DonnishJournals

Donnish Journal of Geography and Regional Planning
Vol 4(1) pp. 027-034 November, 2023.
http://www.donnishjournals.org/djgrp
ISSN: 2984-8725

Original Research Paper

Appraisal of Rainfall Variability and Sustainable Development in Southwest Nigeria: A Geospatial and Statistical Analysis

Adewoye Olugbenga Adewale[1]*, Oyelami Kehinde[2] and Adeyemo Adewale[3]

[1]Department of Surveying and Geoinformatics, Osun State College of Technology, Esa-oke
[2]Department of Quantity Surveying, Osun State College of Technology, Esa-oke
[3]Department of Building Technology, Osun State College of Technology, Esa-oke

Accepted 26th October, 2023.

This study presents a comprehensive analysis of rainfall variability and its impact on sustainable economic growth in Southwest Nigeria. The study combines geospatial and statistical approaches to examine the relationship between rainfall patterns and Gross Domestic Product (GDP) within a specific range of years. Data for the study were sourced from secondary sources. The rainfall data was obtained from the Nigeria Meteorological Agency (NiMet) while data on the Gross Domestic Product ((GDP) was obtained from the National Bureau of Statistics. Randomized data was utilized to conduct the analysis, ensuring unbiased and objective results. The findings confirmed a positive correlation between rainfall and sustainable economic development, thereby shedding light on the potential implications of rainfall variability on the region's socio-economic growth and provide valuable insights for policymakers and stakeholders.

Keywords: Economy, Economic Growth, Rainfall and Sustainability

INTRODUCTION

Climate change is a statistical variation that occurs for an extended period of time that is usually for a decade or more. It is a shift in the frequency and magnitude of weather conditions and a continuous rise in global average temperature (Intergovernmental Panel on Climate change, 2001). It is a swing in climatic and atmospheric conditions which causes deviation from the natural patterns and frequencies of weather pattern(Battern,2018)

Odusola and Abidoye (2012) in their study, opined that across the globe, mean temperatures are rising and the duration and intensity of rainfall is fluctuating and the number of time weather events occur have escalated. These fluctuations are responsible for frequent and disastrous storms floods drought and extremely abnormal temperature which the planet is experiencing.

Research on some scholastic evidence show the role of climate conditions on productivity as well as economic growth. Barriers (2010) used new cross country panel climate data to examine how rainfall trends affect the poor growth performance in sub Saharan African nations compared to the developing nations, the results show that rainfall is a significant factor in determining the economic growth of African countries. Brown(2010)also did a regression analysis of datasets of rainfall, temperature and per capital GDP to explain the role of rainfall variability in the economic well being of the nation.

The region of Southwest Nigeria experiences significant rainfall variability, which has implications for the region's sustainable development efforts. Understanding the relationship between rainfall patterns and GDP is crucial for informed decision-making and effective policy formulation. This study aims to assess the impact of rainfall variability on sustainable development in Southwest Nigeria using a combination of geospatial and statistical analyses. The study area is the Southwestern part of Nigeria, which consist of 6 states including, Lagos, Ogun, Osun, Oyo, Ekiti and Ondo State, respectively. This is shown in figure 1.

LITERATURE REVIEW

A comprehensive review of literature reveals that rainfall variability can have substantial socio-economic consequences, affecting agriculture, water resources, infrastructure, and overall

Corresponding Author: waleadewoye@gmail.com

economic growth. Sustainable development in the region is highly dependent on the optimal utilization and management of water resources, making rainfall patterns a critical factor to consider.

METHODOLOGY

The study employed a geospatial and statistical approach to analyze rainfall data and GDP information for Southwest Nigeria. The southwest Nigeria comprises of Osun Ondo, Ekiti, Oyo, Ondo and Lagos state which may be represented by their capital cities of Osogbo, Ado-Ekiti,Oyo, Akure,Ibadan and Ikeja Rainfall data was obtained from the Nigeria Meteorological Agency (NiMet) across the region, while GDP data was sourced from national economic databases. Both datasets were randomized to ensure objectivity in the analysis. Geospatial techniques were applied to visualize rainfall patterns, and statistical methods such as correlation analysis and regression modeling were used to examine the relationship between rainfall and GDP.

