International Journal of Geography and Regional Planning Research
Vol.9, No.1, pp.1-12, 2024
Print ISSN: 2059-2418 (Print),
Online ISSN: 2059-2426 (Online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

Rainfall and Temperature Variability in Some Selected Areas of Northern Nigeria: Evidence from Rainfall Parameter

Ejeh Lawrence Udeh, Tijjani Yahaya Abdullahi and Lawan Bulama
Department of Geography, Federal University Gashua, Nigeria
Email: tijjaniyansabo@gmail.com

doi : https://doi.org/10.37745/ijgrpr.15/vol9n1112 Published November 16, 2024

Citation : Udeh E.L., Abdullahi T.Y. and Bulama L. (2024) Rainfall and Temperature Variability in Some Selected Areas of Northern Nigeria: Evidence from Rainfall Parameter, *International Journal of Geography and Regional Planning Research*, Vol.9, No.1, pp.1-12

Abstract : *Rainfall variability has become a topical concern largely because of its impacts on natural and human systems. Rainfall data spanning a period of 30 years (1988-2018) for four stations in northwestern Nigeria (Minjibir, Lere, Musawa and Illella) were used to determine the trend in annual rainfall for the region. Five-year running mean was calculated for annual rainfall for the selected stations. The decadal means were compared with the long-term mean. Evidence from the four stations considered shows that there is significant increase in annual rainfall amount in the last decade of the study. It means, therefore, that we are experiencing wetter conditions in the Sudano-sahelian zone of Nigeria. The findings further revealed that the region is becoming wetter in terms of the climatic elements (rainfall and temperature). It further shows that there is a vice versa between the selected cereals crops and the weather parameters (High climatic variables produce low yield of selected cereals crops). The study recommended that more emphasis on dissemination of weather variability and changes through the mass media is highly needed; there is need for extension agents, policy makers and researchers to try and get farmers to effectively adapt to climate change.*

Key words: agriculture; climate change; rainfall; temperature, variability

INTRODUCTION

Agriculture largely depends on climate, hence climatic factors such as precipitation, solar radiation, wind, temperature, relative humidity solely determine distribution of crops and their productivity. Rosenthal (2003) observed that changes in temperature and precipitation directly affect crop production and can even alter the distribution of agro-ecological zones; especially in Africa, and agricultural losses can result from climate variability and the increased frequency of changes in temperatures and precipitation (including drought and floods). Food and Agriculture Organisation (FAO, 2005) reported that by 2100, Nigeria and other West African countries are likely to have agricultural losses of up to 4% due to climate change. Given that

rainfall changes will present a major threat to so many smallholder farmers who account for most of the food crops produced in Nigeria rely directly on rainfall for their foods and livelihood (Ikpe, 2021).

The Sudan-Sahel savannah bioclimatic zone is characterized by a savannah type climate with alternating wet and dry seasons. Rainfall in this region varies from 1500mm per annum in the southern part to 400 mm in the northern part (Ariko et al, 2024). The rainy season lasts from about 7 months (April to October) in the southern part to as low as 3 months (July to September) in the northern part (Ati et al. 2002). The rainfall intensity is very high between the months of July and August. As a result, the environment is generally dry, crops are frequently lost through too much rain. It also results in rapid surface run-off, soil erosion and water-logging (Udo, 1970). Besides, inter-annual variability is high (Iwegbu, 1993). Because of the large inter-annual variability of rainfall, this zone is subject to frequent dry spells, often resulting in severe and widespread droughts, capable of large scale destruction of plants, animals and human life (Ati et al. 2002). The gross features of rainfall patterns in this region, as in other parts of the country are usually in association with what is often called the Inter Tropical Discontinuity (ITD) (Oladipo, 1993). The movement of the ITD northwards across the country between January and August, and its retreat from the southern fringe of the Sahara desert, after August, cause much part of Nigeria to experience seasonal rainfall (Olaniran and Summer, 1989). The ITD itself is the boundary at the ground between the dry Tropical Continental (cT) air of northern origin and the moist Tropical Maritime (mT) air of southern origin.

