits (see Figure 14(a) and (b)).

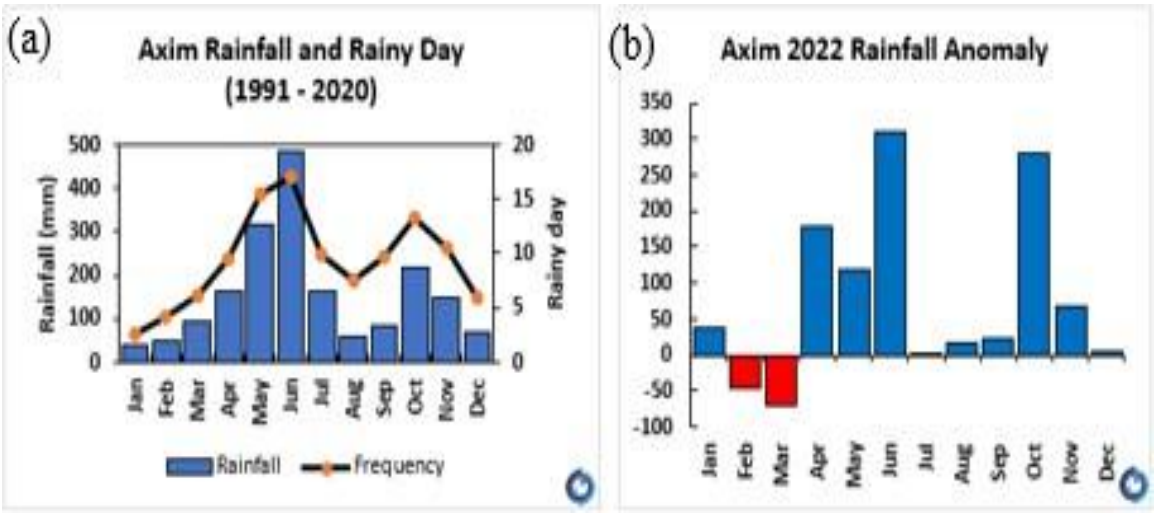

Figure 1414: Monthly rainfall climatology and monthly rainfall anomaly for Axim 2022

3.5.2 East Coast

Accra located in the East Coast in 2022 had surplus rainfall in the major and minor seasons except for the following months namely December, January – March and June as shown in figure 15.

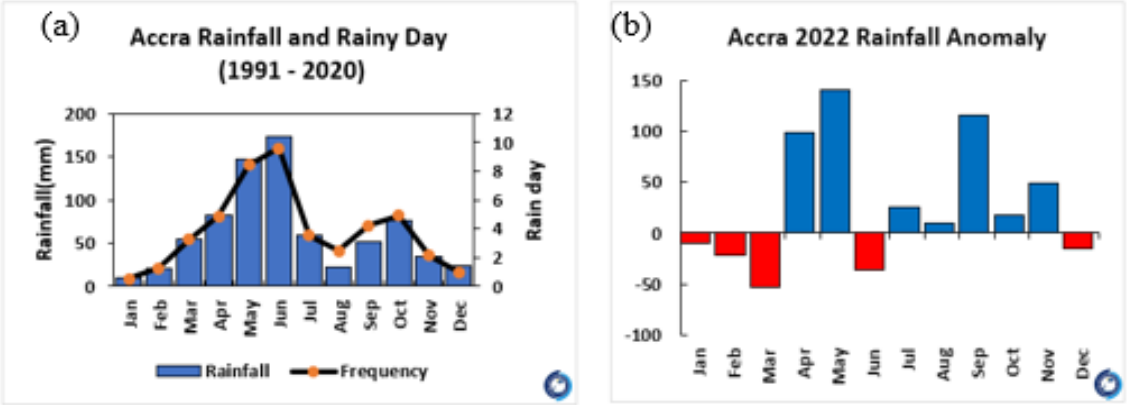

Figure 1515: Monthly rainfall climatology and Accra monthly rainfall anomaly for Accra 2022

3.5.3 Forest

Kumasi and Ho are located in the Forest zone and are characterized by major and minor seasonal rainfall patterns. In 2022, Ho experienced surplus rainfall during the major season however in the minor season, deficit rainfall was recorded (Figure 16(a) and (b)).

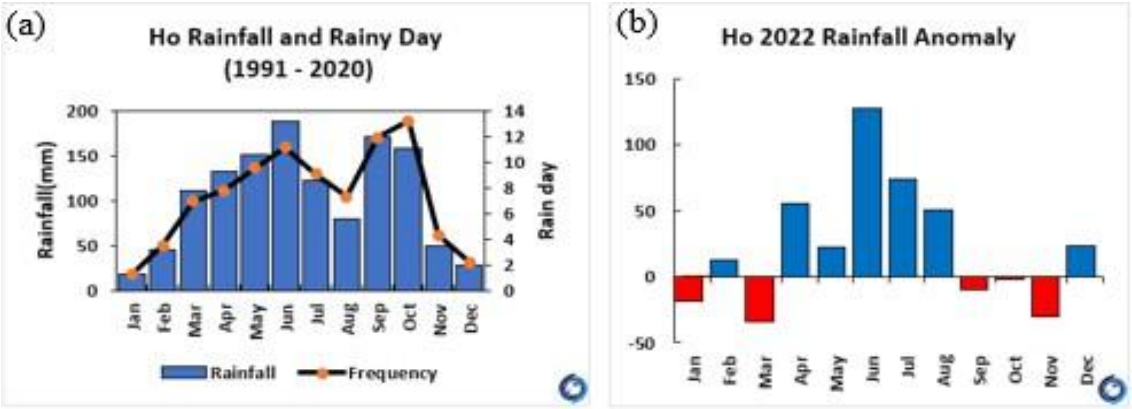

Figure 1616: Monthly rainfall climatology and monthly rainfall anomaly for Ho 2022

During the major season, Kumasi recorded lots of rainfall deficit however in the minor season, despite the fact that October recorded a deficit, the minor season was averagely above normal (Figure 17(a) and (b)).

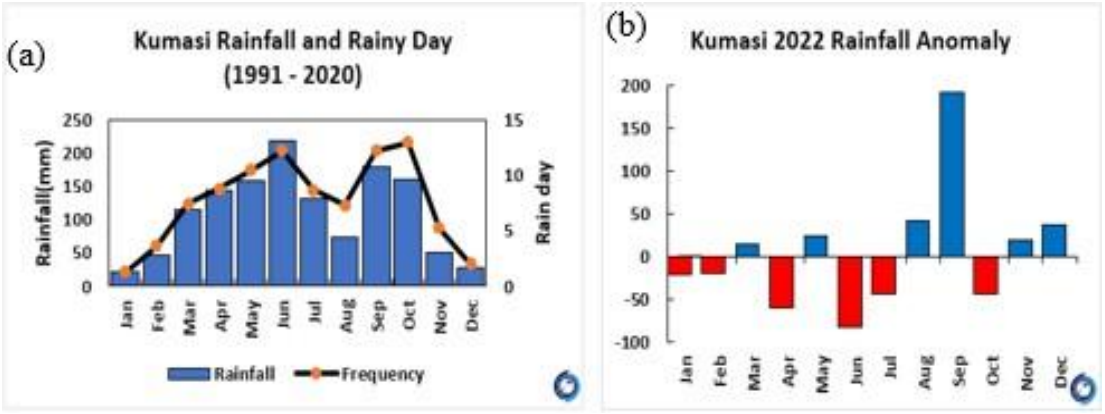

Figure 1717: Monthly rainfall climatology and Monthly rainfall anomaly for Kumasi 2022

3.5.4 Transition

The transition sector of Ghana is a very important sector of the country because it has characteristics of both north and middle sector i.e., unimodal and bimodal pattern. Averagely, high deficit rainfall was recorded during the rainy season for Kete Krachi station (Figure 18(a) and (b)) whilst for Wenchi (Figure 19(a) and (b)), there was surplus rainfall during both major and minor seasons.

