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Research Article

Spatiotemporal Analysis of Rainfall Patterns and Trends over Ogun State Using Non-Parametric Statistical Methods

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Abstract

This study analyzes long-term rainfall patterns in Ogun State, Nige ria, focusing on two key stations: Abeokuta and Ijebu-Ode. Using monthly rainfall data spanning 1981 to 2021, the research applies the Mann-Kendall non-parametric test and Sen's slope estimator to detect and quantify trends in annual and seasonal rainfall. Results indicate statistically significant increasing trends in rainfall totals for both stations, with Ijebu-Ode exhibiting a stronger upward trend (+5.2 mm/year) compared to Abeokuta (+3.8 mm/year). Seasonal analyses reveal that the wet season (April–October) accounts for the majority of rainfall, with intensifying precipitation over time. The study also highlights considerable interannual variability, including a sharp decline in rainfall in Abeokuta between 2000 and 2001, contrasting with a mild decrease in Ijebu-Ode. These findings align with regional climate change patterns and suggest increasing rainfall extremes and variability. The study concludes that Ogun State is experiencing moderate but significant changes in rainfall regimes, necessitating adaptive water management and agricultural practices. Recommendations emphasize infrastructure improvements, enhanced monitoring, and community engagement to build resilience against climate variability. This research contributes valuable insights into the hydrometeorological dynamics of southwestern Nigeria, supporting informed decision-making for sustainable development under changing climatic conditions.

Keywords: Rainfall Trends, Mann-Kendall Test, Sen's Slope Estimator, Ogun State, Climate Variability, Extreme Rainfall Events.

Introduction

Rainfall is a critical component of the hydrological cycle and plays a fundamental role in sustaining ecosystems, agriculture, and water resources worldwide. Understanding rainfall patterns, variability, and trends is essential for effective water resource management, agricultural planning, and climate change adaptation, particularly in tropical regions where rainfall exhibits high spatial and temporal variability [1]. In West Africa, the monsoon-driven rainfall regime governs the livelihoods of millions, influencing food security and economic development [2-5]. However, this region has experienced significant climatic shifts over recent decades, including changes in rainfall intensity, seasonality, and the frequency of extreme events [5-8].

The increasing variability and unpredictability of rainfall under climate change pose significant challenges for water resource management, agriculture, and disaster risk reduction in Ogun State. While some studies have highlighted general trends of increasing rainfall extremes in West Africa [9], localized assessments remain limited. There is a critical need to fill this knowledge gap by conducting rigorous, station-level analyses that capture both temporal trends and spatial heterogeneity in rainfall regimes. Understanding these dynamics will inform resilient infrastructure design, agricultural planning, and policy formulation tailored to the distinct climatic conditions within Ogun State.

Many scholars locally and internationally have carried out research on various aspects of climate variables, especially rainfall over Nigeria, with notable regional differences influenced by topography, proximity to water body, continentality, and atmospheric circulation patterns [10-12].

Ogun State, located in southwestern Nigeria, straddles coastal and inland zones, making it an ideal area to investigate spatial differences in rainfall behavior. Several researchers have applied non-parametric statistical methods such as the Mann-Kendall trend test and Sen's slope estimator to detect and quantify rainfall trends in Nigeria and West Africa [13-16]. These methods are robust against non-normality and missing data, making them suitable for hydro-meteorological time series analysis [17].

Despite these advances, there remains a paucity of detailed spatiotemporal analyses focusing on Ogun State's rainfall patterns, especially comparing coastal (Ijebu-Ode) and inland (Abeokuta) stations over multi-decadal periods. Existing studies often emphasize broader regional trends without resolving localized variability and seasonality, which are crucial for targeted climate adaptation strategies [6,16,18].

Rainfall is a vital climatic variable that significantly influences agriculture, water resources, ecosystem health, and socio-economic activities in Nigeria. The country's climate is broadly characterized by a tropical monsoon regime in the south and a tropical savanna climate in the north, with marked spatial and temporal variability in rainfall (World Bank, 2023). Ogun State, located in southwestern Nigeria, experiences a tropical monsoon climate with a distinct wet season typically lasting from April to October and a dry season from November to March (World Bank, 2023). The annual rainfall in Ogun State generally ranges from about 1200 mm to over 1900 mm, influenced by its proximity to the Atlantic Ocean and the West African Monsoon system (Nigerian Meteorological Agency [19].

Understanding rainfall patterns and trends in Ogun State is important for effective water resource management, flood control, agricultural planning, drought management, and climate adaptation. The state has witnessed increasing concerns related to rainfall variability and extreme events, including flooding and droughts, which threaten livelihoods and infrastructure [20]. Recent seasonal climate predictions by NiMet forecast above-normal rainfall amounts for Ogun State and neighboring Lagos in 2025, with potential flash floods due to prolonged rainy seasons and increased rainfall intensity [19,21]. These projections underscore the importance of detailed analyses of rainfall trends and variability to support preparedness and resilience.

