Sokoto Journal of Geographical Studies (SJGS)

Volume 3, Issue 1, December, 2025 Edition

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Published by the Department of Geography, Sokoto State University, Sokoto P.M.B. 2134, Along Birnin Kebbi Road, Sokoto State-Nigeria

Department of Geography, Sokoto State University, Sokoto P.M.B. 2134, Along Birnin Kebbi Road, Sokoto State-Nigeria

E-ISSN: 3115-5812, PRINT ISSN: 3034-551X

Volume 3, Issue 1, December 2025 Edition

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ANALYSIS OF RAINFALL VARIABILITY IN AKOKA, LAGOS STATE USING REMOTE SENSING DATA

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https://doi.org/10.65760/sjgs.v3.i1.10

Abstract

This study examined the spatial and temporal variability of rainfall in Akoka, Lagos State, over a 31-year period (1993–2023), using CHIRPS satellite-derived rainfall data analyzed in QGIS across 20 synoptic stations. The temporal assessment showed that rainfall was highest between 2003 and 2012, followed by a gradual decline from 2013 to 2022. Variability analysis using the Coefficient of Variation (CV) indicated moderate year-to-year fluctuation, with CV values ranging from 12% to 18%, confirming that rainfall in Akoka is variable but not extremely unstable. Seasonal rainfall, measured from March to November, was generally consistent, although individual years such as 2003, 2008, and 2019 showed higher variability. Monthly averages revealed June, July, September, and October as the wettest months, while January and December remained the driest with minimal spatial differences across the area. Spatial rainfall maps showed a clear gradient across Akoka, where tighter contour spacing reflected areas of sharper rainfall change and wider spacing indicated more uniform distribution. Annual totals ranged from 1,085 mm in 2001 (the driest year) to 2,364 mm in 2019 (the wettest year). Analysis of major El Niño episodes demonstrated that their influence on rainfall in Akoka is inconsistent: events such as those in 1997-1998 and 2015-2016 corresponded with reduced rainfall, while others, including 2002-2003 and 2009-2010, did not produce any decline. Overall, the findings highlight the complex behavior of rainfall in Akoka and underscore the need for continuous climate monitoring and proactive water-resource planning.

Keywords: *Climate Change, Rainfall Variation, Remote Sensing.*

Introduction

Rainfall characteristics including trend, variability, onset and cessation, amount, and frequency are critical to Nigerian farmers, who largely depend on rainfall for their crop production (Nicholson, 2013). Beyond agriculture, rainfall influences many facets of societal life, including energy generation (via dam reservoirs), transportation, and public health. Several studies document fluctuations in Nigeria's rainfall amount and duration (Sobowale *et al*., 2016; Nzoiwu *et al*., 2017), while others report negative impacts on health and energy systems (Nebedum & Emodi, 2016; Adelekan, 2010).

Recent decades have seen both increasing and decreasing rainfall in different regions of Nigeria (Akinsola & Ogunjobi, 2014; Diagi, 2018; Ogunrinde *et al*., 2019). Such variability can adversely affect agriculture, livelihoods, and even cultural/religious activities. For example, Yamusa & Abdulkadir (2020) and Akinsanola & Ogunjobi, (2014) documented changes in onset and cessation of rainfall in the Sudan and Sahel savanna between 1968 and 2017. Extreme rainfall events such as floods and droughts have become more frequent, especially in semi-arid regions, the Niger Delta, and along the Niger and Benue Rivers (Nigerian Meteorological Agency, 2021; Ugba *et al*., 2018; Hassan et al., 2020). In some regions, reduced rainfall has triggered meteorological and agricultural droughts (Yamusa & Abdulkadir, 2020; Ugwu *et al*., 2023). In Awka, South East Nigeria, rainfall declined between 1976 and 1987 then increased between 1988 and 2000, illustrating pronounced spatio-temporal variability in rainfall characteristics (Mosunmola et al., 2020; Emeka-Chris *et al*., 2022).

In terms of methodologies, many previous studies of rainfall variability in Nigeria have relied on ground-station observational data and basic statistical trend analyses (for example, Okeowo *et al*., 2015 and Awosika & Oyebande, (2019) analyzed rainfall and maize yield data in Lagos State; Onwuadiochi *et al*., (2021) assessed rainfall trends across multiple Nigerian locations using meteorological station records). By contrast, this study employs satellite-based remote sensing data (in addition to available ground station data) to capture both spatial and temporal variability in rainfall for Akoka. This approach allows coverage of areas that terrestrial weather stations may not adequately monitor and provides a detailed mapping of rainfall patterns in an urban coastal environment (Kummerow, *et al.*, 2000).