RESULTS AND DISCUSSION

The analysis section focuses on the assessment of rainfall variability in Southwest Nigeria. Historical rainfall data is examined to identify trends, seasonality, and long-term changes in rainfall patterns. Geospatial representations, including rainfall maps and spatial distribution patterns, aid in visualizing the variability across the region. The map in figure 2, shows the precipitation distribution and variability across the study area, with regions like Lagos, Ondo having the largest precipitation, followed by Abeokuta and Osun State and the states with the least compared with others is Oyo State and Ondo, respectively. This section explores the impact of rainfall variability on key sectors of sustainable development in Southwest Nigeria.

The study investigates the influence of rainfall on agriculture, water resources, infrastructure, and overall economic growth. The findings provide insights into the vulnerability of these sectors changing rainfall patterns and their implications for sustainable development goals. The analysis extends to the examination of socioeconomic indicators and their relationship with GDP in the context of rainfall variability. Statistical analyses, including correlation analysis and regression modeling, are employed to explore the impact of rainfall on economic productivity and development. The findings highlight the influence of rainfall variability on GDP and provide valuable insights for policymakers and stakeholders. The GDP of the region between 1992 and 2021 is shown in figure 3, with the highest GDP experienced in 2014 and the least in 1993.

The analysis revealed significant rainfall variability across Southwest Nigeria during the selected range of years. Geospatial representations, including rainfall maps and spatial distribution patterns, provided visual insights into the variations. Statistical analyses indicated a moderate positive correlation between rainfall and GDP, suggesting that rainfall variability can influence economic productivity in the region. The findings underscore the need for climate-resilient strategies to ensure sustainable development in the face of changing rainfall patterns In Ondo state, the period with relatively high volume of rainfall is usually between April and October across the entire time series charts. The year with the highest annual rainfall is 2005. The least annual rainfall was experienced in 1998. This is shown in figure 4 In Osun state, the period with relatively high volume of rainfall is usually between April and October across the entire time series charts. The year with the highest annual rainfall is 2021. The least annual rainfall was experienced in 2005. This is shown in figure 5.

The period with relatively high volume of rainfall is usually between April and October across the entire time series charts. The year with the highest annual rainfall is 2021. The least annual rainfall was experienced in 2005. This is shown in figure 6.In Lagos state, the period with relatively high volume of rainfall is usually between April and October across the entire time series charts. The years with the highest annual rainfall is 2010. The least annual rainfall was experienced in 2000. This is shown in figure 7. In Ekiti state, the period with relatively high volume of rainfall is usually between April and October across the entire time series charts. The year with the highest annual rainfall is 2021. The least annual rainfall was experienced in 1999 and 2005. This is shown in figure 8.In Ogun state, the period with relatively high volume of rainfall is usually between April and October across the entire time series charts. The year with the highest annual rainfall is 2010. The least annual rainfall was experienced in 2000. This is shown in figure 9.

To understand the relationship between the socio-economic factors adopted in this study, which is GDP and the annual rainfall, the following were observed The descriptive analysis, Regression and Correlation analysis, respectively.

Descriptive analysis of rainfall data for Ondo State

With a skewness value of 0.080581 which is near zero as shown in table 1, also affirm that the distribution is approximately normal. Ekiti State with a skewness value of 0.097621 which is near zero as shown in table 2, also affirm that the distribution is approximately normal. Ogun state with a skewness value of 0.00408 which is near zero as shown in table 3, also affirm that the distribution is approximately normal. For Oyo state with a skewness value of 0.702011 which is near zero as shown in table 4, also affirm that the distribution is approximately normal. In Osun a skewness value of 0.226426 which is near zero as shown in table 5, also affirm that the distribution is approximately normal. for Lagos state a skewness value of 0.059468 which is near zero as shown in table 6, also affirm that the distribution is approximately normal.