It has been argued that the convergence of trade wind and monsoonal airflow, in the region of the ITD, is unable to produce sufficient vertical motion (and depth of clouds) to induce rainfall (Hulmes and Tosdevin, 1989). The relevance of the ITD therefore lies in its provision of a framework for following the south/north motion of the rain bearing maritime air mass (mT). Within the mT air mass is enclosed a number of rainfall producing systems, such as the disturbance lines (especially the easterly waves), squall lines and the two tropospheric jet streams. It is the magnitude of these systems that influences the amount and seasonal distribution of rainfall over the region (Ayoade, 1988).

Agricultural production in the zone as in many parts of the country is largely rain-fed. Agricultural production follows the rhythm of the seasons with most of the farming activities occurring during the rainy season which last between 7 months in the southern part of the zone to 4 months in the extreme north (Ariko et al. 2024). During the dry season, secondary occupations like weaving (of caps and mats) and dyeing are practiced. The short rainy season limits crop production to only those crops that can grow and mature within a short time. These crops include millet, cowpea, ground nuts, maize and rice (Adamu, 2000). Agriculture is largely of the subsistent type and land holding are characteristically small and fragmented. Most of the farming activities is carried out by subsistent farmers who grow these crops only for food and the little left over is sold in the market to meet urgent financial needs (Ariko et al. 2020). The main tools used in farming consist of hoes, cutlasses, axes and knifes. There is much dependence on manure, and recently, artificial

fertilizers to prevent loss of soil fertility. Irrigation farming is also much practiced here. The fadamas (low laying areas) are used for dry season cropping of vegetables and sugar cane (Chambers, 1990).

STUDY AREA

Northwestern Nigeria is located between Latitude 12˚00′ North to 13˚45′ N and Longitude 3˚30′ East to 11˚ 35′ East. The boundary of the study area which commenced from Latitude 12˚00′ North on the southern frontier going northward up to Latitude 13˚ 45′ North has been chosen because it corresponds with areas severely affected by climatic fluctuation. The climate of Northwestern Nigeria is tropical wet and dry as well as semi-arid steppe types (Suleiman et al, 2023). Agriculture is the predominant economic activity in the study area, the types of crops produced includes millet, sorghum, rice, cowpea, soya beans, wheat, groundnut, maize, cotton, and sesame (Harris and Mohammed, 2003).