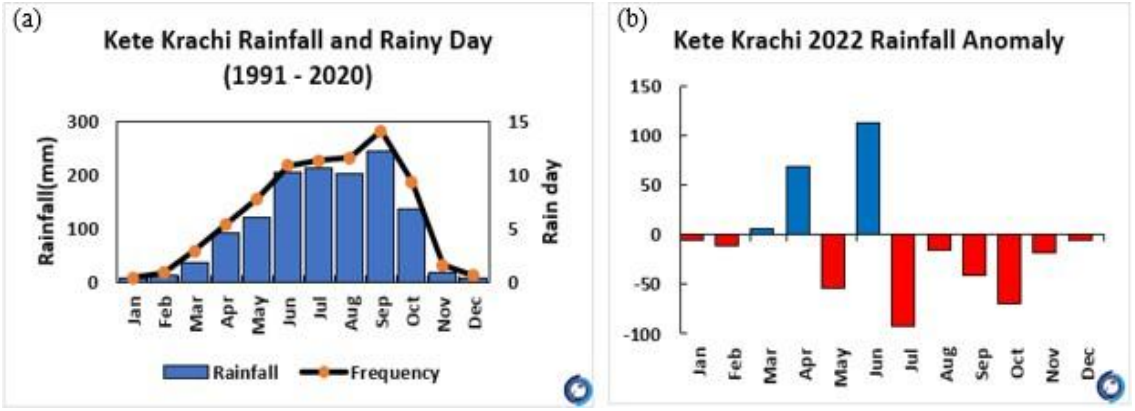

Figure 1818: Monthly rainfall climatology and monthly rainfall anomaly for Kete Krachi 2022

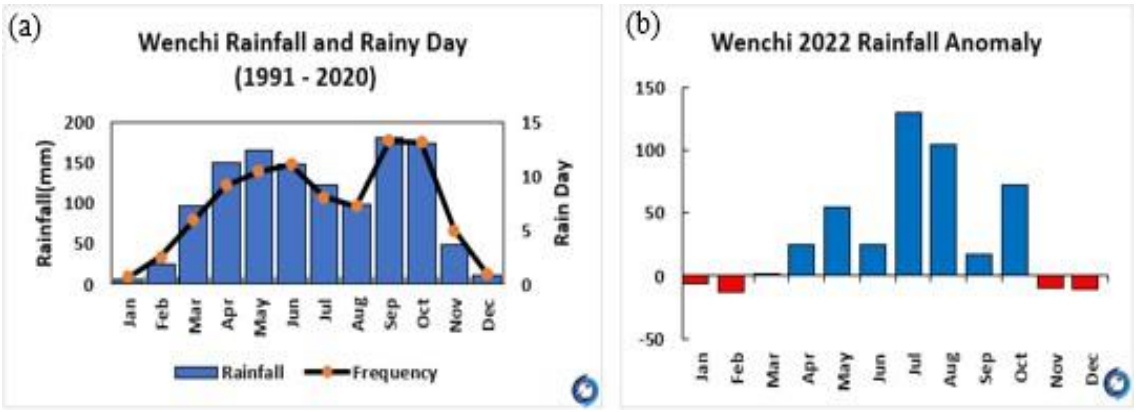

Figure 1919: Monthly rainfall climatology and Monthly rainfall anomaly for Wenchi 2022

3.5.5 North

The northern sector of the country has a unimodal rainfall pattern (Figure 20 and 21).

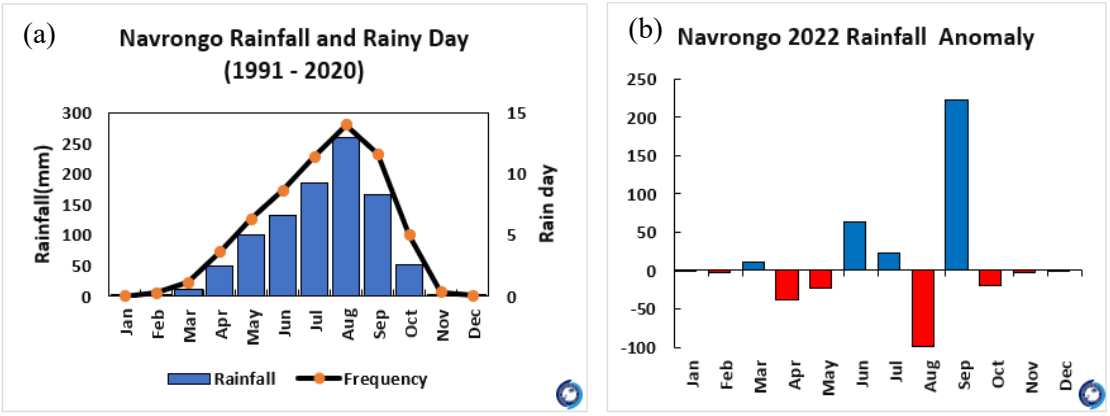

Figure 2020: Monthly rainfall climatology and monthly rainfall anomaly for Navrongo2022

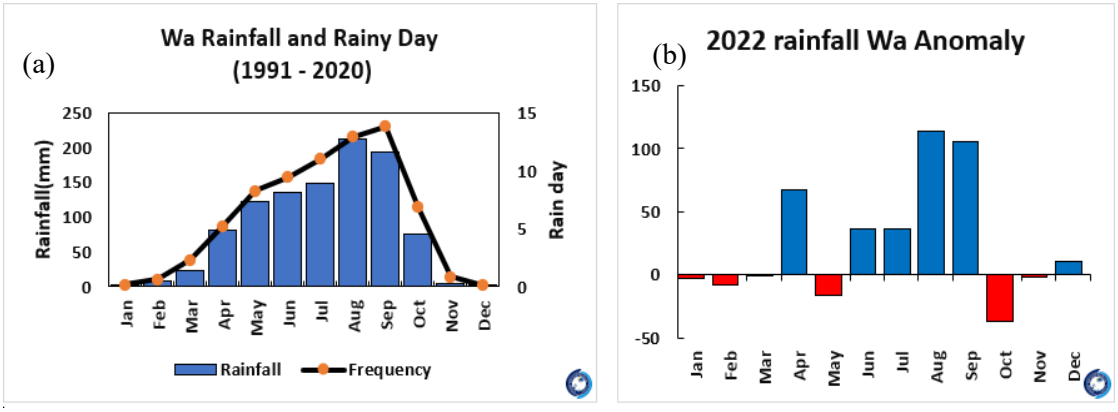

Figure 2121: Monthly rainfall climatology and monthly rainfall anomaly for Wa 2022

3.6 Seasonal Total Rainfall, Frequency and Standardized Anomaly

3.6.1 March – April – May (MAM) MAM Total Rainfall

The climatology map for MAM (1991-2020) rainfall (Figure 22(a)) for Ghana reveals the south- western portion of the country with the higher volume of rainfall. The volume of the rains reduced towards the north with the least seasonal averages occurring over the north-east portion of the country. The south-western portions experience seasonal average rainfall of above 500mm. The east coast, part of the transition and the northern portions receive seasonal average values of 200mm and 600mm.