The correlation analysis show that all variable are positively correlated to the rainfall data for each state with Ibadan having the highest positive correlation, then Osun, Ogun, Lagos, Ekiti and Ondo respectively in decreasing order. This is shown in table and the chart for the correlation analysis is shown in figure 16.

As shown in table, the dependent variable is the Gross Domestic product (GDP), while the rainfall data for the six Southwestern state are the independent variable. The analysis is given as;

There is a overall positive correlation between GDP and Rainfall for each states, except the correlation values of Ondo state which is negative in slope(-0.6076). Oshogbo rainfall has the highest correlation coefficient in slope (0.2212). The rainfall data for Ibadan can explain 10% of the GDP data, 5% for Oshogbo, 4% for Abeokuta and Ikeja, while Ondo show the least explanatory variable of 1% for the GDP values.

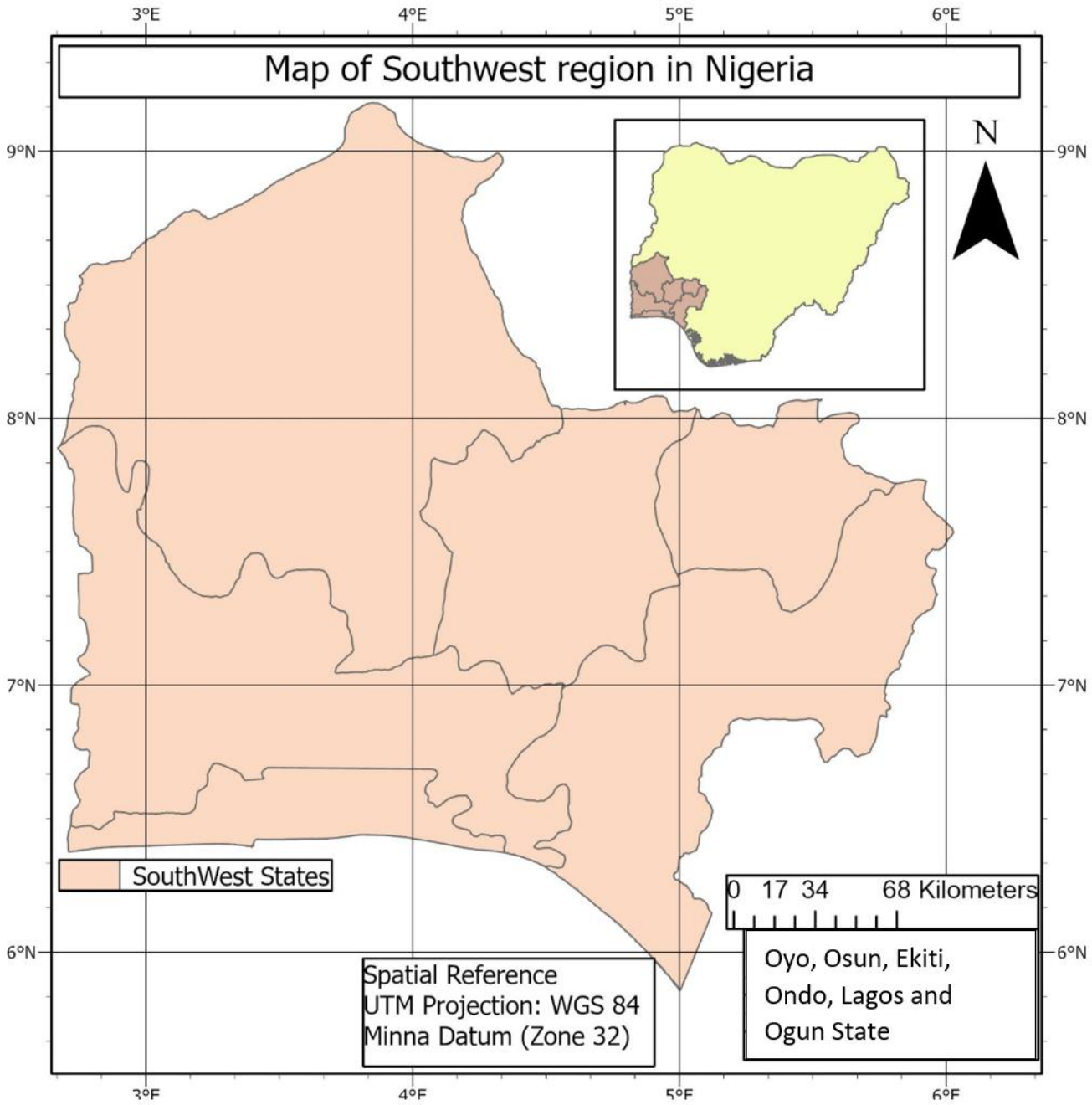

Figure 1: Map Showing the Study Area

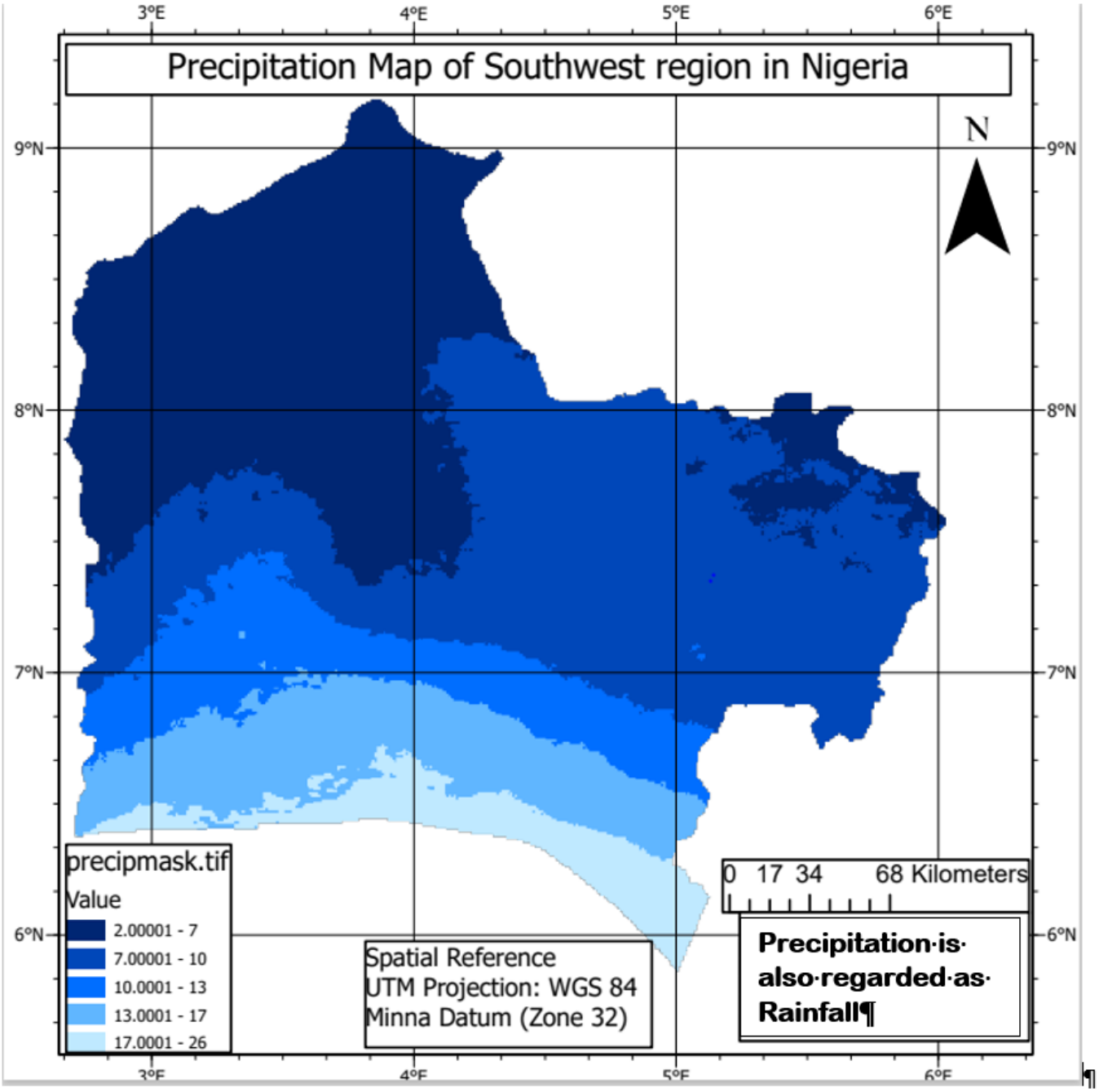

