Adamawa State University Global Journal of Geography and Environmental Sciences
(ADSU-GJGES)
Volume 06 Issue 1, 2026
ISSN: 2651-3830 (Print); 2756-4142 (Online)

Website: gjges.adsu.edu.ng *Email: gjges@adsu.edu.ng*

ORIGINAL RESEARCH ARTICLE

Assessing the Trends and Patterns of Some Selected Climate Change Variables (Temperature, Humidity and Rainfall) on Agricultural and Pastoral Livelihood of the People of Bassa Local Government Area of Plateau State Between 1994 and 2024

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DOI: https://doi.org/10.64290/gjges.v6i1.43

ARTICLE INFO

Article History:
Received 29th April 2026
Revised 2nd May 2026
Accepted 10th May 2026

Keywords:
- Climate change;
- Temperature;
- Humidity;
- Rainfall;
- Trends;
- Patterns;
- Livelihood.

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ABSTRACT

This study assessed the trends and patterns of some selected climate change variables, which includes temperature, humidity and rainfall in Bassa Local Government Area, Plateau State, Nigeria, between 1994 and 2024. Secondary climatic data were collected from the Nigerian Meteorological Agency (NiMet). The analysis of the climatic data, included annual mean maximum and minimum temperatures, relative humidity, and rainfall for the period understudy (1994–2024). Temperature increased from 29.8°C to 32.9°C (maximum) and 14.0°C to 16.3°C (minimum), while relative humidity declined from 62.4% to 55.6%, and rainfall fluctuated between 1,025 mm and 1,918 mm. The study concludes the trends and patterns of climate change have witness significant changes, over the past 30 years in Bassa Local Government. Consequently, the study shows a direct link between climate change effects on climatic variability, the changes have led to reduced pasture availability, altered vegetation composition, and diminished access to water sources which has also increased competition for environmental resources.

Introduction

Climate change refers to significant, long-term alterations in temperature, precipitation patterns, and other atmospheric conditions on Earth. It is broadly understood as shifts occurring over decades or longer, distinguished from short-term weather variability (IPCC, 2018). Globally, climate change has been driven primarily by anthropogenic activities, most notably the burning of fossil fuels, deforestation, and intensive agriculture, that increase greenhouse gas concentrations in the atmosphere, such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (United Nations Environment Programme [UNEP], 2019). These gases trap heat, leading to global warming and changes in climatic systems.

In the African context, climate change manifests with distinct characteristics shaped by the continent's unique geographical and socio-economic vulnerabilities. Africa contributes the least to global greenhouse

ADSU-GJGES, 6(1) 123 – 130, May 2026
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emissions yet faces some of the most severe impacts (Niang *et al.,* 2019). Climatic variability here is marked by rising mean temperatures, altered rainfall patterns, and increased frequency of extreme weather events, including droughts, floods, and heatwaves (Adesina *et al.*, 2020). The Intergovernmental Panel on Climate Change (IPCC, 2021) notes that Africa's mean surface temperature is rising faster than the global average, exacerbating environmental stress.

The primary cause of contemporary climate change is the increased concentration of greenhouse gases, linked to industrialization, urbanization, and changing land use. However, natural factors, such as volcanic activity, solar radiation fluctuations, and oceanic circulation patterns also influence climate but to a lesser degree over recent decades (Masson-Delmotte *et al.*, 2018). The characteristic variability includes rising average temperatures, shifts in precipitation regimes (both spatially and temporally), and altered seasonal cycles.

Specifically, in Africa, these changes are irregular and regionally differentiated. For instance, West Africa has experienced a decline in rainfall over the Sahel region, contributing to desertification and drought, while East Africa shows a trend toward increased precipitation and flooding (Niang *et al.,* 2019). Temperature increases are consistent across the continent but have more severe consequences in arid and semi-arid zones (Kouassi *et al*., 2020). Moreover, these climatic shifts disrupt phonological cycles of flora and fauna, impacting biodiversity and ecosystem services.