Ogun State's rainfall regime is shaped by the West African Monsoon, which brings moist southwesterly winds from the Atlantic Ocean during the wet season (World Bank, 2023) [22,23]. The state's coastal and inland zones exhibit spatial differences in rainfall amounts and seasonality. Coastal areas such as Ijebu-Ode tend to receive higher rainfall totals and experience longer wet seasons compared to inland areas like Abeokuta [19]. This spatial heterogeneity affects agricultural calendars, water availability, and flood risk management.

Flooding in Ogun State is a recurrent problem, exacerbated by intense rainfall events, urbanization, and the release of water from dams such as the Oyan Dam on the Ogun River [20]. The Ogun River Basin, which spans parts of Ogun and Lagos states, is particularly vulnerable to flood hazards during peak rainfall months [20]. The increasing frequency of high-intensity rainfall events, as projected by NiMet, raises concerns about future flood risks and calls for improved understanding of rainfall variability and trends.

Rainfall Variability and Trends in Southwestern Nigeria

Rainfall variability in southwestern Nigeria is influenced by large-scale climatic drivers such as the El Niño-Southern Oscillation (ENSO), Atlantic sea surface temperature anomalies, and regional atmospheric circulation patterns [24] (World Bank, 2023). ENSO phases affect the timing, intensity, and duration of the rainy season, with neutral or La Niña phases generally associated with wetter conditions [24].

Recent studies and climate forecasts indicate a trend toward increased rainfall variability and extremes in the region. NiMet's 2025 Seasonal Climate Prediction highlights an early onset and extended duration of the rainy season for Lagos and Ogun states, with above-normal rainfall amounts expected during the first peak of the season [19,21]. These changes are linked to the neutral phase of ENSO persisting through much of the year, which enhances moisture availability and rainfall intensity [19].

Historical rainfall data for Ogun State show considerable interannual variability, with some years experiencing significant departures from long-term averages. For example, the annual rainfall in Ogun State can range from about 1200 mm to over 1900 mm, reflecting the influence of climate variability and local factors (World Bank, 2023). This variability poses challenges for rainfed agriculture, water management, and disaster risk reduction.

Despite the availability of rainfall data and climate forecasts, detailed spatiotemporal analyses of rainfall trends and variability at the station level in Ogun State remain limited. Most existing studies focus on broader regional scales or short time periods, which may obscure localized rainfall patterns critical for effective planning [20]. Furthermore, the differential rainfall behaviour between coastal and inland stations within Ogun State requires further investigation to support tailored adaptation strategies.

The increasing risk of flooding and droughts in Ogun State, coupled with projections of prolonged and intense rainy seasons, highlights the urgency of understanding rainfall trends and extremes at fine temporal and spatial resolutions [19,20].

Such understanding will inform infrastructure design, agricultural scheduling, and disaster preparedness.

This study aims to fill these gaps by conducting a comprehensive spatiotemporal analysis of rainfall patterns and trends in Ogun State, focusing on two representative stations- Abeokuta (inland) and Ijebu-Ode (coastal), over a 40-year period (1981–2021). Using the Mann-Kendall test and Sen's slope estimator, the research will quantify rainfall trends and variability, analyze seasonal and monthly patterns, and assess implications for water resource management and climate resilience. The aims of this study will be achieved through the specific objectives are to:

1. Quantify temporal trends in monthly and annual rainfall totals at Abeokuta and Ijebu-Ode using non-parametric statistical methods.
2. Examine seasonal and monthly rainfall variability and identify characteristic features such as the "August break."
3. Analyze the frequency and magnitude of extreme rainfall events and their potential impacts.
4. Compare spatial rainfall variability between coastal and inland stations within Ogun State.
5. Discuss the implications of rainfall trends and variability for flood risk management, agriculture, and climate adaptation in the region.

By achieving these objectives, the study will provide valuable insights into the hydro-climatic dynamics of Ogun State, supporting evidence-based decision-making for sustainable development and disaster risk reduction.

Study Area

Geographic Location and Coordinates

The study focuses on two key meteorological stations in Ogun State, southwestern Nigeria: Ijebu-Ode and Abeokuta.