Figure 2: Rainfall Distribution map of Southwest Nigeria

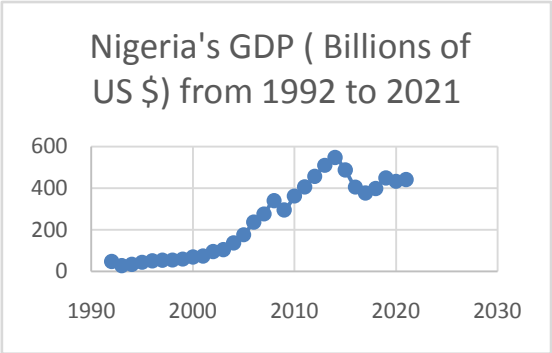

Figure 3: Nigeria's GDP (Billions of US $) from 1992 to 2021

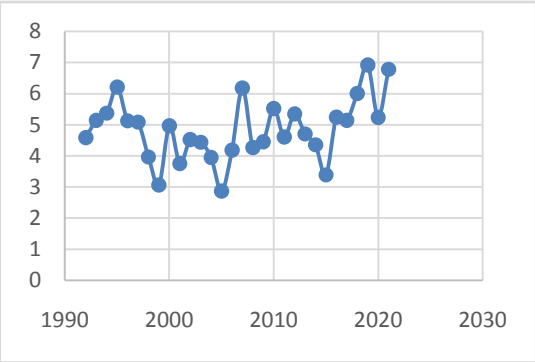

Figure 4: Time series analysis of annual rainfall in Ondo State between 1992-2022 (mm)

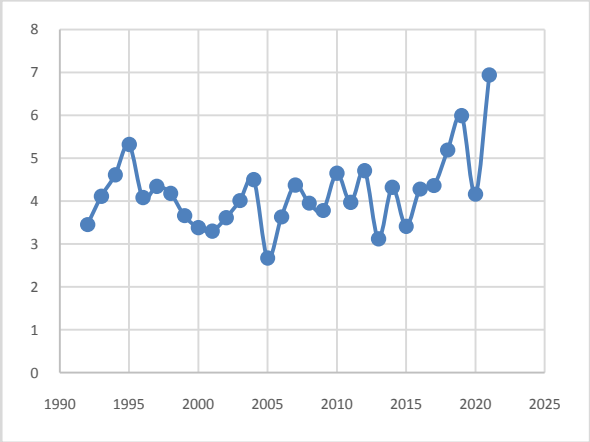

Figure 5: Time Series Analysis of Annual Rainfall in Oyo State between1992-2022 (mm)

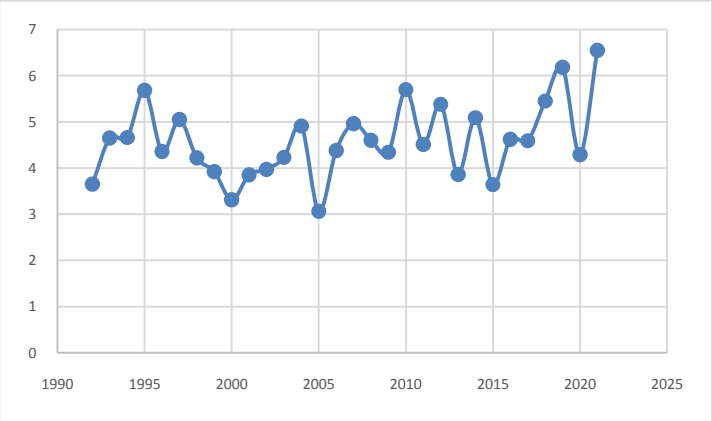

Figure 6: Time series analysis of annual rainfall in Osun State 1992-2022 (mm)