Lagos State is a uniquely important context for rainfall variability research due to its coastal location, dense population, high urbanization, and dependence on rainfall for agriculture, water supply, and infrastructure resilience (Balogun, *et al*., 2016; Huffman, *et al*., 2015). Flooding is a recurrent risk in Lagos, often linked to intense rainfall and inadequate drainage systems. Therefore, analyzing rainfall variability in Akoka, Lagos State, is timely and relevant for local adaptation, urban planning, and water resource management. Understanding rainfall variability is crucial for mitigating losses from extreme events, including damage to crops, property, infrastructure, and human life. This study aims to fill a knowledge gap by analyzing rainfall variability in Akoka, Lagos State using satellite remote sensing data, complementing previous studies that primarily relied on ground station observations. The findings will be valuable for policymakers, water resource managers, and the general public.

Materials and Methods

Study Area

Akoka is located in the eastern part of Lagos State, within the Lagos Metropolis. Akoka is a suburb of Yaba in Lagos state (Folarin, 2015; Ebert, *et al.*, 2007). It is located between latitude 6°30’00’’N and 6°31’30’’N and longitude 3°23’00’’E and 3°24’30’E as shown in (Figure 1). It is a site of major tertiary institutions in Lagos including the University of Lagos and Federal College of Education. It characterized by distinct wet and dry seasons. The wet season typically spans from April to October, while the dry season occurs from November to March influenced by the ITCZ and Atlantic Ocean dynamics. The average annual temperature in Lagos State is approximately 26.9°C, with mean annual precipitation around 1,165 mm.