Empirical evidence from recent meteorological studies reveals that Nigeria has experienced significant warming over the past four decades, with temperature increases particularly pronounced in the Guinea and Sudan savanna belts. Analysis of long-term temperature records shows that average annual temperatures have risen by approximately 0.8°C to 1.3°C in these regions between 1980 and 2020 (Adeola *et al*., 2019). The Sudan savanna belt in northern Nigeria records more pronounced warming compared to the relatively milder Guinea savanna in the middle belt, a spatial disparity linked to variations in vegetation cover and surface albedo. Seasonal temperature trends further indicate a notable rise in dry season temperatures, intensifying heat stress on agricultural and pastoral systems (Eze *et al*., 2020). Satellite-based climate models corroborate these ground observations, reporting increased frequency of extreme heat days, with projections suggesting that such extremes will become more frequent and severe by mid-century (Okeke & Udo, 2021). This warming exacerbates evapotranspiration rates and moisture deficits, contributing to soil degradation and altered hydrological cycles, which have critical implications for crop yields and livestock productivity in the savanna zones. Furthermore, the enhanced thermal stress is linked to shifts in phenology and ecosystem dynamics, affecting biodiversity and the resilience of natural habitats (Ibrahim & Musa, 2022). These temperature trends form a critical backdrop to understanding the broader climatic pressures impacting Nigeria's ecological and socio-economic systems.

Rainfall variability in Nigeria's savanna belts manifests as a complex pattern of shifts in total precipitation, seasonal distribution, and intra-annual variability. Empirical analyses utilizing data from the Nigeria Meteorological Agency (NIMET) and regional climate centers reveal divergent rainfall trends in the Guinea and Sudan savanna zones over the past 30 years. The Guinea savanna belt has experienced modest increases in mean annual rainfall, estimated at around 5-8%, although this increase is accompanied by heightened inter-

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annual variability and irregular onset of rains (Onwuka *et al.,* 2019). Conversely, the Sudan savanna has suffered a significant decline in rainfall amounts, with reductions ranging from 10% to 20% in some localized areas, particularly in northeastern Nigeria (Abubakar & Danjuma, 2020). This decline has coincided with delayed rainy season onset and erratic rainfall distribution, leading to shorter growing seasons and increasing the unpredictability of rain-fed agriculture. Additionally, there is empirical evidence of increased frequency and intensity of extreme rainfall events, causing localized flooding and soil erosion despite overall declines in total precipitation (Abiodun *et al.*, 2021). These changes disrupt traditional agricultural calendars, complicate water resource management, and impose significant constraints on both crop production and pasture regeneration. Studies also show spatial heterogeneity within the savanna belts, with microclimates influenced by topography and land use changes further modifying rainfall patterns (Nwachukwu *et al.*, 2022). Collectively, these rainfall trends underscore the dual challenge of managing drought risks and flood hazards in Nigeria's transitional ecological zones.

Bassa LGA is a strategically significant location for assessing the effects of climate change on agricultural and pastoral livelihoods. It lies within the Guinea savannah ecological zone which is climatic transition belt that is highly sensitive to shifts in temperature, humidity and rainfall (Adefolalu, 2015). This region has experience increasing climatic variability over recent decades, making it a very critical region for studying how crop farmers and pastoralists adapt to environmental stress. Also, the economy of Bassa LGA is predominantly agrarian, with the large proportion of the population engaged in rain-fed crop farming and rearing of livestock. Maize, yam, sorghum are staple crops that are widely cultivated, while cattle, sheep and goats, form the backbone of pastoral livelihoods (Ogbonnaya & Eze, 2021). These activities are highly dependent on predictable seasonal patterns, rendering local communities to become vulnerable to climatic disruptions such as rising temperatures, prolong dry spells and delayed rainfall onset.

Furthermore, the area has witnessed escalating farmer-pastoralist conflicts in recent times, which are increasingly linked to climate-induced resource scarcity. As drier conditions encroach from the north, pastoralists are forced to alter migration routes and extend their stay in neighboring grazing reserves, often leading to competition over dwindling land and water resources (Mortimore, 2010). This intersection of climate stress and socio-ecological tension underscores the importance of localized climate studies in Bassa LGA. The 30-year study period (1994-2024) also aligns with a period of accelerated global warming and intensified land-use changes in the country. Over these decades Plateau state in particular has experienced deforestation urban expansion and declining ecosystem resilience, all of which amplify climate risks (Ogbonnaya & Eze, 2021). Despite these observable changes, there remain a paucity of long-term, localized climatic studies that focused on the study area, limiting evidence-based adaptation planning.

Therefore, focusing on Bassa LGA not only addresses a critical data gap but also contributes actionable insights for community-based adaptation, formulation of policies, conflict mitigation and safeguarding livelihoods in a climatic-vulnerable region such as Bassa LGA.