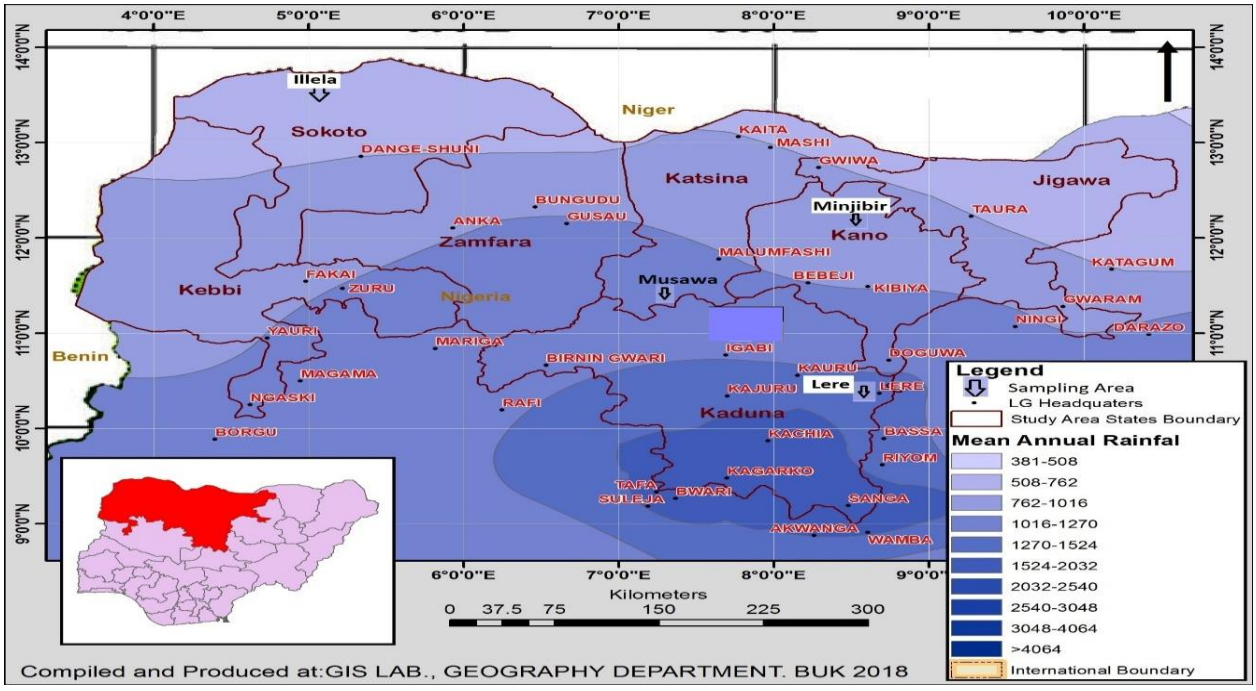

Figure 1: The study area showing the sampling site

MATERIALS AND METHODS

Rainfall data for 4 stations namely (Minjibir, Lere, Musawa and Illella) spanning a period of 30 years (1988-2018) were used for the study. Rainfall and temperature data were obtained from the archive of the Nigerian Meteorological Agency (NiMet). The series of data for the four selected

stations were tested for normality using the Microsoft Excel software. The normalizing limit is 95% of the error margin (Brazel and Balling, 1986). Five-year running mean was calculated for annual rainfall for the selected stations. Further analyses were carried out using line graphs, and time series analysis was undertaken to observe trends in both the data collected (1988-2018).

RESULTS AND DISCUSSION

Minjibir

The rainfall pattern in Minjibir shows some ups and downs. The trend analysis revealed that the length of rainy season decrease on average between 1988 to 1995, and rises from 1996 to 2006 and from there begin to rises up to 2018. Pentadal mean annual values however show the immediate two decades (1994-2003 and 2004-2013) as the wettest decade of the century indicating that Minjibir is becoming wetter. Other studies have shown that settlements within the study area is also becoming greener which might invariably be linked to the increase in wet season (Badamasi et al, 2013) and (Mohd et al, 2014). The 5 years period moving average however shows the lowest duration of the rainy season were experienced between the eighties (Fig. 2). These periods corresponded with the severe drought experience in the area. What can only be inferred is that droughts were experienced between 1980s. The causes of that might be influenced by the interplays of the natural variability in the atmospheric circulation. However, the recent increase in rainfall of the area could be as a result of anthropogenic factors. Kano and its environ including Minjibir is increasing in rainfall in the recent years than what it used to be in the 1980s. This corroborates some findings by Buba (2010) that indicated the fact that climate of the region is becoming wetter. This results agree with the findings of Ikpe (2021) which reported an increasing total annual rainfall in Sokoto.