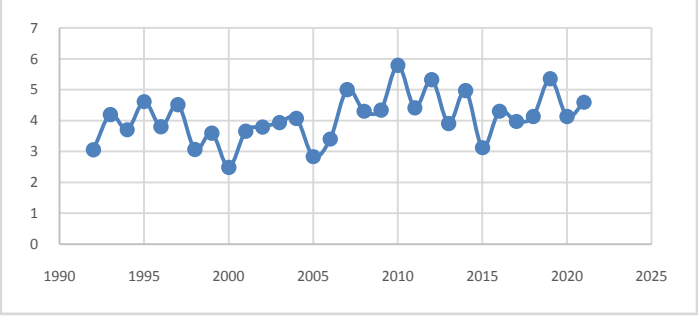

Figure 7: Time series analysis of annual rainfall in Lagos State between1992-2022(mm)

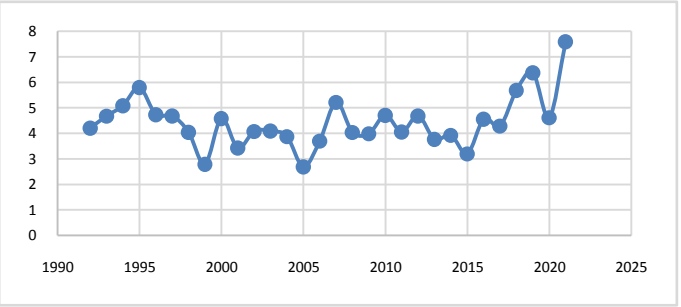

Figure 8: Time series analysis of annual rainfall in Ekiti State 1992-2022 (mm)

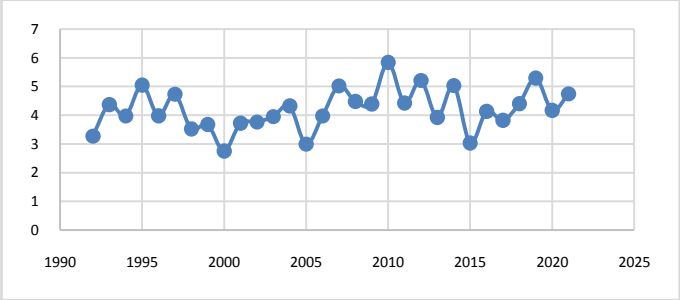

Figure 9: Time series analysis of Annual rainfall for Ogun State 1992-2022 (mm)

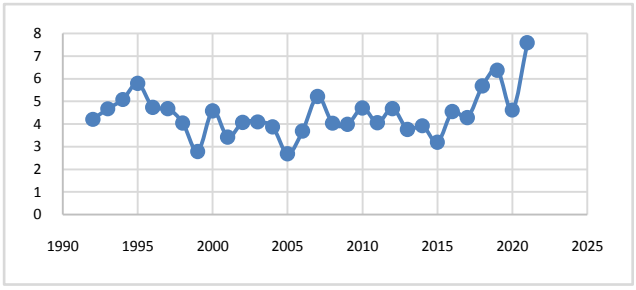

Figure 10: Time series analysis of Annual rainfall for Ogun State 1992-2022 (mm)

Table 1: Descriptive analysis of Ondo State

Mean	1902.806
Standard Error	53.67315
Median	1944.9
Mode	#N/A
Standard Deviation	298.8395
Sample Variance	89305.03
Kurtosis	-0.48188
Skewness	0.080581
Range	1143.1
Minimum	1375.3
Maximum	2518.4
Sum	58987
Count	31

Table 2: Descriptive analysis of Ekiti State

Mean	1426.433
Standard Error	46.22903
Median	1419.4
Mode	#N/A
Standard Deviation	257.3923
Sample Variance	66250.81
Kurtosis	-0.0144
Skewness	0.097621
Range	1019.4
Minimum	895.4
Maximum	1914.8
Sum	44219.42
Count	31