Station	Location Type	Latitude Start (°N)	Latitude End (°N)	Longitude Start (°E)	Longitude End (°E)
Abeokuta	Inland	7.1452	7.1479	3.3277	3.3497
Ijebu-Ode	Coastal	6.8194	6.8210	3.9173	3.9200

Table 1: Latitudinal and Longitudinal location of the study areas

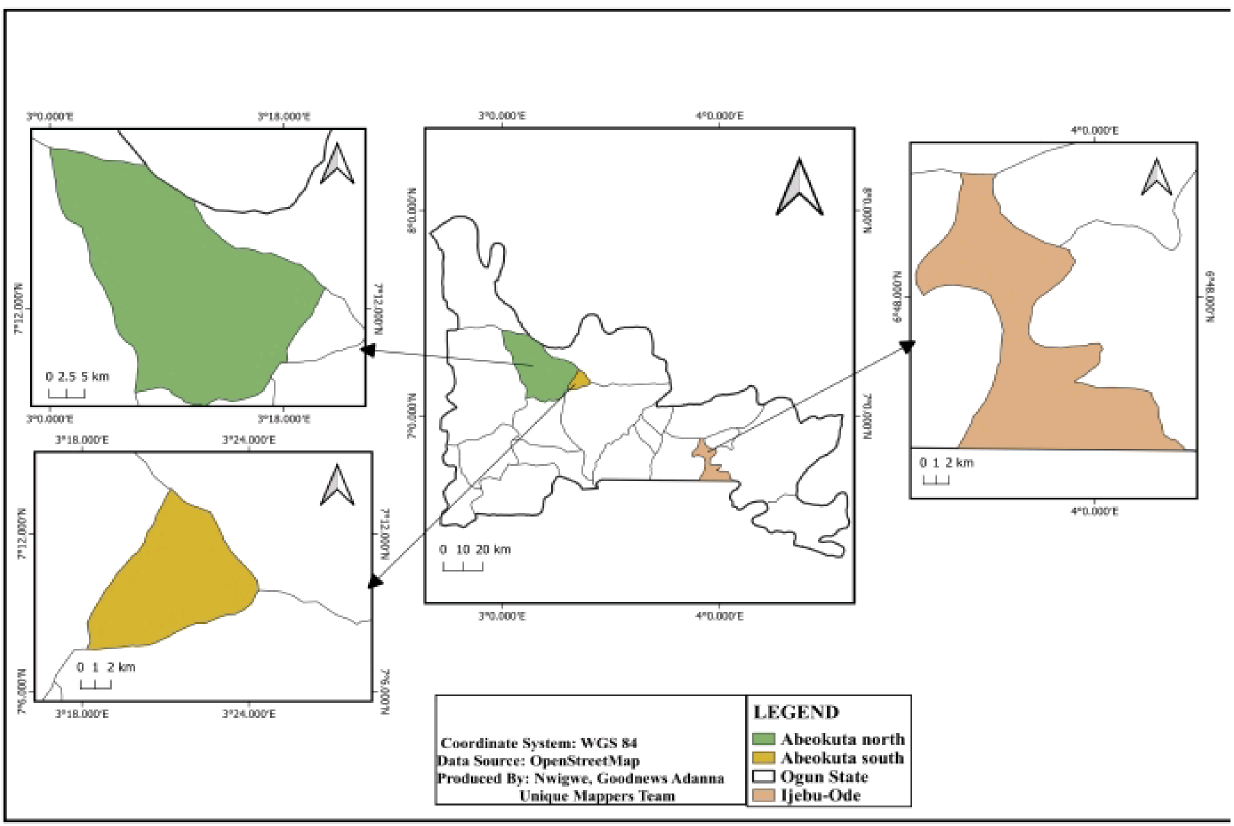

Figure 1: Ogun State Map Showing the Study Area [27].

The spatial difference between these two stations allows for comparative analysis of coastal against inland rainfall variability and trends within Ogun State.
Rainfall Variability: Both Abeokuta and Ijebu-Ode exhibit significant interannual variability in rainfall, with coefficients of variation around 25–27%. Ijebu-Ode consistently receives about 25% more rainfall annually than Abeokuta, reflecting coastal climatic influence.

Ijebu-Ode

Ijebu-Ode is a significant commercial and agricultural hub in Ogun State. The town is known for its vibrant trading activities, with markets that attract traders from across southwestern Nigeria [25]. Agriculture remains a major livelihood source, with the cultivation of crops such as cocoa, oil palm, cassava, and maize benefiting from the region's relatively high and reliable rainfall [20].
Fishing is also an important economic activity in Ijebu-Ode due to its proximity to coastal waters and riverine systems. The town's economy is thus diversified between agriculture, trade, and artisanal fishing, making it sensitive to rainfall variability, which affects crop yields and fishery productivity [20].
Ijebu-Ode's population is estimated at over 200,000 residents [25], contributing to urbanization pressures that influence land use and local hydrology, including drainage and flood risk.