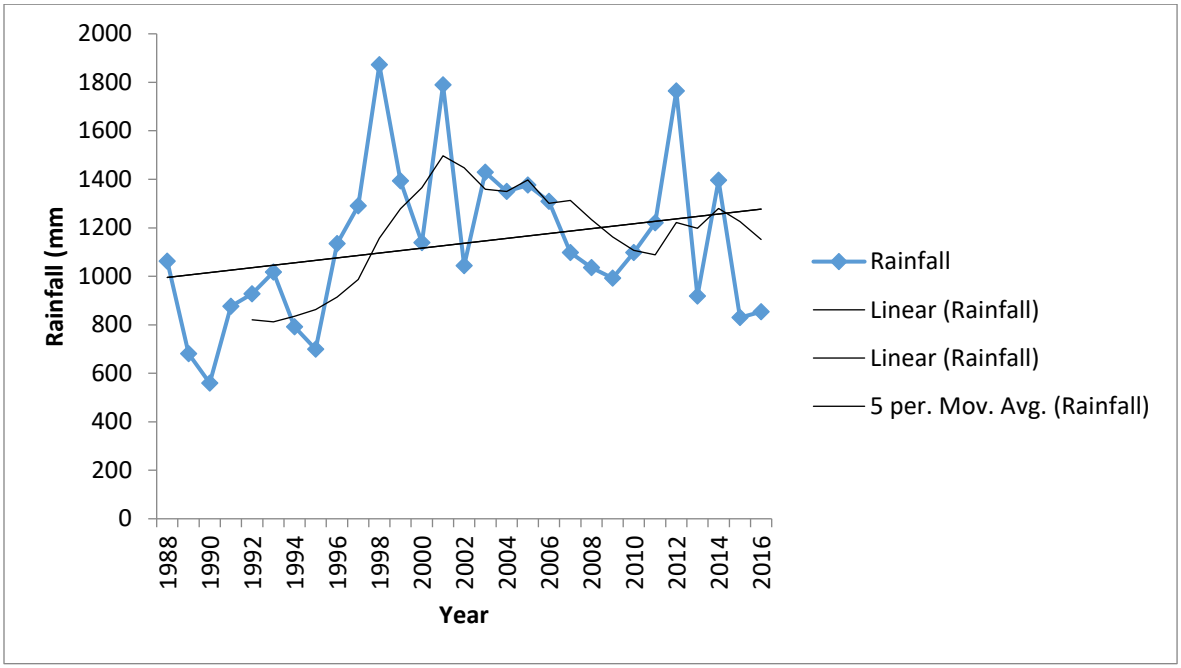

Figure 2: Time Series Graph of the Mean Annual Rainfall in Minjibir (1988 to 2018) Source: Field Data Collection, 2018.

Lere

The trend analysis revealed that the length of rainy season increased on average between 1988 to 1992, and decreases from 1993 to 2000 and from 2001 to 2003 there was high increase of rainfall which led to flood in the urban areas and its environs including Lere which might be as a result of climatic change. The 5 years period moving average shows that the lowest duration of the rainy season were experienced in the nineties. The result corroborated the study of Ikpe et al. (2023) which reported increasing rainfall amount in Kubau LGA of Kaduna State, Nigeria.

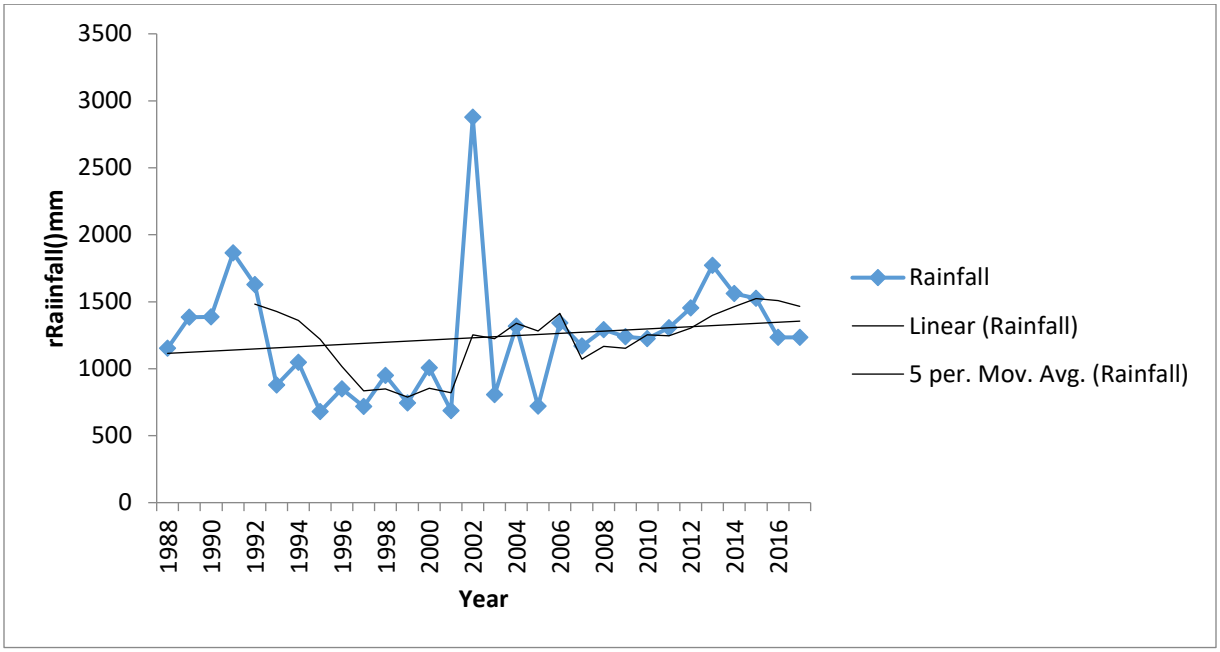

Figure 3: Time Series Graph of the Mean Annual Rainfall In Lere Between 1988 to 2018
Source: Field Data Collection, 2018