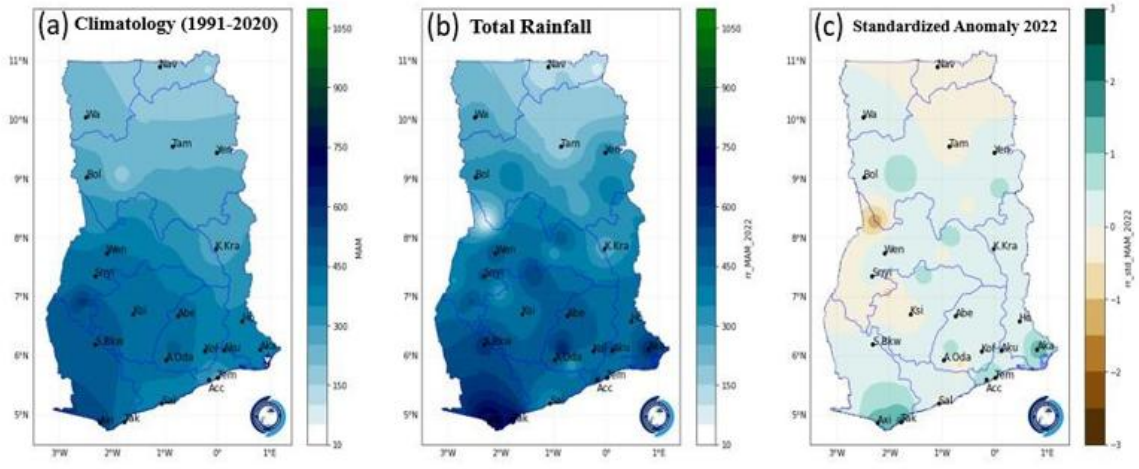

Figure 2222: Climatology, total rainfall amount and Standardized rainfall anomaly for MAM 2022

The total seasonal rainfall for MAM 2022 as in Figure 22(b), shows the south-western portions of the country recorded the highest volume of rainfall of over 600mm. Stations such as Axim, Takoradi and Half Assini recorded seasonal totals of 800.8mm, 711.7mm and 568.9mm respectively. The coast and most portions of the forest zone also experienced values above 500mm, while the least seasonal values were between 88.2mm at Garu to 379.1mm in Damongo over the north. The rainfall anomaly values (Figure 22(c)) within the season, revealed above normal rains over most parts of the country. Axim and Takoradi around the west coast recorded seasonal values of 800.8mm and 711.7mm respectively as against LTMs of 557.2mm and 394.6mm respectively. Accra and Tema along the east coast as well as other portions of the forest zone and the north-western portions of the country received some enhanced rainfall. The western portions of the middle and the north-eastern part of the north observed below normal rains for the MAM season.

3.6.2 MAM Rainfall Frequency

The number of climatological seasonal average rainy days for MAM season shows that, most portions of the forest zone including the west coast experience the highest number of rainfall occurrences (25 to 35 rainy days), compared to the other parts of the country. The least average number of rainfall occurrences were over the north and portions of the transition with 25 rainy days and below (Figure 23(a)).

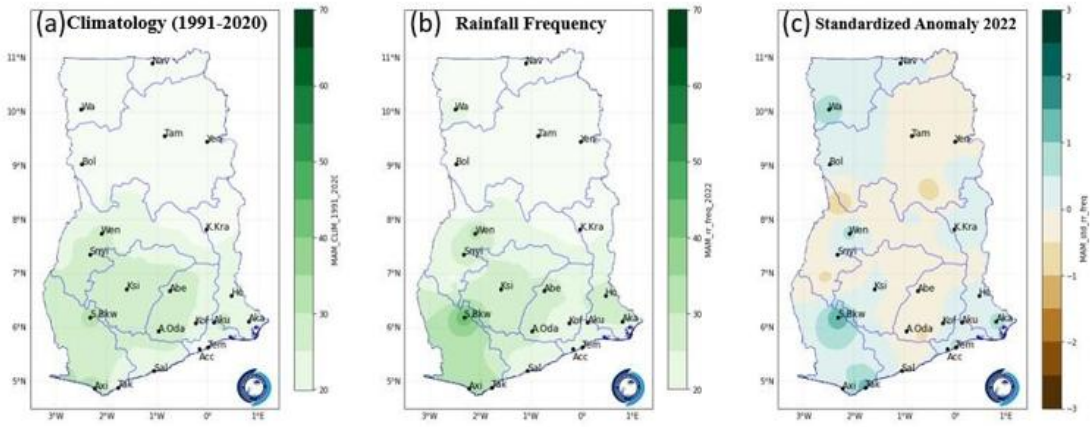

Figure 2323: Climatology, total rainfall frequency and standardized rainfall frequency anomaly for MAM 2022

The frequency of rainfall during the MAM season depicts the climatological trend where the forest zone and the west coast visibly dominate with the number of rainfall occurrence between 25 to 40 times. For the other parts of the country, the east coast had the frequency between 20 to 25 times, while part of the transition and the north experienced less than 20 number of rainy days within the period. The frequency of the average rainfall anomaly for the year 2022 reveals the south-western portions, the extreme south-eastern and the north-west visibly experiencing the highest positive anomaly during the MAM season. Most portions of the middle and the north-eastern part were also dominated with frequency of below normal rains (Figure 23(b) and (c)).

3.6.3April – May – June (AMJ) AMJ Total Rainfall

The climatological analysis on April-May-June (AMJ) seasonal rainfall for Ghana from the year 1991- 2020 shows the south-western part of the country with over 700mm of seasonal totals. The east coast, the forest zone through to parts the transition experienced average seasonal rainfall totals of about 500mm to 700mm within this period. Part of the transition and the north receive average seasonal total values between 200mm and 600mm (Figure 24(a)).

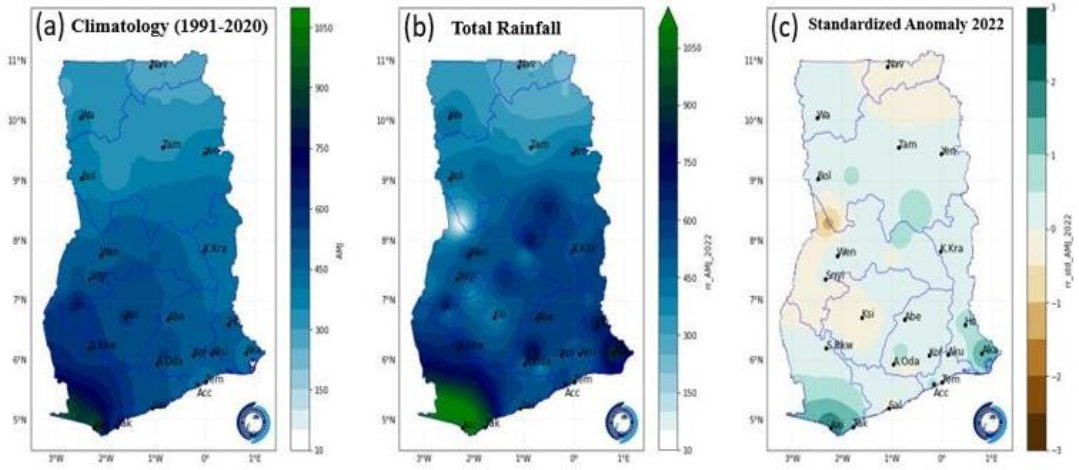

Figure 2424: Climatology, total rainfall amount and Standardized rainfall anomaly for AMJ 2022

The rainfall performance for AMJ 2022 season depicts seasonal totals values of 800mm to 1400mm over the south-western portion of the country. Part of the forest zone and the east coast received between 400mm and 700mm of rainfall. Portions of the transition and the northern part of the country also received seasonal rainfall totals of about 200mm to 500mm. The rainfall anomaly distribution for AMJ 2022 season, reveals generally normal to above normal rains over most portions of the country. Surplus rains were experienced over stations such as Takoradi, Axim and Half Assini in the west coast, Ho and Akatsi over the south-eastern fringes of the country. Below normal seasonal total rains were observed over Bui, Kumasi, Dormaa Ahenkro, Garu and Walewale during the period (Figure 24(b) and (c)).