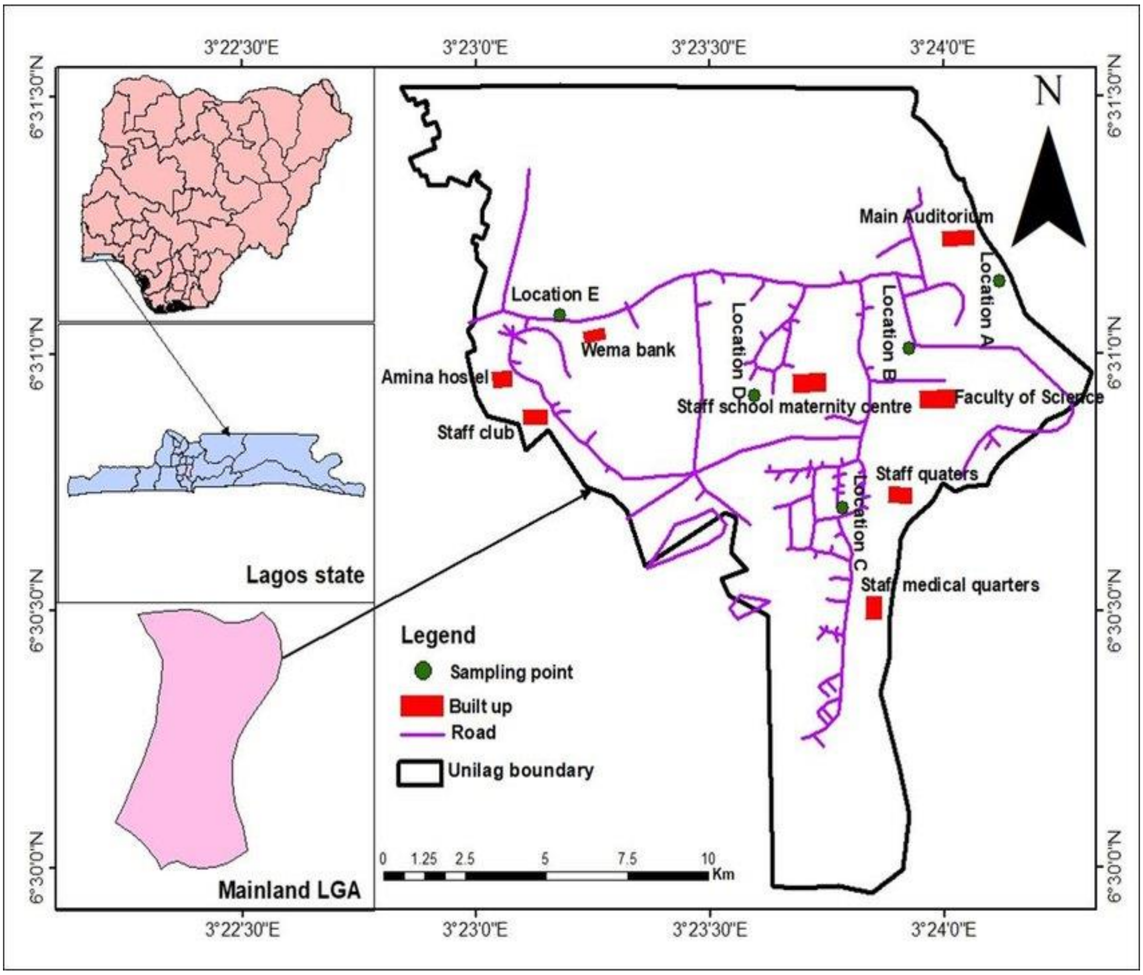

FIGURE 1: THE STUDY AREA

Data Collection

The data to be used in this study were remotely sensed rainfall data from the Climate Hazards Group Infra-Red Precipitation with Station Data (CHIRPS) dataset, covering 1988 or 1993-2023 of daily rainfall data for Akoka, Lagos state. The CHIRPS is a quasi-global rainfall data set. As its title suggests it combines data from real-time observing meteorological stations with infra-red data to estimate precipitation. CHIRPS incorporates 0.05° spatial resolution[1] satellite imagery with in-situ station data to create gridded rainfall time series for trend analysis and seasonal drought monitoring. Since 1999, U.S. Geological Survey (USGS) and CHG scientists, supported by funding from the U.S. Agency for International Development (USAID), the National Aeronautics and Space Administration (NASA), and the National Oceanic and Atmospheric Administration (NOAA), have been developing techniques for producing rainfall maps, especially where surface data is sparse. The creation of CHIRPS has supported drought monitoring efforts by the USAID Famine Early Warning Systems Network. There are two main data sets. The first is quasi-global and covers the whole world from 50°N to 50°S. The second covers Africa and parts of the Middle-East. It covers the area from 40°N to 40°S and from 20°W to 55°E. The global data set has data on a 0.05° grid at monthly, pentad and daily times steps. This is equivalent to 31 km^2. The 'Africa' data set also includes data at a 0.10° grid at a 6-hour time step.

[1] *The 0.05° resolution refers to the spatial resolution of the CHIRPS dataset, indicating the size of each grid cell (approximately 5-6 km at the equator).*

Data Analysis

-Descriptive Statistics

Descriptive statistics was employed to summarize the rainfall data to identify patterns in rainfall variability. The m**ean average rainfall** represents the average amount of rainfall over the specified period. It provides a single value to represent the central tendency of rainfall across years or seasons. For example, calculating the mean monthly rainfall helps understand typical rainfall patterns in Akoka. The standard deviation was also used to show the spread of rainfall around the mean.

- **Trend Analysis**

i. **Temporal Analysis:** Descriptive statistics were used to assess annual, seasonal, and monthly characteristics of the rainfall dataset. Calculating the mean and standard deviation for each year helps determine how rainfall values fluctuate over time. However, to properly detect trends rather than simple variability, the Coefficient of Variation (CV) was computed for each year. The CV provides a normalized measure of dispersion, allowing clearer identification of years with unusually high or low rainfall relative to the mean**.**
ii. **Inter-Annual Variability (IAV):** Inter-annual variability was examined to understand year-to-year fluctuations in rainfall totals. The Coefficient of Variation (CV) was incorporated as an additional metric to quantify the magnitude of variability. A higher CV value indicates greater annual variability, while lower values suggest more stable rainfall patterns over the study period.

- **Spatial Variability**

Rainfall data was interpolated using GIS-based spatial analysis techniques, such as IDW or Kriging to generate an Isoyetal Map for spatial analysis.

Results And Discussion

Dekadal Analysis of Rainfall 1993 to 2023

Figure 2 presents the Dekad comparison of rainfall trends across the 20 locations in Akoka over the three decades from (1993 to 2022), with 2023 representing the most recent year. The chart compared the average annual rainfall grouped from 1993-2002, 2003-2012, 2013-2022, and 2023 respectively. The comparison revealed the highest rainfall was recorded in 2003-2012 across the most locations, showed the peak of rainfall over three decades. Rainfall level began to decline steadily from 2013 to 2022, with 1993-2002 showed a clear drop in rainfall compared to all the previous decades, indicating that recent rainfall has reduced significantly.