Materials and Methods

Study Area

Bassa Local Government Area (LGA) is situated in the northern axis of Plateau State,

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Nigeria, within the Guinea Savannah vegetation belt Middle Belt region. Bassa Local Government Area lies between latitudes 9°45′N and 10°23′N of the Equator and longitudes 8°37′E and 8°57′E of the Prime Meridian (Latitude.to, 2024). Bassa LGA occupies part of the northwestern section of the Jos Plateau highland system and extends across a landmass of approximately 1,453 km². The problems associated with climate change in the area just like everywhere else can not be over emphasized.

Methodology

This study solely relied on secondary climatic data in order to strengthen the validity of the findings related to climate change. The secondary data were sourced from Meteorological records. Climatic data included the temperature, humidity and annual rainfall records, were obtained from the Nigerian Meteorological Agency (NiMet) for temporal analysis of the climatic trends between 1994 and 2024**.** The analysis was primarily descriptive, using Microsoft Excel to support data entry, coding, the generation of graphs for visualization and trend assessment. The graphs helped in identifying patterns and present the climatic parameters, which are temperature, humidity and rainfall trends over the study period.

Results and Discussion

Trend in Mean Maximum and Minimum Temperature (1994-2024)

Figure 1 indicates a clear and sustained upward trend in both mean maximum and mean minimum annual temperatures in Bassa Local Government Area between 1994 and 2024. In 1994, the mean maximum temperature was 29.8°C while the mean minimum was 14.0°C. Over the three-decade period, both indices rose steadily: by 2010, the mean maximum had increased to approximately 31.8°C and the mean minimum to 15.3°C, and by 2024, the values reached 32.9°C and 16.3°C respectively. This represents an overall increase of about 3.1°C in maximum temperature and 2.3°C in minimum temperature within thirty years. Such magnitude of warming is climatologically significant and cannot be dismissed as natural short-term fluctuation. Particularly noteworthy is the steady rise in minimum temperatures, indicating warmer nights and a narrowing diurnal temperature range. This pattern is commonly associated with the area's increased greenhouse gas concentrations from bush burning, fossil fuel combustion, deforestation, and unsustainable agricultural practices. These activities have led to rise in temperatures, land surface modifications, and reduced vegetation cover, all of which enhance heat retention at nights.

However, climatic trends and patterns variability has altered vegetation patterns in not only Bassa LGA but also in many parts of northern Nigeria. Increase in temperatures which affects rainfall cycle, contribute to declining pasture biomass and shortened growing seasons (Abaje *et al*., 2014). In Plateau State especially in Basss LGA, land degradation from bush burning, deforestation, and overgrazing which contributes to increase in temperature has further intensified ecological stress (Ofuoku & Isife, 2009).

While global climate change is driven by greenhouse emissions which set the broader stage (Adefolalu, 2015), local factors are amplifying the warming effects in the study area. One key driver is land-use change, particularly deforestation and expansion of settlement or build up areas. Plateau state has seen a significant tree cover loss due to logging, charcoal production and conversion of forested areas into other land-uses. Trees act as natural coolants through evapotranspiration, so the removal reduces local humidity and increases surface temperatures (Ogbonnaya & Eze, 2921). This

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implies that even if global warming is moderate, local deforestation could make the area hotter.

The implication of this is that, for crop farmers, high temperatures accelerate soil moisture loss, shorten crop growing cycles and increase heat stress on plants such as maize and beans. This can lead to lower yields or even total crop failure. Warmer conditions also favor pests such as stem borers and diseases such as maize streak virus, which thrive in hotter and drier environment. While for pastoralist, rising temperatures mean their livestock expend more energy to cool down, leads to weight loss and decrease in milk production. Heat stress also limits grazing hours, animals tend to rest in shades during peak heat period, reducing feeding time. Combined with shrinking pasturelands and drying water points, this exerts serious pressure on the pastoral livelihood.