3.6.4 AMJ Rainfall frequency

The climatology of the average number of rainfall occurrences within AMJ season (1991-2020) revealed that, the south-western portions of the country experienced average rainy days of about 45 to 55 times. The other part of the forest zone mostly receives between 30 to 40 average rainy days (Figure 25(a)).

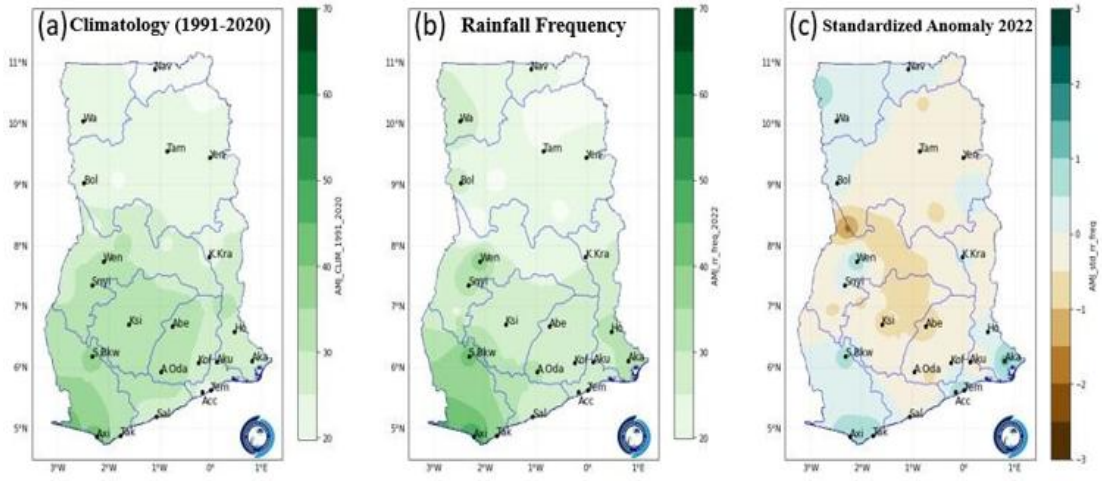

Figure 2525: Climatology, total rainfall frequency and standardized rainfall frequency anomaly for AMJ 2022

The east coast, the transition and part of the north experienced average rainy days of 20 to 35. The least average number of rainy days is observed over the north-eastern part of the country. The 2022 rainfall occurrences were higher over Axim, Half Assini and Sefwi Bekwai around the south-western portion of the country with about 40 to 55 rainy days. 30 to 45 rainfall occurrences were mostly witnessed over the forest zone. Most portions of the transition and the north experienced less than 25 rainy days (Figure 25(b)).

The anomaly plots on the number of rainfall occurrences for the 2022 AMJ season depicts mostly normal rainy days for the period. Some stations such as Takoradi, Axim, Accra, Tema, Akatsi, Wenchi and Babile experienced an increase in the number of rainfall occurrences, while station such as Bui, Kumasi, Abetifi, Kintampo and Walewale had a decrease number of rainy days (Figure 25(c)).

3.6.5 May – June – July (MJJ) MJJ Total Rainfall

The seasonal Climatology analysis of MJJ season (1991-2020) show over 600mm of rainfall totals occurring over the forest zone with high total values of about 1000mm at stations such as Dunkwa and Half Assini around the south-western portion of the country. The rest of the country experience about 400mm to 600mm (Figure 26(a)).

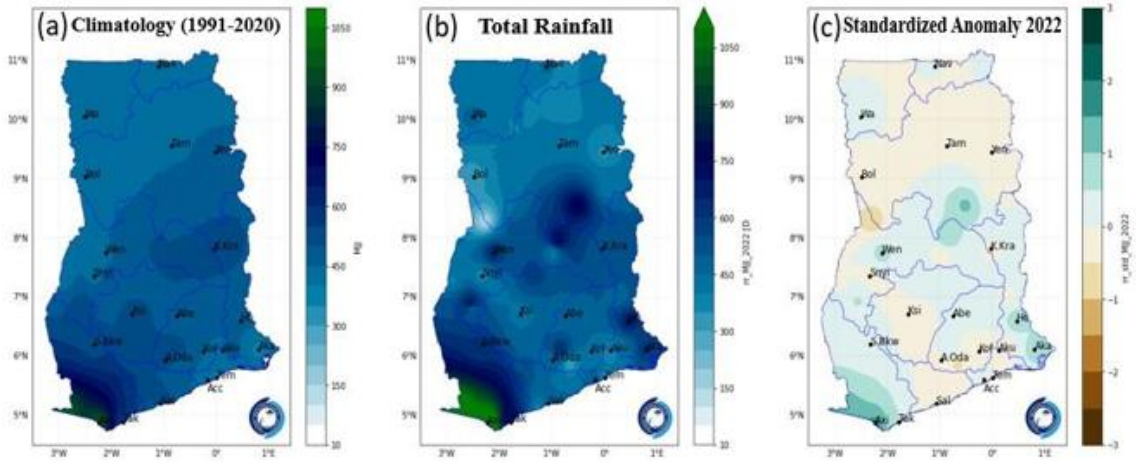

Figure 2626: Climatology, total rainfall amount and Standardized rainfall anomaly for MJJ 2022

The total seasonal values of rainfall for the year 2022 indicates high rainfall amount over the forest zone as compared to other parts of the country. The south-western portions received rainfall values above their LTMs. Higher values of over 1000mm occurred over Axim, Dunkwa and Half Assini. The east coast and that of the north experience 200mm to 600mm (Figure 26(b)).

The 2022 rainfall anomaly distribution for MJJ season indicates mostly normal rains over most parts of the country. Few stations such as Axim, Half Assini, Akatsi, Ho, Wenchi, Salaga and Prang experienced above normal rains within the period, while below normal rains were also experienced at Bui and Asamankese (Figure 26(c)).