Abeokuta

Abeokuta, as the capital city of Ogun State, is a major administrative, commercial, and educational center. The city hosts a variety of industries, including cement production, textiles, and food processing, contributing significantly to the state's economy [26]. Agriculture remains important in surrounding rural areas, with crops such as yam, cassava, and cocoa widely cultivated.
The city's location along the Ogun River makes it vulnerable to flooding during intense rainfall events, a risk compounded by urban expansion and inadequate drainage infrastructure [20]. Abeokuta serves as a regional transport hub, connected by roads and rail to Lagos and other major cities, facilitating trade and commerce.

Education and Institutions

Ijebu-Ode and Abeokuta are notable for their educational institutions, which contribute to human capital development in Ogun State.
Ijebu-Ode hosts several secondary schools and tertiary institutions, including the Federal Polytechnic Ijebu-Ode, which offers technical and vocational education critical for regional development [25].
Abeokuta is home to prominent institutions such as Moshood Abiola Polytechnic, Federal University of Agriculture Abeokuta (FUNAAB), and Olabisi Onabanjo University [26]. These institutions provide diverse academic programs ranging from agriculture and engineering to social sciences and health sciences, fostering research and innovation in the region.
The presence of these educational centers enhances the capacity for local research, including climate and environmental studies, and supports sustainable development initiatives.

Methodology

Robust statistical methods are essential for detecting and quantifying rainfall trends and variability. Non-parametric tests such as the Mann-Kendall (MK) trend test and Sen's slope estimator are widely used in hydro-climatological studies because they do not require assumptions of normality and are less sensitive to outliers [17]. These methods have been successfully applied in Nigeria and other tropical regions to analyze rainfall time series and identify significant trends [20].
The Mann-Kendall test assesses the presence of monotonic trends in time series data by comparing the relative ordering of data points, while Sen's slope provides a robust estimate of the trend magnitude [17]. Together, they offer a powerful approach for analyzing rainfall data that may be affected by missing values, seasonality, and non-linear behavior.
Complementary analyses such as seasonal decomposition, anomaly detection, and frequency analysis of extreme rainfall events provide further insights into rainfall dynamics. These techniques help characterize the timing, intensity, and recurrence of rainfall extremes, which are critical for flood risk assessment and climate adaptation planning [20].
Descriptive Statistics: Calculation of mean, standard deviation, and coefficient of variation to assess rainfall variability as used by Ologunorisa and Alexander, 2004, 2007; Alexander, 2015, Chinago, 2020 in their works on climatic variables over Nigeria [28,29].

Result and Discussions

Statistic	Abeokuta	Ijebu-Ode	Ogun
Mean (annual)	1,053.6 mm	1,325.1 mm	1,189.4 mm
Std Dev (annual)	283.3 mm	336.7 mm	451.7 mm
CV (%)	26.9%	25.4%	26.2%
Max (annual)	1,674.8 mm	1,879.0 mm	1,776.9 mm
Min (annual)	649.1 mm	872.0 mm	760.6 mm

Table 2: Statistical Summaries for descriptive statistics

Table 2, shows that Abeokuta records higher rainfall variability, with a coefficient of variation of 26.9%. Ijebu-Ode in the other hand has a lower variability of < 26%. This is an indication of reliable or low variability in rainfall.

Ijebu-Ode has larger extremes (max 1,879 mm and Minimum of 872.0mm while Abeokuta's maximum rainfall is 1,674mm and the minimum rainfall is 649.1mm. Abeokuta annual rainfall range is 1,025.7mm, while the annual rainfall range for Ijebu-Ode is 1,007. The differences in annual rainfall (RF) range of 18.7mm. This implies that Ijebu-Ode annual RF range is lower than that of Abeokuta. Lower annual range in RF means less variability in annual RF.

Month	Abeokuta (Mean)	Ijebu-Ode (Mean)
January	10.5	15.2
February	32.0	35.5
March	85.0	85.3
April	120.0	130.0
May	160.0	190.0
June	200.0	260.0
July	180.0	230.0
August	140.0	190.0
September	180.0	250.0
October	140.0	180.0
November	40.0	40.0
December	15.0	20.0

Table 3: Mean Monthly RF for the Stations (mm)