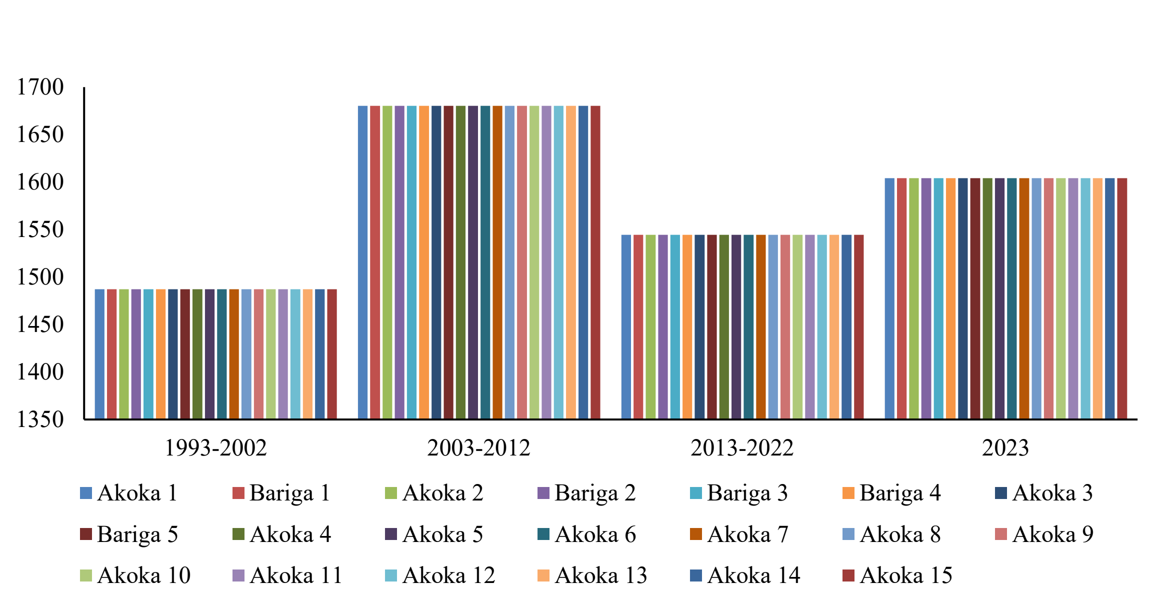

FIGURE 2: DEKAD COMPARISON OF RAINFALL TRENDS FROM 1993-2023

Figure 3 presents the total annual seasonal rainfall for the study locations. The rainy season was defined as spanning from March to November to account for years when the onset or end of the rainy season varied. The rainfall amounts for these months were summed, and the totals for each location were compared by plotting them together. Analysis of the data and the corresponding plot indicates that seasonal rainfall differences among the study areas were generally minimal throughout the study period. However, the years 1997, 1999, 2003, 2004, 2007, 2008, 2009, 2010, 2014, 2018, and 2023 showed greater variation in total seasonal rainfall across the locations.

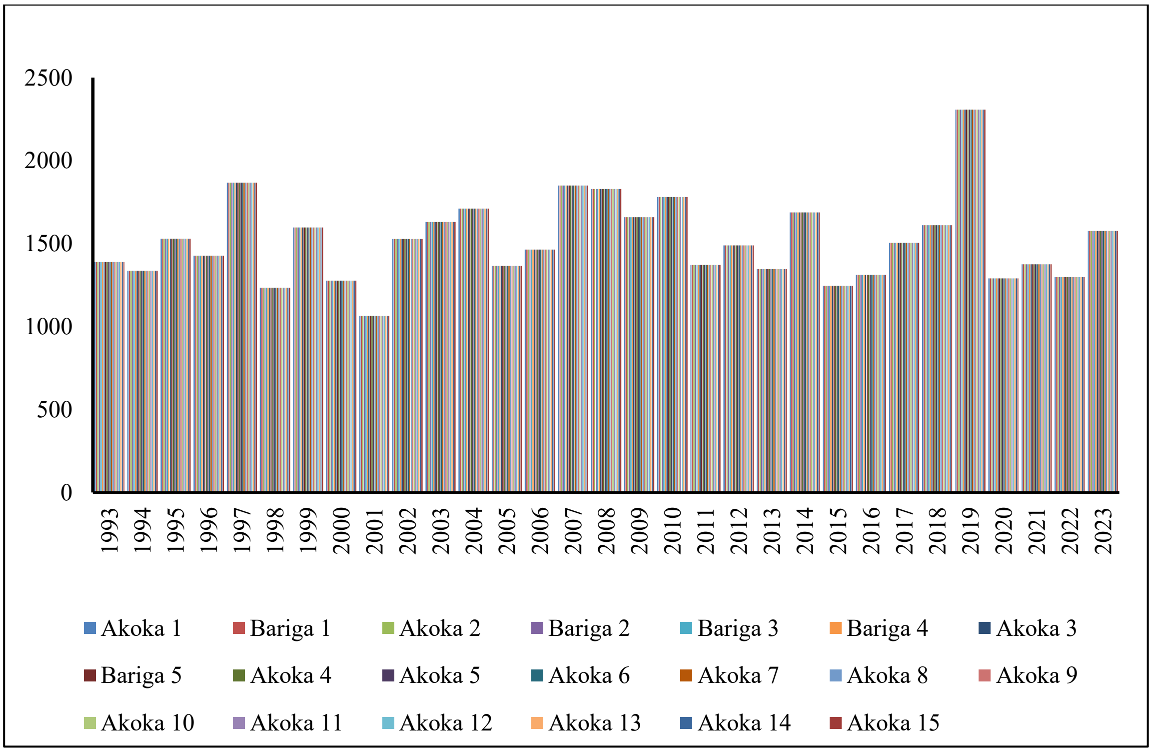

FIGURE 3: ANNUAL RAINFALL OF STUDY AREA FROM MARCH TO NOVEMBER

Figure 4 presents the monthly rainfall data compiled for each year, and the average for each month was calculated over the entire study period. These monthly averages were then plotted for comparison across the study locations. The analysis revealed that June (317 mm), July (223 mm), September (208 mm), and October (209 mm) exhibited the greatest differences in rainfall among the study areas. In contrast, January (16 mm), February (31 mm), and November (11.5 mm) showed the smallest variations. Overall, June recorded the highest average rainfall variation, while December had the lowest.