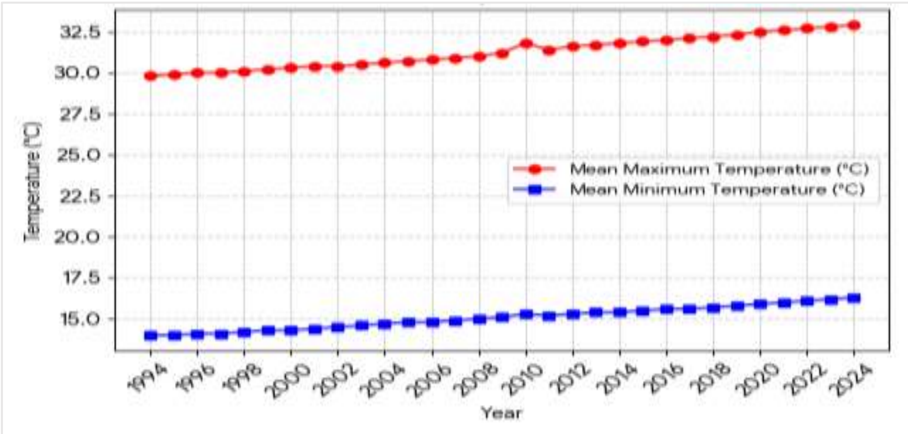

Figure 1: Annual Mean Maximum and Minimum Temperature (°C)
Source: Nigerian Meteorological Agency, 2024

Trend in Mean Relative Humidity (1994–2024)
Figure 2 indicates that there is a general declining trend in the annual mean relative humidity in Bassa LGA between 1994 and 2024. In 1994, the annual mean relative humidity was recorded at 62.4%, but by 2024 it had declined to 55.6%, representing a reduction of 6.8% over the study period. Although the trend exhibits fluctuations particularly slight rebounds in the late 1990s, and the early 2000s the overall trajectory is downward, with more pronounced declines observed after 2004. This progressive atmospheric drying corresponds with the concurrent rise in temperature observed in the same period, as warmer air masses increase evaporative demand and reduce the capacity of the atmosphere to maintain stable moisture levels. This also implies that, the decline in relative humidity in Bassa LGA is mainly driven by rising temperatures, which reduce relative humidity by increasing the air's moisture-holding capacity. Reduced and erratic rainfall, along with land use changes such as deforestation and urbanization, have further limited atmospheric moisture through decreased evapotranspiration. While early fluctuations reflect natural climate variability, the sustained decline especially after 2004 indicates the growing influence of broader climate change across the country.

Declining relative humidity in the area reduces crop productivity by increasing moisture loss, shortening growing seasons, and degrading soil quality. It also negatively affects pastoral livelihoods through reduced pasture and water availability, leading to

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poorer livestock health and heightened resource competition in Bassa LGA.

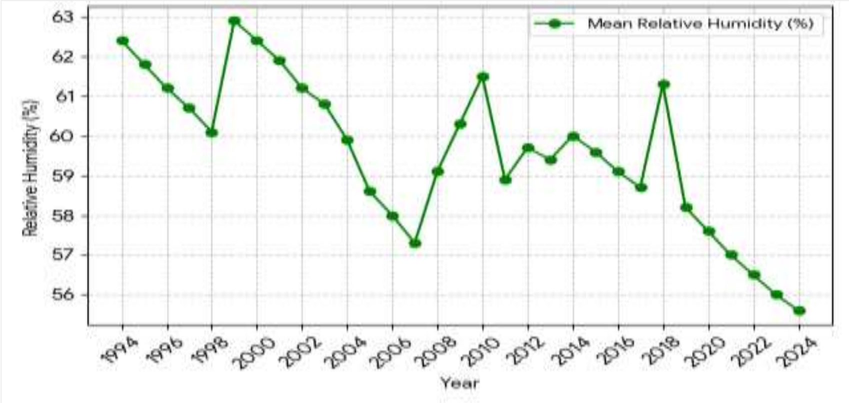

Figure 2: Annual Mean Relative Humidity in Bassa LGA (1994-2024)
Source: Nigerian Meteorological Agency, 2024

Trend and Variability in Annual Rainfall (1994-2024)

As a finding, Figure 3 illustrates a considerable inter-annual variability in annual rainfall totals in Bassa between 1994 and 2024, rather than a simple linear increase or decrease. In 1994, annual rainfall totaled 1,499 mm. This declined to a minimum of 1,025 mm in the 2005, followed by the fluctuations that included a notable peak of 1,918 mm in 2018. Post-2005 rainfall values oscillated between approximately 1,250 mm and 1,520 mm, with periodic highs and dips. The defining characteristic of the rainfall pattern are therefore variability and irregularity rather than a steady decline. Such irregular distribution implies delayed onset of the rains, mid-season dry spells, and intense short-duration rainfall events that may contribute more to surface runoff and erosion than to effective soil moisture recharge. The rainfall variability in the area is also influenced by human activities such as deforestation, farming expansion, unsustainable environmental resource usage and urbanization, which alter local climate conditions and disrupt normal rainfall patterns. These activities reduce vegetation and moisture in the environment, making rainfall more irregular and less predictable in the study area.