Table 3: Descriptive analysis of Ogun State

Mean	1241.971
Standard Error	34.00969
Median	1209.9
Mode	#N/A
Standard Deviation	189.358
Sample Variance	35856.43
Kurtosis	-0.02626
Skewness	0.00408
Range	788.5
Minimum	849.2
Maximum	1637.7
Sum	38501.1
Count	31

Table 4: Descriptive analysis of Oyo State

Mean	1441.987
Standard Error	56.53749
Median	1377.2
Mode	#N/A
Standard Deviation	314.7874
Sample Variance	99091.13
Kurtosis	0.210787
Skewness	0.702011
Range	1290.3
Minimum	920.6
Maximum	2210.9
Sum	44701.6
Count	31

Table 5: Descriptive analysis of Osun State

Mean	1366.555
Standard Error	33.28159
--Median	1361
Mode	#N/A
Standard Deviation	185.304
Sample Variance	34337.58
Kurtosis	-0.68804
Skewness	0.226426
Range	677.1
Minimum	1014.7
Maximum	1691.8
Sum	42363.2
Count	31

Table 6: Descriptive analysis of Lagos State

Mean	1524.937
Standard Error	48.11232
Median	1553.7
Mode	#N/A
Standard Deviation	267.8781
Sample Variance	71758.67
Kurtosis	0.492383
Skewness	0.059468
Range	1198.15
Minimum	926.5
Maximum	2124.65
Sum	47273.05
Count	31

Mean	247.9456
Standard Error	32.68358
Median	255.8648
Mode	#N/A
Standard Deviation	179.0153
Sample Variance	32046.5
Kurtosis	-1.66532
Skewness	0.121868
Range	518.9242
Minimum	27.7522
Maximum	546.6764
Sum	7438.367
Count	30

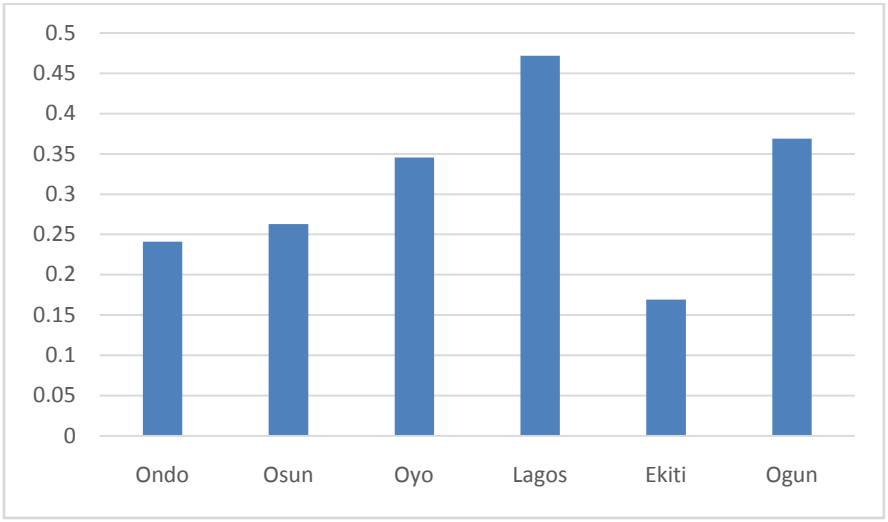

Figure 16: Correlation analysis between Annual rainfall and GDP in Southwest states in Nigeria from 1992-2022

Table 8: Correlation analysis between GDP and Annual rainfall in each State.