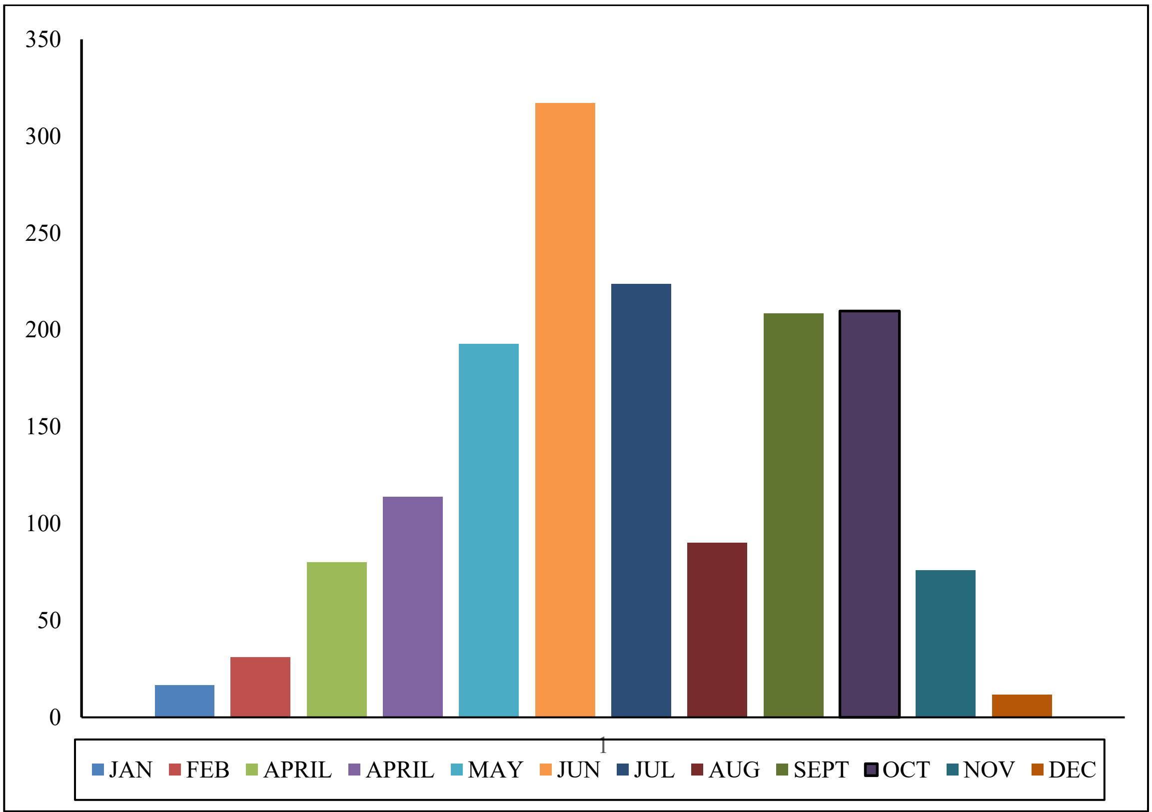

FIGURE 4: MEAN MONTHLY RAINFALL FROM JANUARY - DECEMBER, FOR THE STUDY PERIOD

Spatial Distribution of Rainfall

Figure 5 presents the spatial pattern of mean annual rainfall across the 20 stations within Akoka over the 30-year period. Rainfall distribution across Akoka was analyzed using CHIRPS remote-sensing data processed in QGIS. The dataset covered 1993-2023 and provided gridded rainfall values at a 0.05° spatial resolution. The aim was to capture how rainfall varies across locations within the study area over time. The map shows a generally uniform rainfall pattern across the area, but with subtle spatial differences that reflect local-scale influences such as proximity to the coast, urban structures, and micro-climatic conditions. Overall, rainfall in Akoka remains relatively evenly distributed, but the map confirms that some pockets consistently receive slightly higher totals than others. These variations, although not extreme, are important for understanding localized flooding tendencies, drainage performance, and water-resource planning within the community (Adejuwon, 2005; Adekoya & Ajayi, 2024).