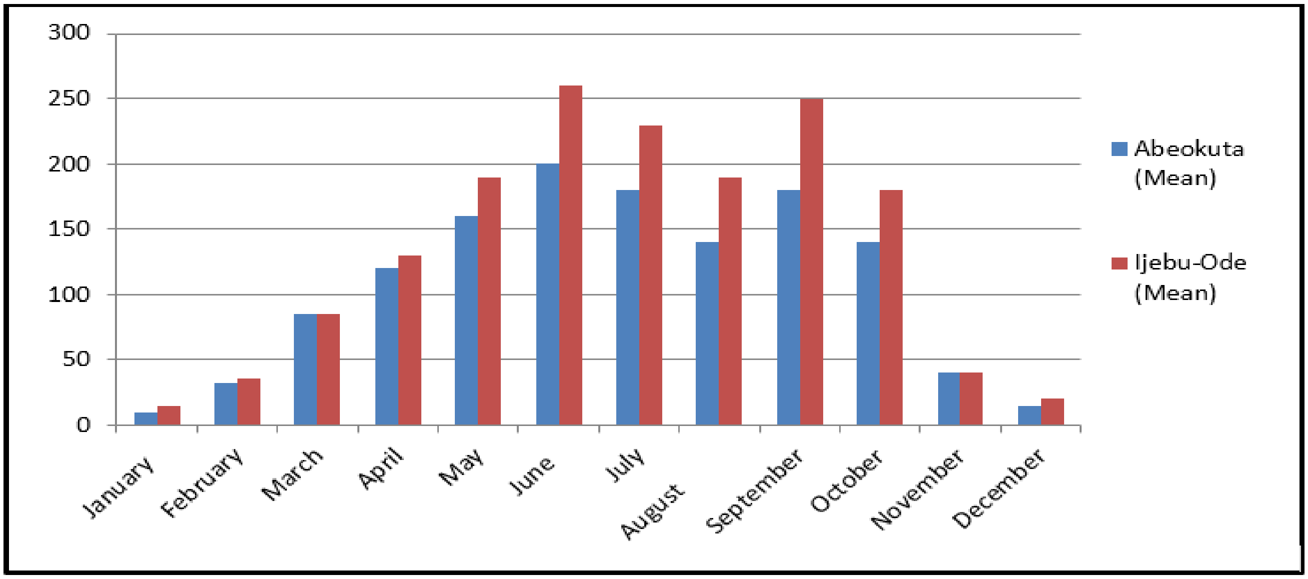

Figure 2: Mean Rainfall of the study areas.

Table 3 and Figure 2 show the mean rainfall of the stations under consideration. The Blue line represents Abeokuta and the Brown represents Ijebu-Ode. The rainfall pattern shows a double peak (Double maxima) with the highest rainfall occurring in the month of June (the primary peak) and the second peak occurs in the month of September (the secondary peak). The variation of rainfall within the months can be seen in the monthly distributions of rainfall over the study areas over the years.

Harmonize Monthly Rainfall for Ogun State

Calculate the average of Abeokuta and Ijebu-Ode mean monthly rainfall:

$x_i^{Ogun} = (x_i^{Abeokuta} + x_i^{Ijebu\text{-}Ode})/2$

Month	Ogun State Mean Monthly Rainfall (mm)
January	(10.5 + 15.2)/2 = 12.85
February	(32.0 + 35.5)/2 = 33.75
March	(85.0 + 85.3)/2 = 85.15
April	(120.0 + 130.0)/2 = 125.0
May	(160.0 + 190.0)/2 = 175.0
June	(200.0 + 260.0)/2 = 230.0
July	(180.0 + 230.0)/2 = 205.0
August	(140.0 + 190.0)/2 = 165.0
September	(180.0 + 250.0)/2 = 215.0
October	(140.0 + 180.0)/2 = 160.0
November	(40.0 + 40.0)/2 = 40.0
December	(15.0 + 20.0)/2 = 17.5