Musawa

The trend analysis revealed that the length of rainy season decrease on average between 1988 to rainfall drastically reduced up to the year 1995, although there were some anomalies when rainfall exceeded the normal upward but the range of decline was from 27.5% below normal in 1967; 36.4% below normal in 1983 and 57.6% below normal in 1995. This pattern was a sharp decrease within the 28 years as there was decrease in 30%. From 1996 however, rainfall sharply increased (ranged from 10.4% in 1999 to 56% above normal in 2009) up to 2013 with only minor downward fluctuation below the normal in 2007/2008. Afterwards, there was a sharp increase in 2011 which later decrease from 2012 and 2013 and in 2015 there was another sharp increase in rainfall trend in Musawa. The 5 years period moving average however shows that the lowest duration of the rainy season were experienced in the eighties and mid-nineties. These periods corresponded with the severe drought experience also in the area (Ikpe et al. 2020).

Therefore it shows that there is significant increase in annual rainfall amount in the Musawa. The decades between 1988 and 1992 shows decrease in annual rainfall totals. It means, that the zone is now experiencing wetter conditions in the northwestern zone of Nigeria. This results corroborated some findings by Buba (2010) which indicated the fact that climate of the region is becoming wetter.

The 5-year moving for Illela are presented in Figure 4.

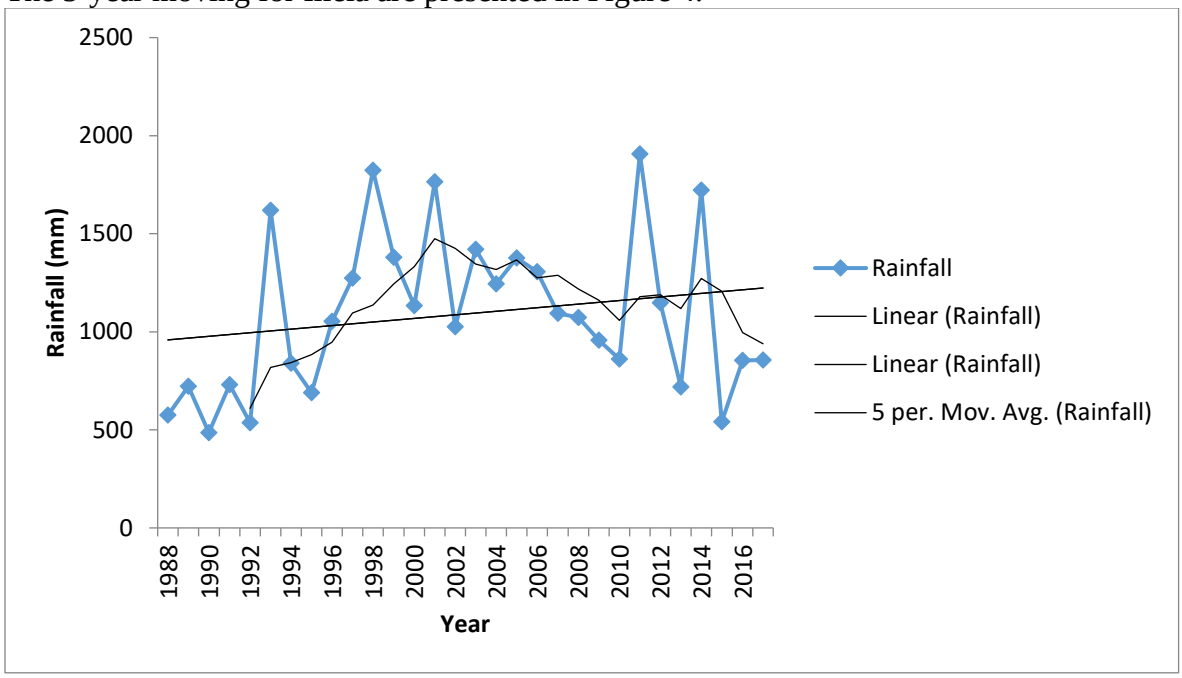

Figure 4: Time Series of the Mean Annual Rainfall In Musawa (1988 to 2018) Source: Field Data Collection, 2018

Illella

The results show that annual rainfall was above the long-term mean from the beginning of the 1988 up to the early 1990s. From the early1991 to the late 2000s the rainfall start to increase. The year 2000 to 2010 was a time of sharp increase in rainfall (with range of 27% above the normal in 1998 to 72% above the normal 2010) and from there the rainfall decreased from that point to 2018. This results corresponded with the report of Kayode et al (2012) which reported that rainfall in the Nigeria dryland areas is variables. Nnachi et al. (2018) further stated that rainfall in the northern part of Nigeia experienced fluctuations between 1988 – 2002 due to climate variability.