	Ondo	Ado-Ekiti	Abeokuta	Ibadan	Oshogbo	Ikeja
GDP	-0.10432	0.174642	0.202946	0.318038	0.224986	0.200302

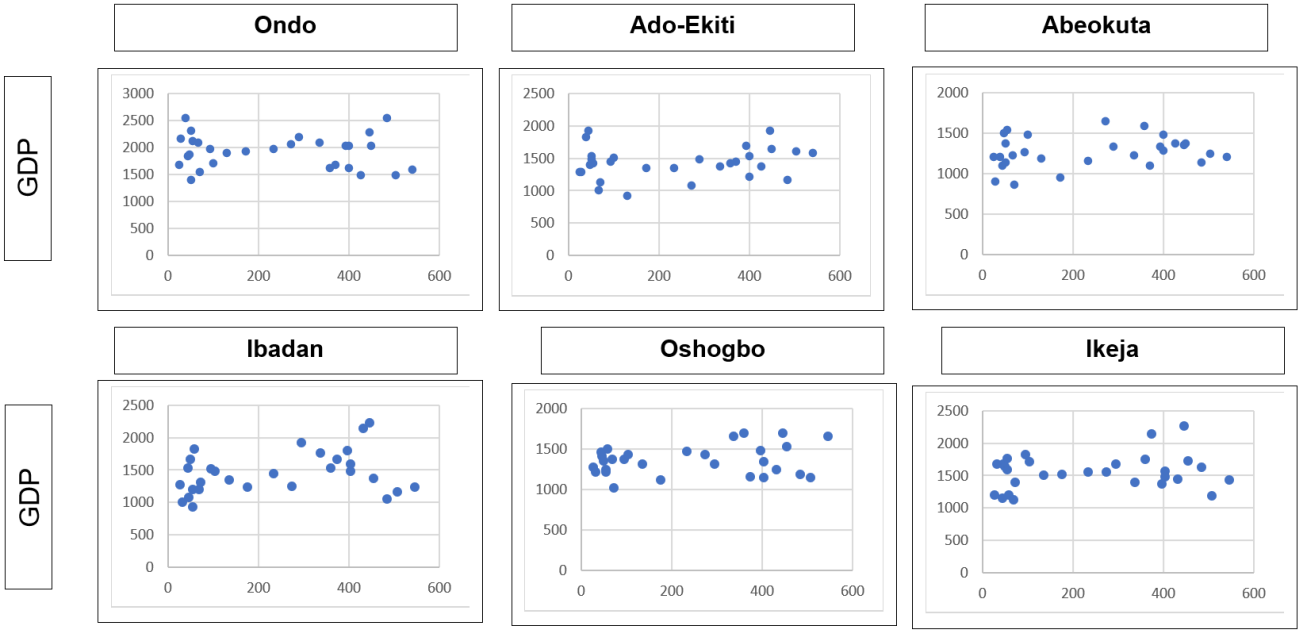

Figure 17: Scatter Plot of GDP and Annual Rainfall in Southwestern States

Table 9: Regression Analysis

	Ondo	Ado-Ekiti	Abeokuta	Ibadan	Oshogbo	Ikeja
Multiple R	0.104324	0.174642	0.202946	0.318038	0.224986	0.200302
R Square	0.010884	0.0305	0.041187	0.101148	0.050619	0.040121
Adjusted R Square	-0.02575	-0.00541	0.005676	0.067858	0.015456	0.00457
Standard Error	180.6558	178.8555	177.8669	172.2155	176.99	177.9658
Observations	29	29	29	29	29	29
F	0.297088	0.849397	1.159824	3.038331	1.43957	1.128536
Significance F	0.590188	0.364885	0.291031	0.092699	0.240632	0.297498
Intercept	356.2705	64.63406	7.886853	-12.5213	-58.2561	30.87386
X Variable 1	-0.06076	0.125778	0.186868	0.175053	0.221231	0.135751

CONCLUSION

In conclusion, this report provides valuable insights into the relationship between rainfall variability and sustainable development in Southwest Nigeria. The geospatial and statistical analysis revealed the significance of rainfall patterns in shaping economic productivity. By understanding these relationships, policymakers and stakeholders can make informed decisions to ensure climate-resilient and sustainable development practices in the region. Implications an

The study's findings have several implications for sustainable development in Southwest Nigeria. The identified correlation between rainfall and GDP highlights the importance of incorporating climate change adaptation measures into development plans. Enhancing water management systems, promoting drought-resistant agriculture, and investing in climate-resilient infrastructure are key recommendations to mitigate the potential negative impacts of rainfall variability. Collaboration between policymakers, researchers, and local communities is essential for effective implementation.

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