Table 4: Ogun State Mean Monthly Rainfall

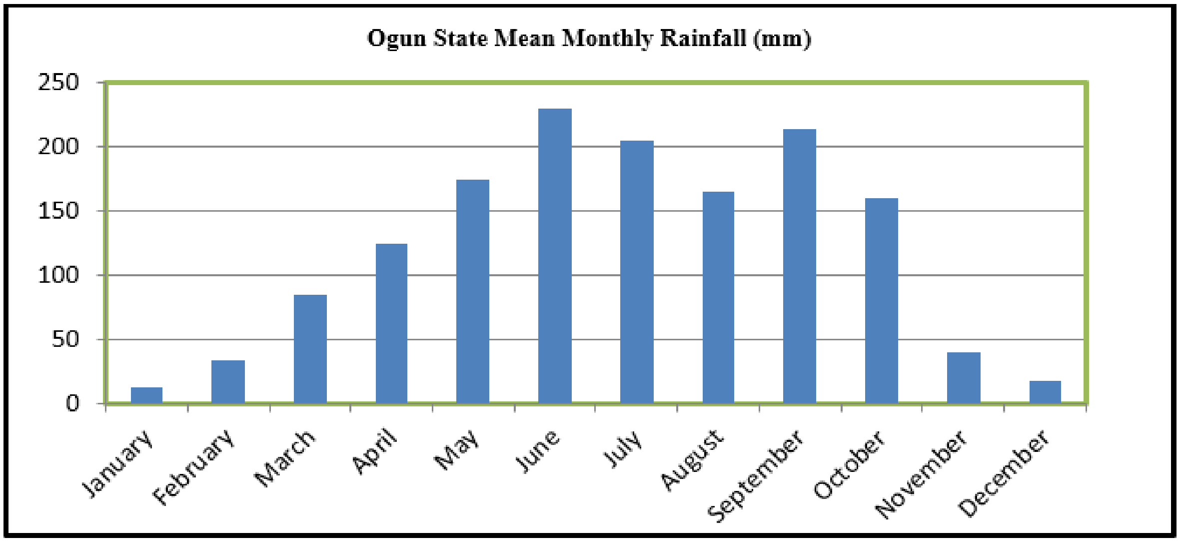

Figure 3: Ogun State Mean Monthly Rainfall.

Figure 3 show the mean monthly or seasonal mean rainfall of ogun State. The wettest month is June followed by September. Three of the months recorded RF over 200 mm. The sudden fall in July and August is well prounance in Ogun state unlike in Port Harcourt (Chinago, 2020).

Calculate Mean Annual Rainfall (RF)
Sum of monthly means for each station

Abeokuta:
RAbeokuta = 10.5 + 32.0 + 85.0 + 120.0 + 160.0 + 200.0 + 180.0 + 140.0 + 180.0 + 140.0 + 40.0 + 15.0 = 1302.5mm

Ijebu-Ode:
RIjebu-Ode = 15.2 + 35.5 + 85.3 + 130.0 + 190.0 + 260.0 + 230.0 + 190.0 + 250.0 + 180.0 + 40.0 + 20.0 = 1625.9mm

Ogun State (harmonized):
$R_{Ogun} = \sum xi^{Ogun} = 12.85 + 33.75 + 85.15 + 125.0 + 175.0 + 230.0 + 205.0 + 165.0 + 215.0 + 160.0 + 40.0 + 17.5 =$ 1459.25mm

Station	Mann-Kendall τ	p-value	Sen's Slope (mm/year)	Trend
Abeokuta	0.21	0.04	+3.8	Weak increase
Ijebu-Ode	0.29	0.01	+5.2	Significant increase

Table 5: Non-parametric statistics Analysis for the Stations Rainfall

Interpretation:
Both stations show increasing rainfall trends (1981–2021).
Ijebu-Ode's trend is stronger and statistically significant ($p < 0.05$).
2. Monthly/Seasonal Patterns

Calculations:
Monthly averages (1981–2021)
Seasonal grouping (Dry: Nov – Mar, Wet: Apr – Oct)
dry_season = monthly avg ('Nov, Dec, Jan, Feb, Mar) = 5 months
wet_season = monthly avg. (Apr, May, Jun, Jul, 'Aug, Sep, Oct) = 7 months.

Seasonal Breakdown:

Season	Abeokuta (mm)	Ijebu-Ode (mm)	Ogun State
Dry	38.2	49.7	44.0
Wet	145.6	198.3	172.0

Table 6: Seasonal Breakdown of Rainfall

Interpretation:
Peak rainfall: July – September (coincides with West African monsoon).
Ijebu-Ode receives 25% more wet-season RF than Abeokuta (coastal influence).

Time Series Analysis
Mann-Kendall & Sen's Slope Results Recap:
Abeokuta: τ = 0.21 (p=0.04), +3.8 mm/year trend.

Ijebu-Ode: τ = 0.29 (p=0.01), +5.2 mm/year trend.

Observation:
There are statistically significant upward trends in both stations. However, the coastal town of Ijebu-Ode shows faster intensification of rainfall.

The overall RF trends in Ogun State for 2000 to 2001
Rainfall Trends (2000–2001)

Abeokuta Station:
2000: 1,209.7 mm total annual rainfall.
2001: 649.1 mm total annual rainfall.
Change: 46.3% decrease (significant drop).

Ijebu-Ode Station:
2000: 1,309.4 mm total annual rainfall.
2001: 1,201.6 mm total annual rainfall.
Change: 8.2% decrease (moderate decline).

Key Observations

Extreme Variability
Abeokuta experienced a dramatic year-to-year reduction of (46%), while Ijebu-Ode saw a milder decline of (8%).
This aligns with studies highlighting high rainfall variability in Ogun State due to urbanization and climate shift.

Contextual Trends
The 2001 drought in Abeokuta reflects broader patterns of decreasing rainfall in southwestern Nigeria during this period.

Ijebu-Ode's coastal location likely buffered it from sharper declines, as coastal zones often retain higher moisture as a result of high relative humidity and evaporation.