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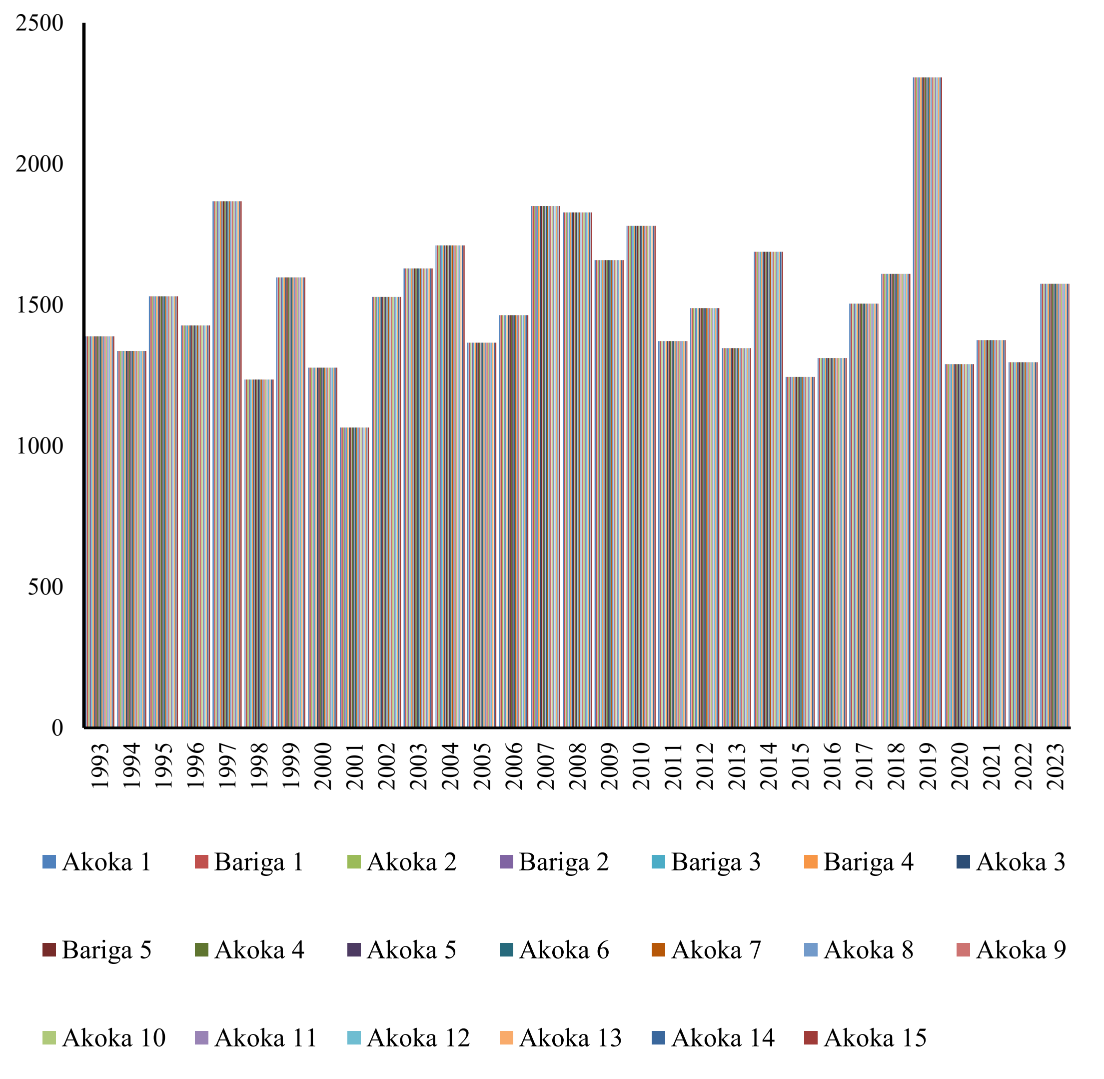

FIGURE 5: SPATIAL DISTRIBUTION OF MEAN ANNUAL RAINFALL IN AKOKA (1993-2023)

Effect of El Nino on Rainfall Distribution from 1993-2023

As shown in Table 1, the analysis of major El Niño episodes over the 32-year period showed that their influence on rainfall in Akoka was not uniform. Some events, such as those in 1997-1998 and 2015-2016, coincided with years of markedly reduced rainfall, falling well below the long-term mean. In contrast, other episodes, including 2002-2003 and 2009-2010, did not suppress rainfall, as the affected years recorded totals above the climatic average. Overall, the pattern indicates that while El Niño can contribute to rainfall deficits in Akoka, its impact varies across events, with some episodes exerting minimal or no observable effect. The detailed comparison of each El Niño year with corresponding rainfall performance is presented in Table 1, which highlights where reductions occurred and where rainfall remained stable or above average.

Table 1: Major El Niño Events and Corresponding Rainfall Response in Akoka (1993-2024)

S/N	El Niño Year	Impact Year	Annual Rainfall (mm)	Mean Annual Rainfall (mm)	Comparison to Mean	Observed Impact on Rainfall
1	1997-1998	1998	1285	1570	Below	Rainfall was significantly lower than the mean, indicating a clear reduction linked to the El Niño event.
2	2002-2003	2003	1750	1570	Above	Rainfall exceeded the mean, suggesting that this El Niño episode did not reduce rainfall in Akoka.
3	2009-2010	2010	1842	1570	Above	Annual rainfall was higher than average, indicating no noticeable El Niño-related decline.
4	2015-2016	2016	1325	1570	Below	Rainfall was below the long-term mean, showing a reduction possibly linked to the El Niño effect.
5	2023-2024	2024	*No data for 2024*	1570	—	Rainfall data for 2024 are unavailable, so the full impact of this El Niño event cannot be assessed.