3.6.6 MJJ Rainfall Frequency

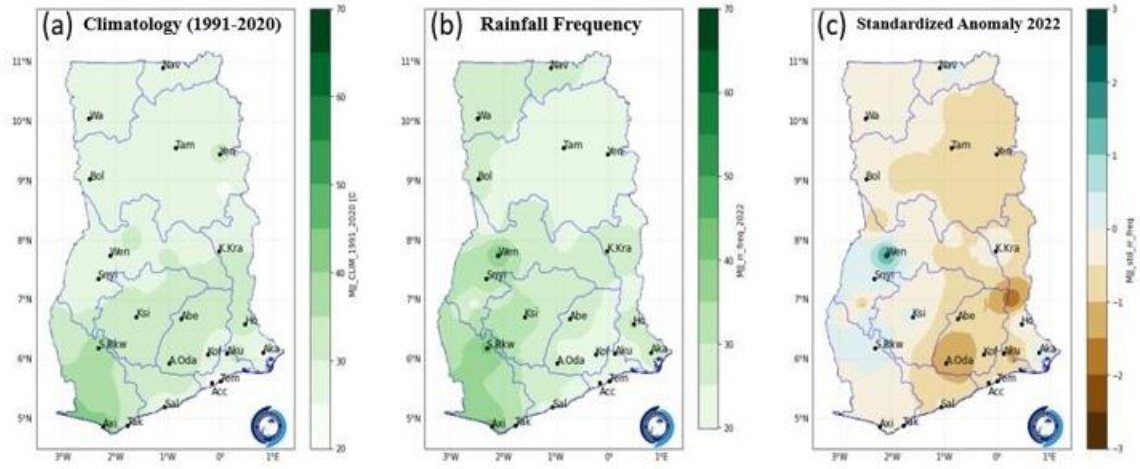

Figure 2727: Climatology, total rainfall frequency and Standardized rainfall frequency anomaly for MJJ 2022

The average seasonal rainfall frequency for MJJ (1991-2020) (Figure 27(a)) over Ghana depicts that, the extreme south-western part, with stations such as Axim, Half Assini and Dunkwa experiences a little above 40 rainy days. Between 30 to 35 average rainy days occurs over stations such as Kumasi, Abetifi and Ho within the forest zone. The east coast and the northern part of the country receives less average number of rainy days between 20 to 30 rainy days. The number of rainy days during the MJJ season for 2022, show stations such as Axim, Dunkwa, Half Assini and Sefwi Bekwai experienced 41, 50, 40 and 41 rainy days respectively (Figure 27(b)). The rest of the stations across the country experienced between 20 to 30 rainfall occurrences. The anomaly on rainy days for the period reveals stations such as Sefwi Bekwai, Dunkwa, Wenchi and Akatsi experienced increase rainy days while the rest of the stations across the country had generally normal rainy days. Decreased number of rainy days were observed over Aim Oda, Akuse and Kpando during the MJJ season (Figure 27(c)).

3.6.7 June – July – August (JJA) JJA Total Rainfall

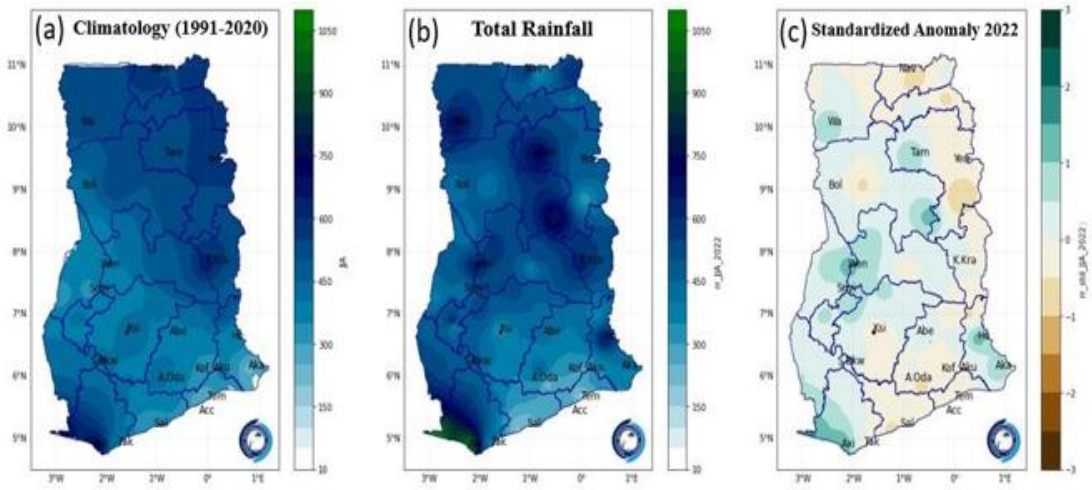

Figure 2828: Climatology, total rainfall amount and Standardized rainfall anomaly for JJA 2022

The climatology for JJA rainfall season (1991-2020) show stations around the extreme south-west (Dunkwa, Axim and Half Assini) with higher seasonal average rainfall values of between 700mm to 1000mm. Between 500mm and 600mm over the northern part of the country and between 300mm 500mm over the rest of the country (Figure 28(a)). The total rainfall recorded for the year 2022 shows that, Dunkwa, Half Assini and Axim reported seasonal value of 1189.2mm, 1078.9mm and 1032.2mm respectively. Tamale, Wa and Salaga over the north, recorded 711.7mm, 682.0mm and 791.2mm respectively, while the rest of the country witnessed total seasonal rainfall values between 200mm and 500mm. The rainfall anomaly analysis depicts stations such as Axim, Half Assini, Ho, Akatsi, Wenchi, Salaga, Tamale and Wa experienced above normal rains. Below normal rains were also experienced over stations such as Damongo, Bolgatanga, Zuarungu, Garu, Bimbila and Cape Coast within the period (Figure 28 (b) and (c)).

3.6.8 JJA Rainfall Frequency

Annual average number of rainy days for JJA season (1991-2020), reveals most stations over the north with 30 to 36 average rainfall occurrences. Stations such as Tema, Akuse, Akatsi, and Accra experience the least average rainy days between 16 and 20 (Figure 29 (a)).

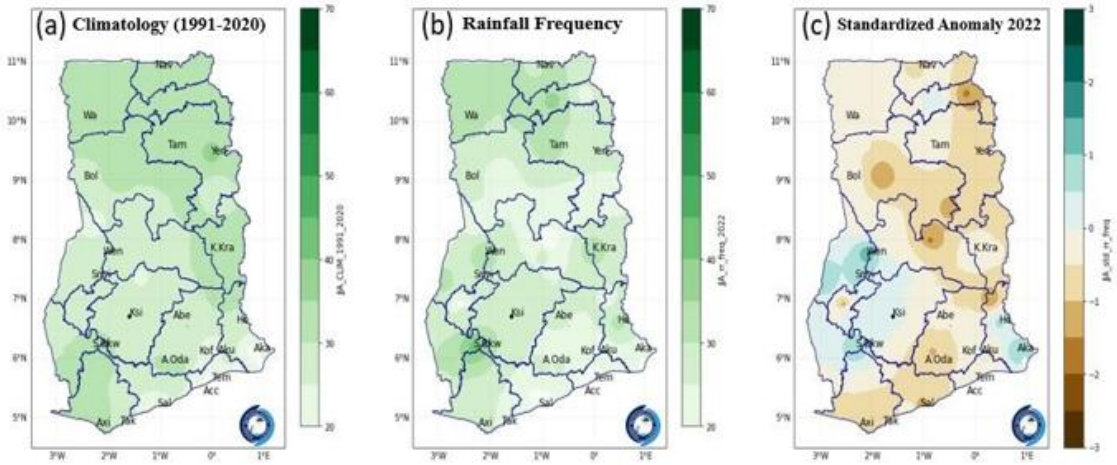

Figure 2929: Climatology, total rainfall frequency and Standardized rainfall frequency anomaly for JJA 2022

The frequency of rainfall during the year 2022 were mostly lower than the average rainy days across all sectors of the country. Few stations such as Sefwi Bekwai, Dormaa Ahenkro, Sunyani, Wenchi, Ho and Akatsi experienced number of rainy days above their LTMs. The anomaly analysis on rainfall frequencies over the period reveals mostly normal number of rainy days across most parts of the country with some stations like Wenchi, Sunyani, Dormaa Ahenkro, Sefwi Bekwai, Ho and Akatsi experiencing above their LTMs. Below normal rainy days were experienced over stations such as Damongo, Kpando, Prang, Salaga and Saltpond during period (Figure 29(b) and (c)).