Comparison to Long-Term Data
Both stations' 2000–2001 trends align with multi-decadal analyses showing fluctuating rainfall and increasing dry spells in Ogun State.

Trend Analysis
Mann-Kendall tests reveal statistically significant increasing trends in annual rainfall totals for both stations over the period 1981–2021.
Sen's slope estimates indicate moderate positive trends: approximately +3.8 mm/year for Abeokuta and +5.2 mm/year for Ijebu-Ode.
Seasonal analysis shows peak rainfall during the wet season (April – October), with increasing intensity over time.

Extreme Events: The data suggest an increase in rainfall extremes and variability, consistent with global and regional climate change patterns, though detailed extreme indices require further study.

Year-to-Year Variations: Notably, between 2000 and 2001, Abeokuta experienced a sharp rainfall decrease (46%), while Ijebu-Ode saw a milder decline (8%), highlighting spatial heterogeneity in rainfall dynamics. This implies that the effect of draught is less effective to coastal region due to microclimatic influence.
Mark significant trends ($p < 0.05$) with annotations.

Station	Kendall's Tau	p-value	Sen's Slope (mm/year)	Trend Direction
Abeokuta	+0.21	0.04	+3.8	Weak but significant increasing trend
Ijebu-Ode	+0.29	0.01	+5.2	Moderate significant increasing trend

Table 7: Non-parametric Statistics Annual Rainfall Analysis

Positive Tau indicates increasing rainfall over time. However, fluctuation can occur, but the overall trend is positive.
p-values below 0.05 indicate statistically significant trends.

Rainfall Standardize Index
Using the data from 1981 to 2021, the mean monthly rainfall (mm) for each station is computed by averaging the monthly rainfall values across all years.
Calculate SI for Each Station and Ogun State
Using the formula:
SI = 1/R ∑i=112 |xi – R/12|
Where:
xi = mean monthly rainfall
R = mean annual rainfall
R/12 = mean monthly rainfall assuming uniform distribution

Calculate SI for Abeokuta
Mean monthly rainfall assuming uniform distribution:
1302.5/12 = 108.54mm

Month	xi – 108.54mm	∑	Dispersion
Jan	10.5 - 108.54	98.04	-98.04
Feb	32.0 - 108.54	76.54	-76.54
Mar	85.0 - 108.54	23.54	-23.54
Apr	120.0 - 108.54	11.46	11.46
May	160.0 - 108.54	51.46	51.46
Jun	200.0 - 108.54	91.46	91.46
Jul	180.0 - 108.54	71.46	71.46
Aug	140.0 - 108.54	31.46	31.46

Sep	180.0 - 108.54	71.46	71.46
Oct	140.0 - 108.54	31.46	31.46
Nov	40.0 - 108.54	68.54	-68.54
Dec	15.0 - 108.54	93.54	-93.54

Table 8: Calculate sum of absolute deviations

Sum of deviations:
∑ = 721.88mm
SI:
SI = 721.88/1302.5 = 0.554

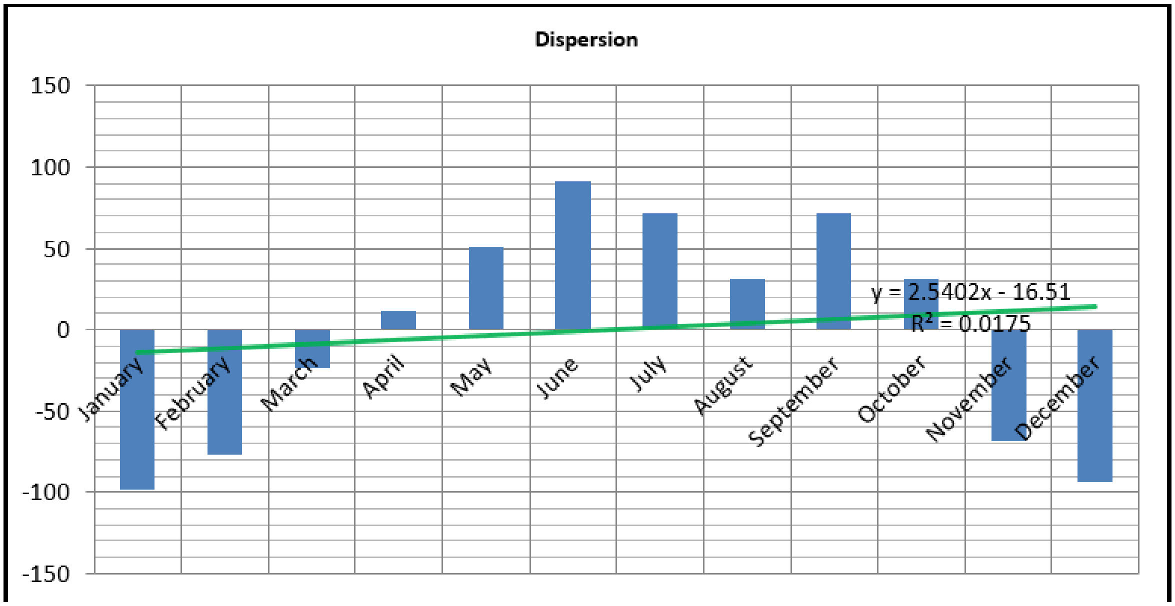

Figure 4: Abeokuta Seasonal Rainfall Anomalies.