Also, rainfall in Bassa LGA has become increasingly erratic, with delayed onset, early cessation and prolonged mid-season dry spells (Ogbonnaya & Eze, 2021). These shifts are linked to a broader climate change, local environmental degradation and land-use changes, which disrupt moisture recycling and weakens local convection systems (Adefolalu, 2015). As tree cover declines, evaporation drops, reducing the likelihood of localized rainfall. For crop farmers who relied on rain-fed agriculture, irregular rainfall makes farming more risky by causing unpredictable planting seasons and unstable yields. It can also lead to higher crop failure risks, especially for moisture-sensitive staples such as maize and yam. It also affects pastoral livelihoods by reducing reliable pasture and water supply, leading to livestock stress and increased competition for resources in between farmers and pastoralists in the study area. Solutions must include rainwater harvesting, agroforestry and early warning systems to build resilience (Mortimore, 2010).

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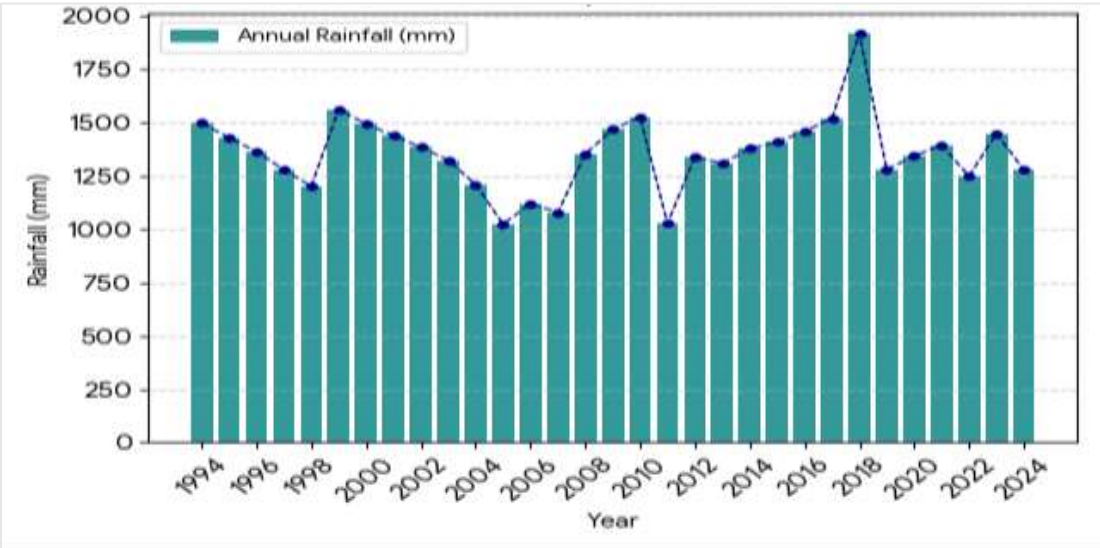

Figure 3: Annual Rainfall Distribution in Bassa LGA (1994–2024)
Source: Nigerian Meteorological Agency, 2024

Conclusion

The study concludes that climate change in Bassa Local Government affects climatic trends and patterns over the period under study. The climatic data, shows rising temperatures (maximum +3.1°C, minimum +2.3°C), declining relative humidity 62.4% to 55.6%, and variable rainfall. Consequently, the study shows a direct link between climate change effects on climatic variability, the changes have led to reduced pasture availability, altered vegetation composition, and diminished access to water sources.
Some of the recommendations suggested are as follows;

Implement sustainable land-use policies that balance agricultural development with pastoral needs, such as establishing designated grazing reserves, protecting rivers and valley grazing zones and controlling urban encroachment on farmland.

Promote climate adaptation measures including drought-tolerant crops, water harvesting, and pasture management programs to sustain both agricultural and pastoral livelihoods under changing climatic conditions.

Support research and capacity building in environmental education for local communities to improve understanding of climate trends and sustainable land management, ensuring policies and interventions are both evidence-based and locally relevant.