3.6.9 July – August – September (JAS) JAS Total Rainfall

The climatology analysis for JAS season (1991-2020) reveals the concentration of the rains over the northern portions of the country. The higher seasonal average values of over 500mm are witnessed over this part of the country, while there is a significantly reduced average values of less than 500mm, especially, along the coast of the country. The analysis of 2022 seasonal rainfall for JAS season indicates mostly above 500mm of rainfall totals over the northern portions and part of the transition zone of the country. Part of the forest zone and the coastal portions of the country received less rains with stations such as Takoradi and Cape Coast recording seasonal totals of 93.5mm and 100.4mm respectively. The concentration of the rains shifts northwards leading to the usual break of rainfall over the southern part of the country (Figure 30(a) and (b)).

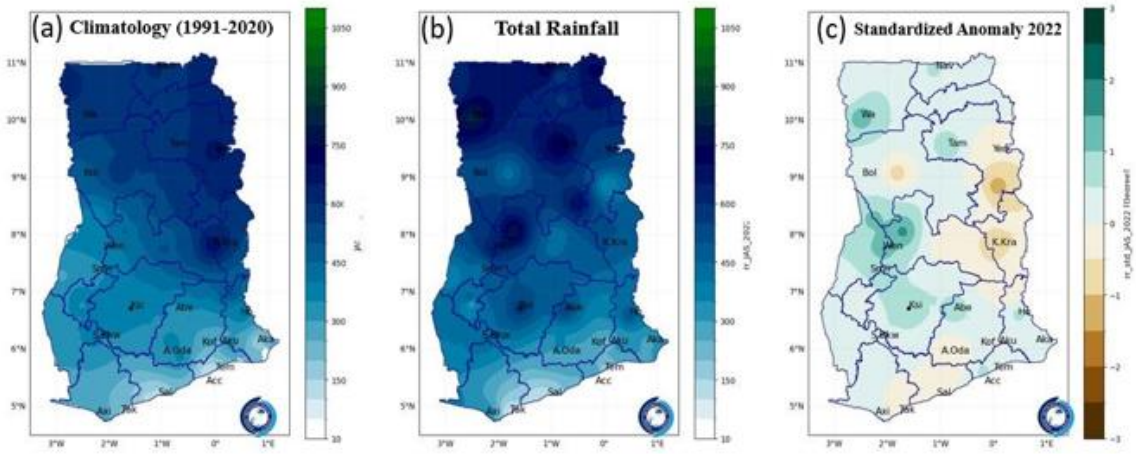

Figure 3030: Climatology, total rainfall amount and Standardized rainfall anomaly for JAS 2022

The rainfall anomaly analysis for JAS season indicates generally normal rains for most parts of the country. Above normal rainfall was experienced over stations such as Wa, Navrongo, Tamale, Wenchi, Kintampo, Bui, Sunyani, Kumasi, Abetifi and Ho. Stations with rainfall amount that was below their LTMs were Takoradi and Cape Coast within the period (Figure 30(c)).

3.6.10 JAS Total Rainfall Frequency

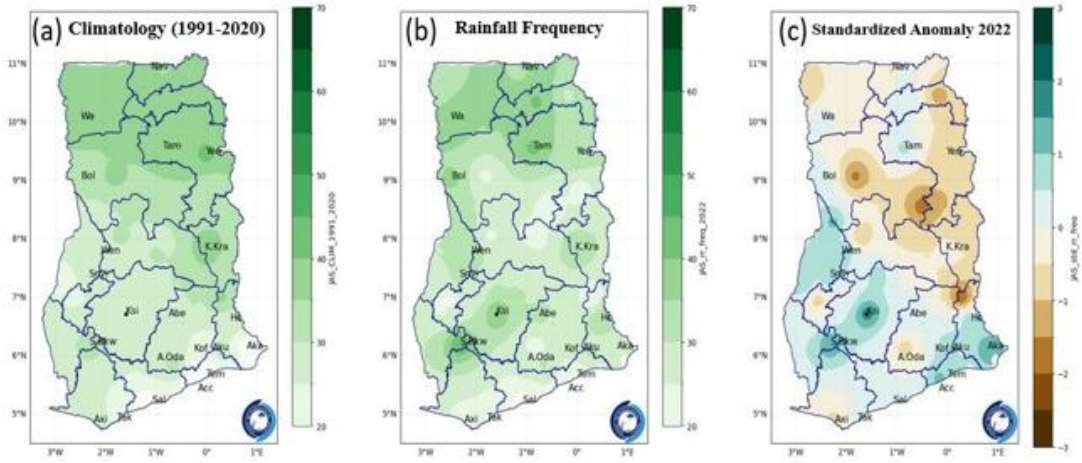

Figure 3131: Climatology, total rainfall frequency and Standardized rainfall frequency anomaly for JAS 2022

The average rainfall frequency during JAS season is relatively higher over the northern part of the country compared to the south. Average rainfall occurrences of over 30 rainy days were experienced over the north during JAS season, while the least average number of rainy days of less than 20 occurs around the coast. The number of rainfall frequencies within JAS 2022 season show that, most stations over the north witnessed above 30 rainy days. The southern portions experienced less rainfall frequencies with the least number of rainy days along the east coast (Figure 31(a) and (b)). The anomaly analysis on the rainfall frequencies across all sectors of the country indicates generally normal rainfall occurrences. Stations that experienced increase number of rainy days were Akatsi, Accra, Sefwi Bekwai and Bui. Decrease number of rainfall occurrences were witnessed over Damongo, Salaga and Kpando (Figure 31(c)).

3.6.11 August – September – October (ASO) ASO Total Rainfall

Analysis on the climatology situation of seasonal rainfall for ASO season (1991-2020) over the country reveals most parts of the north, transition and the forest zone with more rainfall activities (recording average rainfall between 200mm to 500mm), while several portions of the coast record the least rainfall amount of less than 200mm (Figure 32(a)).