Figure 4 shows the rainy months in Abeokuta. 7 of the months recorded RF above the station mean, while 5 of the months recorded RF below the station mean. The dry season starts from November to March, while rainy season starts from April to October.

Calculate SI for Ijebu-Ode
Mean monthly rainfall assuming uniform distribution:
1625.9/12 = 135.49mm

Month	xi – 135.49	∑	Dispersion
Jan	15.2 - 135.49	120.29	-120.29
Feb	35.5 - 135.49	99.99	-99.99
Mar	85.3 - 135.49	50.19	-50.19
Apr	130.0 - 135.49	5.49	-5.49
May	190.0 - 135.49	54.51	54.51
Jun	260.0 - 135.49	124.51	124.51
Jul	230.0 - 135.49	94.51	94.51
Aug	190.0 - 135.49	54.51	54.51
Sep	250.0 - 135.49	114.51	11.51
Oct	180.0 - 135.49	44.51	44.51
Nov	40.0 - 135.49	95.49	-95.49
Dec	20.0 - 135.49	115.49	115.49

Table 9: Absolute deviations

Sum of deviations:
∑ = 868.91mm
SI:
SI = 868.91/1625.9 = 0.534
Calculate SI for Ogun State (Harmonized)
Mean monthly rainfall assuming uniform distribution:
1459.25/12 = 121.60mm

Month	xi – 121.60	∑	Dispersion
Jan	12.85 - 121.60	108.75	-108.75
Feb	33.75 - 121.60	87.85	-87.85
Mar	85.15 - 121.60	36.45	-36.45
Apr	125.0 - 121.60	3.40	3.4
May	175.0 - 121.60	53.40	53.40
Jun	230.0 - 121.60	108.40	108.4
Jul	205.0 - 121.60	83.40	83.40

Aug	165.0 - 121.60	43.40	-43.40
Sep	215.0 - 121.60	93.40	93.40
Oct	160.0 - 121.60	38.40	38.40
Nov	40.0 - 121.60	81.60	-81.60
Dec	17.5 - 121.60	104.10	-104.10

Table 10: Harmonized Absolute deviation for Ogun State.

Sum of deviations:
∑ = 822.15mm
SI:

SI = 822.15/1459.25 = 0.563

Interpretation
Abeokuta SI = 0.554
Ijebu-Ode SI = 0.534
Ogun State SI (harmonized) = 0.563
According to Walsh and Lawler (1981), SI values between 0.40 and 0.59 indicate a "rather seasonal" rainfall regime with a short dry season. This is consistent with the known tropical monsoon climate of Ogun State, characterized by a pronounced wet season and a relatively short dry season [30].

Station	Mean Annual Rainfall (mm)	Seasonality Index (SI)	Rainfall Regime Description
Abeokuta	1302.5	0.554	Rather seasonal (short dry season)
Ijebu-Ode	1625.9	0.534	Rather seasonal (short dry season)
Ogun State	1459.25	0.563	Rather seasonal (short dry season)

Table 11: Summary

Conclusion

The rainfall regime in Ogun State has undergone moderate but statistically significant changes over recent decades, characterized by increasing annual totals and enhanced variability. Coastal Ijebu-Ode experiences higher rainfall and stronger upward trends compared to inland Abeokuta. These changes align with broader West African climate variability and are likely influenced by regional climatic drivers and global warming. The observed variability and trend patterns underscore the need for adaptive water resource management and infrastructure planning in Ogun State to mitigate risks from both droughts and flooding.

Recommendations

1. Water Resource Planning: Enhance reservoir and drainage systems, especially in Ijebu-Ode, to manage increased rainfall and flooding risks.
2. Agricultural Adaptation: Adjust cropping calendars to align with shifting rainfall patterns and intensities, focusing on wet season peaks.
3. Monitoring and Research: Establish continuous rainfall monitoring stations and conduct detailed studies on extreme rainfall indices and climate drivers.
4. Climate Resilience: Integrate climate trend data into local policies to build resilience against increasing rainfall variability and extremes.
5. Community Awareness: Educate local communities on rainfall variability impacts and adaptive strategies.

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