References

Abaje, I. B., Sawa, B. A., & Ati, O. F. (2014). Climate variability and change in northern Nigeria. *Atmospheric and Climate Sciences*, **4**: 566–573.

Abiodun, B. J., Salami, A. T., & Okorie, D. (2021). Impacts of extreme rainfall on agriculture in Nigeria's savanna zones. *Journal of Climate Risk Research*, ***13***(1): 44–58.

Abubakar, M. U., & Danjuma, M. A. (2020). Rainfall trends and variability in northeastern Nigeria: Evidence from Sudan savanna belt. *Nigerian Journal of Environmental Sciences,* **9**(2): 101–112.

Adefolalu, D. O (2015). Climate variability and change: Implication for agriculture in

ISSN: 2705-1900 (Online); ISSN: 2251-0702 (Print)
Website: gjges.adsu.edu.ng *Email:* gjges@adsu.edu.ng *DOI:* https://doi.org/10.64290/gjges.v6i1.43

Nigeria. *Journal of Environment and Earth Science*, **5**(12), 1-8.

Adeola, A. O., Ogunjobi, K. O., & Lawal, M. O. (2019). Warming trends in the Guinea and Sudan savanna zones of Nigeria. *Journal of Meteorological Research*, **34**(2): 55–70.

Adesina, F. A., Ayanlade, A., & Jegede, O. O. (2020). Climate change and variability in Africa: Issues, challenges and implications for sustainable development. *African Handbook of Climate Change Adaptation*, 1–18.

Eze, J. O., Ude, C. N., & Onuoha, C. M. (2020). Dry season warming in Nigeria: Implications for food production. *Climate Science and Policy*, **15**(2): 98–112.

Ibrahim, M. G., & Musa, A. A. (2022). Climate-induced changes in vegetation phenology in Nigeria's savannas. *International Journal of Environmental Science*, **16**(2): 134–148.

IPCC. (2018). Global warming of 1.5°C: An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels. *Intergovernmental Panel on Climate Change*.

IPCC. (2021). Sixth Assessment Report: Climate change 2021 – The physical science basis. *Intergovernmental Panel on Climate Change*.

Kouassi, K. N., Nguatem, W. P. T., & Biaou, G. (2020). Climate change and agricultural productivity in West Africa: Evidence from panel data. *Environmental Development*, **36**: 100579.

Latitude.to (2024). GPS coordinates of Bassa, Plateau State, Nigeria.

Masson-Delmotte, V., Zhai, P., Pörtner, H. O., Roberts, D., Skea, J., Shukla, P. R. & Waterfield, T. (2018). Global warming of 1.5°C: *Summary for policymakers*. IPCC.

Mortimore, M. (2010). Adapting to drought in the Sahel: Lesson for climate change. *Cambridge University Press*. *https://doi.org/1017/CB9780511779133*

Niang, I., Ruppel, O. C., Abdrabo, M. A., Essel, A., Lennard, C., Padgham, J., & Urquhart, P. (2019). Africa. In Climate Change 2014: Impacts, Adaptation, and Vulnerability. IPCC Working Group II Contribution to AR5. *Cambridge University Press.*

Nigerian Meteorological Agency (NiMet). (2024). Annual Climate Report for Plateau State, 2005–2024. Abuja: NiMet.

Nwachukwu, A. C., Chukwu, E. O., & Edeh, C. C. (2022). Microclimatic variations and land use in Nigeria's savannas. *Nigerian Journal of Climatology*, **13**(2): 66–82.

Ofuoku, A. U., & Isife, B. I. (2009). Causes, effects and resolution of farmers-nomadic cattle herders conflict in Delta State, Nigeria. *International Journal of Sociology and Anthropology*, **1**(2), 47–54.

Ogbonnaya, I. A., & Eze, P. O. (2021). Climate change and its impacts on agricultural productivity in Plateau State, Nigeia. *International Journal of Environment and Climate Change*, **11**(5), 398-410.

Okeke, I. C., & Udo, N. M. (2021). Heat wave projections and thermal stress in savanna Nigeria. *Climate Dynamics and Health*, **11**(3): 99–117.

Onwuka, S. O., Nwokolo, C. C., & Okpara, D. A. (2019). Trends in rainfall variability in the Guinea savanna belt of Nigeria. *Climate and Hydrology Reports*, **5**(2): 112-128.

UNEP. (2019). Emissions gap report 2019. United Nations Environment Programme. https://www.unep.org/resources/emissions-gap-report-2019