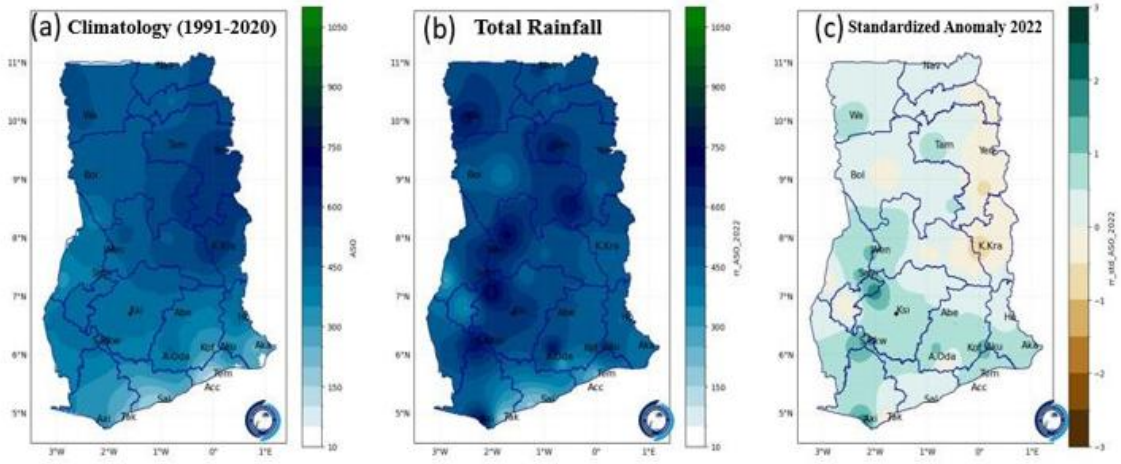

Figure 3232: Climatology, 2022 total ASO rainfall amount and Standardized rainfall anomaly for ASO 2022

The 2022 rainfall distribution for ASO season was generally wet with most stations recording rainfall values that were above their LTMs. Stations such as Bechem, Kintampo, Sefwi Bekwai, Kade, Wa, Tamale and Axim recorded seasonal totals that were above 600mm. Most stations including the coast recorded seasonal total above their long-term means. The analysis on rainfall anomaly distribution for ASO season across all sectors of the country shows, generally normal to above normal rains. Some of the stations with above normal rainfall were Wa, Tamale, Salaga, Wenchi, Sunyani, Bechem, Kumasi, Sefwi Bekwai, Abetifi, Koforidua, Accra and Tema. Below normal seasonal totals were witnessed over Bimbila and Kete Krachi during the period (Figure 32(b) and (c)).

3.6.12 ASO Total Rainfall Frequency

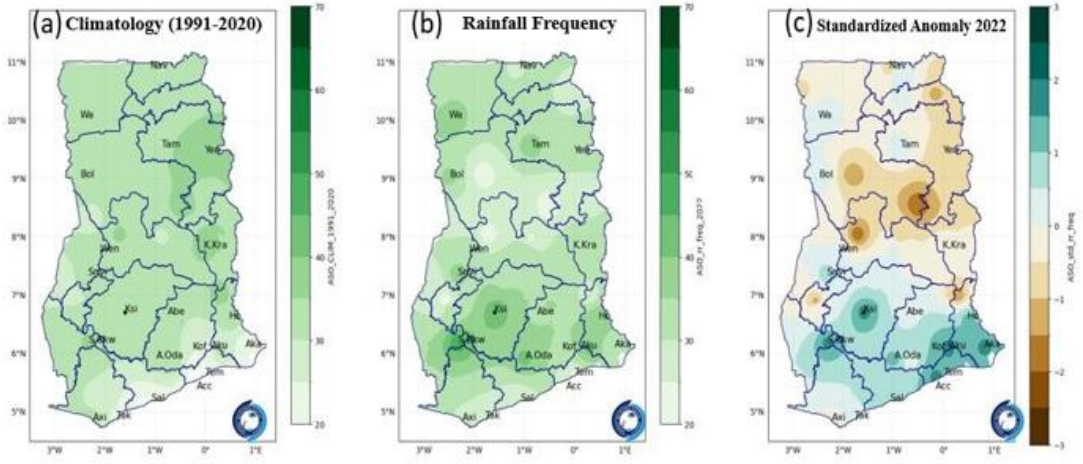

Figure 3333: Climatology, total rainfall frequency and Standardized rainfall frequency anomaly for ASO 2022

The analysis of climatological frequencies on rainfall for ASO season shows most parts of the country with average of over 25 rainy days. The northern portions, the transition and the forest as well as the west coast experienced an average of over 30 rainy days. Stations along the east coast, such as Tema, Accra, Saltpond and cape Coast experienced less than 20 average rainy days during the season (Figure 33(a)). The frequency on rainfall for 2022 ASO season was variable across all sectors of the country with 18 rainy days over Mim to 48 number of rainy days over Sefwi Bekwai. Over 35 rainy days were witnessed over Wa, Bole and Tamale in the north and Wenchi, Sunyani, Sefwi Bekwai, Akim Oda and Ho over the southern portion. The anomaly analysis on 2022 rainfall frequencies (1991-2020), reveals an increase number of rainy days over some stations such as Sunyani, Kumasi, Sefwi Bekwai, Akim Oda, Ho, Koforidua, Akatsi, Accra and Tema in the south. A decreased number of rainfall frequencies were experienced over Babile, Navrongo, Zuarungu, Damongo, and Salaga, Yendi in the north and Kpando and Bechem over the south (Figure 33 (b) and (c)).

3.6.13 September – October – November (SON) SON Total Rainfall

The climatological analysis on SON seasonal rainfall over the country shows reduction in rainfall totals over the north and parts of the transition, as compared to the previous season (ASO). This reflects the usual reduction in rainfall activities in the northern part of the country. The total seasonal rains of less than 300mm were experienced over the north, while between 300mm to 600mm are witnessed over the south during the period (Figure 34(a)).

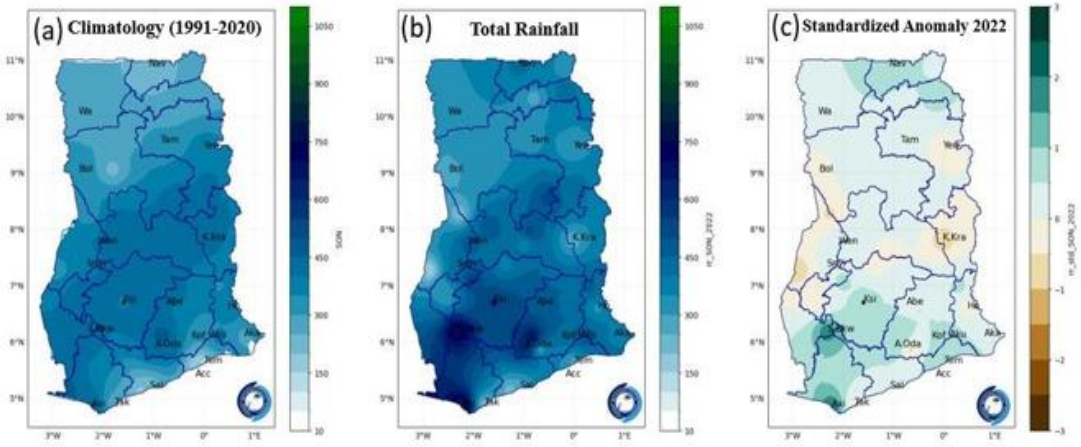

Figure 3434: Climatology, total rainfall amount and Standardized rainfall anomaly for SON 2022

The 2022 SON seasonal rainfall analysis indicates that the season was generally wet over most parts of the country with many stations recording some appreciable amount of rainfall. Stations with less seasonal rainfall totals, compared to the LTMs were Bole, Bui, Dormaa Ahenkro, Kete Krachi, Takoradi Asamankese and Ho. The analysis on rainfall anomaly for SON season depicts generally normal rains for the season. Station that witnessed seasonal rainfall totals above their LTMs were Navrongo, Zuarungu, Sefwi Bekwai, Kumasi, Axim, Half Assini, Accra, Tema, Koforidua and Akuse. Below normal rains were experienced over stations such as Bui, Kete Krachi and Dormaa Ahenkro (Figure 34(b) and (c)).