Conclusion and Recommendations

The study analyzed rainfall patterns over a period of 31-year (1993 to 2023) using remotely sensed data across the Akoka region, Lagos State, Nigeria with the aim to determine whether significant variations existed in total annual and seasonal rainfall among the different study locations, and to offer practical insights for sustainable development and climate adaptation strategies based on the results. The findings revealed notable similarities in rainfall distribution across Akoka, particularly in terms of total annual rainfall, seasonal totals, and average monthly values. The monthly analysis showed a recurring pattern, with rainfall typically peaking in June and a pronounced dry spell beginning around November, consistent throughout the study period. The year 2019 was identified as having the highest annual rainfall, suggesting a greater likelihood of flooding during that time, while 2001 experienced the lowest annual total, pointing to possible drought conditions. These contrasting extremes highlight the significant variability in rainfall within the region. Furthermore, the examination of El Niño years showed that while some events such as those in 1998 and 2016 led to reduced rainfall, others, including 2003 and 2010, were associated with above-average precipitation. This indicates that the impact of El Niño on rainfall in Akoka is not uniform and can vary significantly based on the nature and timing of each event. Based on the findings, local authorities should work closely with meteorological agencies to strengthen early warning systems, especially since El Niño's influence on rainfall in Akoka is inconsistent but sometimes significant. Continuous data collection across all 20 stations must also be maintained to improve real-time monitoring and forecasting. In addition, early warning and preparedness measures should be prioritised for low-lying parts of Akoka, where rainfall variability poses a higher risk of flooding.

References

Adejuwon, J. O. (2005). Rainfall Seasonality in the Niger Delta Belt, Nigeria. *Geojournal, 62*(1), 95-113.

Adekoya, A. O., & Ajayi, V. O. (2024). Spatial Distribution of Rainfall in Lagos Mainland, Nigeria. *International Journal of Social Sciences, 22(1), 1675-1690.* https://ijss-ui.com.ng/volume-22-issue-1-2024/1675-2/

Adelekan, I. O. (2010). Vulnerability of Poor Urban Coastal Communities to Climate Change in Lagos, Nigeria. *Environment and Urbanization, 22*(2), 433-450.

Akinsanola, A. A., & Ogunjobi, K. O. (2014). Analysis of Rainfall and Temperature Variability Over Nigeria. Global Journal of Human-Social Science: B Geography, *Geo-Sciences, Environmental Disaster Management, 14(3), 1-18.*

Awosika, L. F., & Oyebande, L. (2019). Climate and Vegetation of Coastal Nigeria. *International Journal of Environmental Studies, 11(2), 103-115.*

Balogun, I. I., Sojobi, A. O., & Oyedepo, B. O. (2016). Assessment of Rainfall Variability, Rainwater Harvesting Potential and Storage Requirements in Odeda Local Government Area of Ogun State in Southwestern Nigeria. *Cogent Environmental Science*, 2(1), 1138597. https://doi.org/10.1080/23311843.2016.1138597

Diagi, B. E., (2018). Analysis of Rainfall Trend and Variability in Ebonyi State, Southeastern Nigeria. *Environmental and Earth Sciences Research Journal, 5(3), 53 -57.*

Ebert, E. E., Janowiak, J. E., & Kidd, C. (2007). Comparison of Near-Real-Time Precipitation Estimates from Satellite Observations and Numerical Models. *Bulletin of the American Meteorological Society, 88*(1), 47–64.

Emeka-Chris, C. C, Obineche, C., Unaka, B. O. (2022). Precipitation Intensity-Duration Occurrence Models Development for Designated Locations in the Southern Humid Rain Forest Zones of Nigeria. *Turkish Journal of Agricultural Engineering Research, 3(2), 277-291.*

Huffman, G. J., Bolvin, D. T., & Nelkin, E. J. (2015). *Integrated Multi-satellite Retrievals for GPM (IMERG) Algorithm Theoretical Basis Document*. NASA Technical Document.

Kummerow, C., Barnes, W., Kozu, T., Shiue, J., & Simpson, J. (2000). The Tropical Rainfall Measuring Mission (TRMM) Sensor Package. *Atmospheric and Oceanic Technology, 15*(3), 809-817.

Mosunmola, I. A., Samaila, I. K., Emmanuel, B., & Adolus, I. (2020). Evaluation of Onset and Cessation of Rainfall and Temperature on Maize Yield in Akure, Ondo State, Nigeria. *Atmospheric and Climate Sciences, 10,* 125-145, https://www.scirp.org/journal/acs.