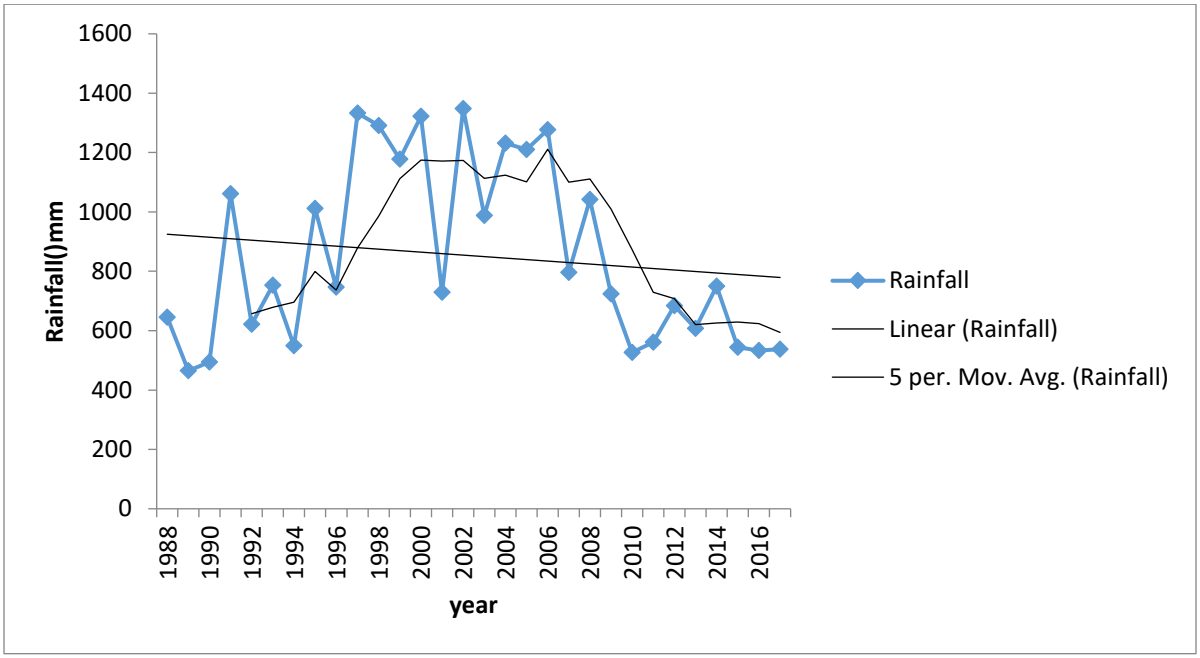

Figure 5: Time Series Graph of the Mean Annual Rainfall In Illella (1988 to 2018)
Source: Field Data Collection, 2018

Comparing and contrasting the results among the four stations, it is obvious that Illella, Minjibir and Musawa stations showed upward or increasing trend in rainfall; the other one station experienced decreasing trend. This has corroborated the works of Haarsmasen et al. (2002) and Odekunle et al. (2008); Ifabiyi and Ojoye (2013) who have observed an increasing trend in rainfall in Minjibir from 1960 to 2009 with a recession in 1970s and 1980s. El-Tantawi (2014) also in a study of rainfall patterns and trends in northern Nigeria from 1942 to 2008 posited that positive (rainfall) trends prevailed at Minjibir and Illella in the north, negative trends were computed at all southern stations (such as Illella). Note that Illella rainfall experienced positive trend only if it is observed from 1940s to 2008. This results confirms the results of Nnachi et al (2020) which stated that rainfall is not evenly distributed around Gusau, Zamfara State. This is normal as pattern and trend of rainfall change when time frame or duration of review changes. But in the case of this study the time that is from 1988 to 2018 Illella shows a negative trend though not a sharp negative trend.