3.6 14 SON Total Rainfall Frequency

The analysis on average rainfall frequencies for SON season (1991-2020) depicts that, the northern part of the country experienced 16 rainy days (Vea) to 27 rainy days (Salaga). Over the transition the average rainfall frequency ranges between 22 rainy days (Bui) to 33 rainy days (Atebubu). Over the forest zone, the rainfall occurrences range between 23 rainy days (Akatsi) to 38 rainy days (Akim Oda) and along the coast the rainfall frequency is between 11 rainy days (Tema) to 37 rainy days (Half Assini) (Figure 35(a)).

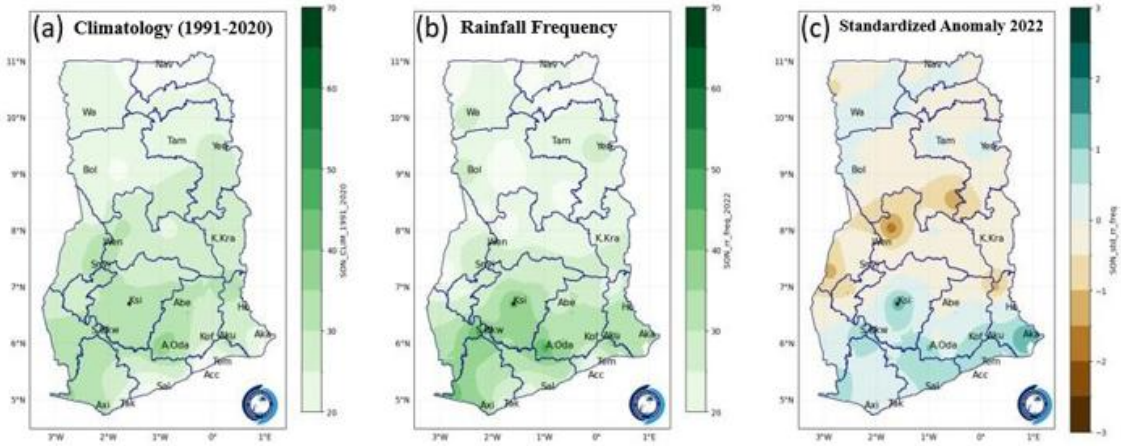

Figure 3535: Climatology, total rainfall frequency and Standardized rainfall frequency anomaly for SON 2022

The 2022 rainfall frequency analysis reveals generally normal rainfall occurrences with the north witnessing number of rains ranging between 16 rainy days (Navrongo) to 28 rainy days (Yendi). The transition portions of the country experienced a reduction in rainfall occurrences, between 16 rainy days (Kintampo) to 30 rainy days (Wenchi). The forest zone experienced 15 rainy days (Dormaa Ahenkro) and 47 rainy days (Akim Oda), while the coast recorded between 8 rainy days (Tema) to 46 rainy days (Half Assini) (Figure 35(b)). The anomaly analysis on rainfall frequencies for 2022 SON season indicates generally normal rainfall frequencies for the season. Few stations that recorded rainfall occurrences that was above their LTMs were Akatsi, Axim, Half Assini, Sefwi Bekwai, Wenchi, Prang and Salaga (Figure 35(c)).

CHAPTER 4: EXTREME EVENTS IN 2022

No	Region	Community affected	Rainfall Amount at a nearest weather station	Day	Link
1	Greater Accra	Accra, Kwame Nkrumah Circle	**175.2mm** from Accra Academy Station	21st May, 2022. Saturday	Saturday's rains cause floods in Accra | General News (classfmonline.com)
2	Greater Accra	Kaneshi, Kwame Nkrumah Circle, Osu, Adabraka, Abossey Okai	**192.0mm** from Accra Academy station	24th May, 2022. Tuesday	Ghana: Disruptions ongoing due to flooding in parts of Accra as of May 24| Crisis24 (garda.com)
3	Greater Accra	Kaneshi, Sakaman	**45.1mm** from Accra Academy station	5th June, 2022. Sunday	Parts of Accra flooded again after downpour (citinewsroom.com)
4	Greater Accra	National Theater, Osu, Atta Mills High Street. Teshie. Labadi, Haatso	**101.5mm** from National Archives station	15th June, 2022. Thursday	#AccraFloods: Police issues alert after hours of rainfall leaves parts of capital submerged (VIDEO) - Graphic Online
5	Central Region	Junkwa, Amamoma. Ankaful.		18th June, 2022. Saturday	River Surowi divides road into 2, travellers stranded on both ends (video) | Pulse Ghana
6	Western Region	Takoradi, Bankyease, Adu,		21st June, 2022. Tuesday	Parts Of Sekondi - Takoradi Submerged
7	Greater Accra	Circle, Adabraka, Kaneshie	**93.9mm** from Accra Girls Senior High	4th July, 2022. Monday	Parts of Accra flooded again, social media users react (ghanaweb.com)

Table 11: Flood records in 2022 in Ghana during the rainy season

Figure 36: 7 dies after boat carrying 20 passengers capsized on the Volta Lake on 14th April 2022 due to a storm

Figure 37: Coastal floods due to tidal waves on 10th October 2022

Figure 38: Flooding at Sakaman a suburb of Accra on the 5th June 2022

Figure 39: Flooding in Kwame Nkrumah Circle on 21st May 2022

Figure 40: Flooding in Kaneshie on 4th July 2022

Figure 41: Flooding in Haatso on 15th June 2022

CONCLUSION

The findings presented in the State of the Climate in Ghana 2022 underscore the reality that Ghana's climate is undergoing significant and, in many respects, unprecedented changes. The documented increases in temperature, coupled with the heightened variability and extremity of precipitation patterns, are consistent with the projections of global climate models and the assessments of the IPCC (2013). These changes are not merely of academic interest; they have direct and far-reaching implications for the nation's socio-economic development, environmental sustainability, and public well-being.

The report's analysis of temperature data reveals a persistent warming trend, with 2022 ranking among the warmest years on record for many locations across the country. The spatial and temporal distribution of temperature anomalies point to the pervasive influence of global warming, driven by the accumulation of greenhouse gases in the atmosphere. The implications for heat stress, agricultural productivity, and human health are significant, particularly in vulnerable communities with limited adaptive capacity.

Precipitation patterns in 2022 were characterized by both surpluses and deficits, reflecting the complex interplay of atmospheric circulation systems that govern Ghana's climate. The occurrence of extreme rainfall events and the resulting floods highlights the increasing volatility of the hydrological cycle, with profound consequences for infrastructure, food security, and disaster risk management. The report's documentation of these events provides a compelling case for the urgent enhancement of early warning systems and the mainstreaming of climate risk into national development planning.

Perhaps most importantly, the "State of the Climate in Ghana 2022" serves as a clarion call for action. The evidence presented leaves no doubt that climate change is already impacting Ghana, and that the window for effective adaptation and mitigation is narrowing. The report advocates for the integration of climate science into policy and practice, the strengthening of institutional capacities, and the mobilization of resources to support climate-resilient development.

In conclusion, the Ghana Meteorological Agency has provided a valuable service to the nation by producing this comprehensive assessment of the state of the climate. The report offers a solid foundation for future research, policy formulation, and public engagement on climate issues. As Ghana navigates the challenges and opportunities of a changing climate, the insights contained herein will be indispensable in guiding the nation towards a more resilient and sustainable future.

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