Nebedum, E. E., & Emodi, N. V. (2016). Climate Change and Is Impact in Nigerian Economy. *Scientific Research and Reports, 10(6)*, 1-13, ID SRR.25162

Nicholson, S. E. (2013). The West African Sahel: A Review of Recent Studies on the Rainfall Regime and Its Interannual Variability. *ISRN Meteorology, 2013*, 1-32.

Nzoiwu, C. P., Ezenwaji, E. E., Enete, I. F., Nwabueze, I. I., (2017). Analysis of Trends in Rainfall and Water Balance Characteristics of Awka Nigeria. *Geography and Regional Planning,* 10(7), 186-196, ID 057FE3964815.

Ogunrinde, A. T., Oguntunde, P. G., Akinwumiju, A. S., Fasinmirin, J. T. (2019). Analysis of Recent Changes in Rainfall and Drought Indices in Nigeria, 1981-2015. *Hydrological Sciences, 64(14),* 1755-1768.

Ojo, A. (2017). Urbanization and Its Impact on the Environment in Lagos State. *Environmental Impact Review, 25(3),* 220-233.

Oke, T. R. (1987). Boundary Layer Climates. *Routledge.*

Olorode, D. O., Olatinsu, O. B., & Ugwoke, E. E. (2012). *Site Investigation Using a Combination of Electrical Resistivity Technique and CPT-A Case Study of a Coastal Area of Lagos, Nigeria*. Geology map of Lagos State.

Sobowale, S. O. S., & Ayodele, O. E. (2016). *Analysis of Recent Onset and Cessation of Rainfall in Southwest Nigeria. Conference Proceedings of the 2016 International Conference on SET (COLENG 2016)*, Federal University of Agriculture, Abeokuta.

Ugbah, P. A., Olaniyan, O., Francis, S. F., & James, A. (2018). *Impact of Climate Change on Growing Season in Nigeria: Seasonal Rainfall Prediction (SRP) as Assessment and Adaptation Tool*. Handbook of Climate Change Resilience, 1-27.

Ugwu, E. B. I., Ugbor, D. O., Agbo, J. U., & Alfa, A. (2023). Analyzing Rainfall Trend and Drought Occurrences in Sudan Savanna of Nigeria. *Scientific African 20, ID* (2020).

Yamusa, A. M., & Abdulkadir, A. (2020). Rainfall and Temperature Trends in Samaru and Minjibir, Northern Guinea and Sudan Savannas of Nigeria. *Journal of Sustainable Development, 55.*

Annex 1: Long-Term Monthly Rainfall Variability in Akoka (1993-2023)

Month	Minimum (mm)	Maximum (mm)	Mean (mm)	Std Dev (mm)	CV (%)
January	5	45	22	12	55
February	8	50	28	15	54
March	25	120	65	28	43
April	50	210	125	45	36
May	110	280	190	60	32
June	180	360	260	70	27
July	200	420	300	80	27
August	180	400	280	75	27
September	150	380	260	70	27
October	100	310	200	60	30
November	50	180	115	40	35
December	10	60	30	15	50

Monthly rainfall in Akoka shows a clear seasonal pattern, with minimal rainfall in the dry months (Jan-Feb, Dec) and peak rainfall during the wet season (Jun-Oct). Coefficient of Variation values indicate higher relative variability in the dry season and moderate variability during the main rainy months.

Annex 2: Long-Term Monthly Rainfall Variability in Akoka (1993-2023)

Month	Minimum (mm)	Maximum (mm)	Mean (mm)	Std Dev (mm)	CV (%)
January	5	45	22	12	55
February	8	50	28	15	54
March	25	120	65	28	43
April	50	210	125	45	36
May	110	280	190	60	32
June	180	360	260	70	27
July	200	420	300	80	27
August	180	400	280	75	27
September	150	380	260	70	27
October	100	310	200	60	30
November	50	180	115	40	35
December	10	60	30	15	50

Annual rainfall across the 20 stations in Akoka shows moderate variability, with CV values around 22-23%, indicating fairly consistent totals despite year-to-year fluctuations.

Annex 3: Inter-Decadal Rainfall Variability in Akoka (1993-2023)

Decade	Decadal Amount (mm)	(mm)	S.D (mm)	CV (%)	Decadal Change (mm)	Difference from Long-Term Average (600.06 mm)
1993-2002	6 200	620	90	15	-	+19.94
2003-2012	6 500	650	95	15	+300	+49.94
2013-2022	5 900	590	85	14	-600	-10.06
2023-2023*	620	620	10	1.6	+30	+19.94

Inter-decadal rainfall in Akoka shows moderate variability, with CV values of 14-15% across decades. The 2003-2012 decade was the wettest, while 2013-2022 experienced slightly below-average rainfall relative to the long-term mean of 600.06 mm.