Conclusion

The rainfall patterns and trends of all the four stations in the study area from 1988 to 2018 has been characterized with oscilliations between wet and drier condition, and that generally the decades 1980s and 1990s were the driest of all, and the wettest could be seen in the 2000s.

Agriculture in the study area is largely rain fed. Therefore, the amount of rain that falls in the area is critical to agricultural planning and development. Rainfall has generally been on the increase in the last decade of the study period. This is good news to the farmers. Although, varieties that have been produce to withstand water stress may be endangered if the current trend continues. Also, water available for irrigation purposes is on the increase creating a favourable condition for irrigation agriculture. The water resources of the study area are also largely dependent on rainfall amounts. Increasing rainfall means increasing recharge of the various surface and underground water resources.

RECOMMENDATION:

Based on the findings of the study, the following recommendations were made:

i. More emphasis on dissemination of climate variability and changes through the mass media is highly needed. Government should broadcast programmes to enlighten farmers on adaptation and copping strategies to reduce factors that aggravate climate variability and change.

ii. There is need for extension agents, policy makers and researchers to try and get farmers to effectively adapt to climate change. This can be achieved by providing free extension advice; information on early warning signals and improved farmer education to create proper awareness on climate related issues and effective adaptation processes that can be employed by farmers from 1988-2018 years interval.

iii. This increase can be harnessed to create adequate water storage against periods of shortage. Dam construction should take into consideration the water that is received from increasing rainfall.

REFERENCE:

Adamu, A. (2000). Agricultural production on the Soba plains in the nineteenth century. Zaria Archaeol. Papers (ZAP), 9: 82-88.

Ariko, J. D., Ikpe Elisha & Suleiman M. B. (2023). Analysis of Farmers' Awareness and Adaptation Strategies to Climate Change in Kachia Local Government Area, Kaduna State, Nigeria. African Journal of Geographical Sciences, 4(1): 68-76.

Ariko, J., Ikpe Elisha, Sawa ,B. A., Abdulhamed, I. & Obadaki, Y. Y. (2020). Analysis of Farmers' Level of Awareness of the Effects of Rainfall Variability on the Yield of Sorghum in Sudan Savanna Region of Nigeria, Gombe (University) Journal of Geography and Environmental Studies (GOJGES) 1(3).

Ariko, J. D., Ikpe, E. & Sawa B. A. (2024). Analysis of rainfall trend and its relationship with sorghum yield in Sudan savanna region of Nigeria. International Journal of Scientific Research in Multidisciplinary Studies, 10(3): 01-14.

Ati, O. F., C. J. Stigter & Oladipo, E. O. (2002). A comparison of methods to determine the onset of the growing season in northern Nigeria. International Journal on Climatol., 22: 731-742.

Ayoade, J. O. (1988). A statistical analysis of rainfall over Nigeria. J. State. Geograph., 31: 1-23.

Badamasi H. (2013). Vegetation and Forestry. In Tanko AI, Mumale SB. (Eds.) Kano Environment, Society and Development. Publishers; London and Abuja, Adonis and Abbey

Brazel, S. W. & Balling, R. C. (1986). Temporal analysis of long-term atmospheric moisture levels in Phoenix, Arizona. Journal of Climate and Applied Meteorology, 25:112-117.

Buba L. F. (2010). Spatio temporal rainfall and temperature variation in Northern Nigeria. An Published Ph.D thesis Submitted to the Geography Department Bayero University Kano, Nigeria.

Chambers, R. (1990). Microenvironments unobserved. IIED Gatekeeper Series 22. International Institute for Environment and Development, London: 15.

Eltantawi, A. M. M. (2011). "Recent Rainfall Variability in Northern Nigeria" Katsina Journal of Natural And Applied Sciences**,** 2(1).

Hastenrath, S. (1991). Climate Dynamics of the Tropics. (KAP: Dordrecht): 488.

Hayward, O. F. & Oguntoyinbo, J. S. (1987). The climatology of west Africa (B and N Books: New Jersey): 263.http://catalogue.nla.gov.au/Record/2500324

Hulme, M. & Tosdevin, N. (1989). The tropical easterly jet and Sudan rainfall: A review. Theor. Appl. Climatol, 39, 179-187.

Ifabiyi, I. P. & Ojoye, S. (2013). "Rainfall trends in the Sudano-Sahelian ecological zone of Nigeria" Earth Science Research; 2(2).

Ikpe Elisha, Ariko, J. & Nnachi, S. (2020). Trends in Rainfall Onset, Cessation and Length of Growing Season and its Implication on Sorghum Yield in Katsina State, Nigeria. Gombe (University) Journal of Geography and Environmental Studies (GOJGES) 1(3).

Ikpe, E. Kilani, M. O., Ibrahim, G. J., Shamsu, A. I., Nura, S. & Ariko, J. D. (2023). Assessment of farmers' perception of climate change issues and resilience towards food security in Kubau Local Government Area, Kaduna State, Nigeria. Zaria Geographer, Department of Geography and Environmental Management, Ahmadu Bello University, Zaria 30(1): 29-44.

Ikpe, E. (2021). Effect of climate change on the yield of selected grain crops and farmers' adaptation strategies in Sokoto State, Nigeria. *PhD* unpublished Thesis, Department of Geography and Environmental Management, Ahmadu Bello University, Zaria, Nigeria.

Iwegbu, I. A. (1993). Some aspects of the spatial and temporal characteristics of drought in Nigeria: A statistical approach. Ph.D. Thesis. Department of Geography, Ahmadu Bello University, Zaria.

Kamara, S. I. (1986). The origins and types of rainfall in West Africa. Weather, 41: 48-56.

Kanote, M. (1984). Climate of the sorghum and millet cultivation zones of the semi-arid tropical regions of W est Africa. In: Agromet. of Sorghum and Millet in the Semi-Arid Tropics. Proceedings of the International Symposium, 5 Nov. 1982, ICRISAT Centre, India.

Kayode A. J. & Francis, O. A (2012). Drought intensities in the Sudano-Sahelian Region of Nigeria. Journal of Sustainable Society. 2012;1(4):88-95.

Mohammad, U. (2014). Temporal changes in vegetation in North Eastern Kano. A Dissertation Submitted to the Department of Geography Bayero University, Kano.

Muller, R. A & Orbeelander, T. M. (1987). Physical Geography Today: A Portrait of a Planet Random House Inc., New York.

Nicholson, S. E. (1981). The nature of rainfall fluctuation in subtropical West Africa. Monthly Weather Rev., 108(4): 473-487.

Nnachi, S., U., Ikpe Elisha, Sawa, B. A., Philemon, A. C. & Balogun, S. E. (2016). Comparison in trend analysis of annual rainfall variability on grain yield pattern in Gusau Station, Zamfara state, Nigeria. International Journal of Science for Global Sustainability (IJSGS - Federal University, Gusau, Zamfara State), 2 (1) 28-39.

Nnachi, S. U., Ikpe, E., Philemon, A. C. & Udeh, E. L. (2020). Trends in dry-spell days and rainfall anomalies in Jos South Local Government Area, Plateau State, Nigeria. FUDMA International Journal of Social Sciences (FUDIJOSS), 2(2)– ISSN: 2735-9522

Nnachi, S. U., Ikpe, E. & Philemon, A. C. (2018). An evaluation of the impact of rainfall variability on rice yield in Zamfara State, Nigeria. Savanna Journal of the Environmental and Social Sciences, Ahmadu Bello University, Zaria, 24(2): 249-256

Oguntoyinbo, J. G. (1986). Climatology in Youdeowei A., Ezedinma F.O.C., Onazi A. (eds). Introduction to Tropical Agriculture. Longman Essex.

Oladipo, E. O. (1993). "Some Aspects of the Spatial Characteristics of Drought in Northern Nigeria": Natural Hazards,8, 171-188, Netherlands: Kluwer Academic Publishers

Oladipo, E. O. (1993). Is the climate of Northern Nigeria becoming more arid? Paper Presented at the 36th Annual Conference of the Nigerian Geographical Association, Federal University of Technology, Minna: 13.

Olaniran, O. J. & Sumner, G. N. (1989). A study of climate variability in Nigeria based on the onset, retreat and length of the rainy season. Int. J. Climatol., 9: 253-269.

Suleiman, M. B., Ikpe, E. & Ariko, J. D. (2023). Appraisal of farmers' utilisation of weather forecast information for climate change adaptation in north-western Nigeria. Sokoto Journal of Geography and the environment, 5(1):131-141.

Udo, R. K. (1970). Geographical regions of Nigeria. Morrison and Gibb: London: 212.