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Rainfall Dynamics and Trend in Central Nigeria for Thirty-Four Years (1986-2019)

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ABSTRACT: *A statistical study of rainfall dynamics and trend in central Nigeria for thirty-four (34) years (1986-2019) has been carried out. The data were obtained from the website of Nigerian Meteorological Agency., Abuja, Nigeria. We used the ET-SCI classification of rainfall rainy season. We found that total rainfall variability ranges between moderate variability in Gombe and high variability in Benin City. Variability in the frequency of rainfall during the period varies between zero variability in Jos and moderate variability at Benin City. In general, the variability in total and seasonal rainfall, and rainfall frequency appears to be dependent on latitude. Rainfall trend analysis shows that seasonal rainfall rises monotonically in all seasons except R99p season.*
Keywords: rainfall; Mann-Kendall; drought; flooding; variability; trend; standardized precipitation index; regression; season

INTRODUCTION

Rainfall characteristics (trend, variability, onset and cessation, amount, frequency, etc.) are important to Nigerian farmers who depend only on rainfall for their activities. Moreover, rainfall impacts almost all aspects of life in our society. For instance, power generation in Nigeria is by mostly from dams. There are many reports on the variations in the amount and duration of rainfall (Sobowale et al. 2016, Nzoiwu et al., 2017). Nebedum and Emodi (2016) reported of the negative impacts rainfall has on health, energy and transportation.

Researchers are interested in understanding the reasons for these variations. There are reports increase in the amount of rainfall in Nigeria or some parts of the country in the last few decades (Akinsola and Ogunjobi, 2014; Diagi, 2018; Ogunrinde et al., 2019). Variations in rainfall imacts negatively on agriculture, socio-economic life of Nigerians and even religious activities. Yamusa

and Abdulkadir, (2020) found variations in onset and caseation of rainfall in the Sudan and Sahel savanna of Nigeria between 1968 and 2017. There are incidences of floods in Nigeria (Ugba et al., 2018; Hassan et al., 2020). Incidences of extreme events such as floods and droughts are rampant in the last two decades especially in the semi-arid region, the Niger Delta areas and around the Rivers Niger and Benue (Nigerian Meteorological Agency, 2021 Report).

High decline in rainfall leads to meteorological droughts and there incidences of it droughts in many parts of Nigeria (Yamusa and Abdulkadir, 2020; Ugwu, et al., 2023). In Awka, South East Nigeria, rainfall declined between 1976 and 1987 but increased between 1988 and 200. This inconsistency in rainfall variation can be seen in a few other towns in Nigeria (Mosunmola et al., 2020, Emeka-Chris et al., 2022). Different techniques/approaches have been used in the study of rainfall characteristics with a view to understand its nature and impacts on the society. Various techniques have been used to study rainfall variability in Nigeria. Ogbu et al. (2020) is of the opinion that satellite data is better data terrestrial network of meteorological stations as satellite can access more areas, even remote areas. However, its accuracy has not been clearly demonstrated.

Losses due to extreme rainfall events are many varied. There are loss of human and animal lives, residential areas and farms, property and farm inputs etc., it is necessary that efforts be put into research in this area. Results will be beneficial to farmers and policy makers as well as water resources managers and even the general public. There is a paucity of knowledge on the area of seasonal rainfall in Nigeria and this paper aims at improving on the existing body of knowledge

MATERIALS AND METHOD

Study Area

Nigeria lies between latitude $4^0 – 14^0$ N and longitude 4^0 and 14^0 E. It shares border with Republic of Cameroon and Republic of Benin in the east and west respectively. The Republics of Niger and Chad are its border Nigeria in the north while in the south is the Gulf of Guinea. By Köppen classification, three different climate zones in Nigeria: the tropical Monsoon (Am) in the south, the tropical Savana (Aw) in the central region, and the hot semi-arid Sahel climate (BSh) in a small part of north. This means that Nigeria is in the Tropics, south of the Sahara Desert and north of the Atlantic Ocean. It has an estimated population of over 193 million in 2022 according to Nigeria's National Population Commission. Thus, it is the most populous Black Country in the world and majority of the populace are peasant farmers who practice rain-fed agriculture.There are two seasons in Nigeria: the wet and dry seasons. The Central Region falls into the AW climate zone and rainy season starts in April and ends in October. The wet season starts in April and ends in September with an average annual rainfall of 1,200 mm. The dry season from October to March. The southern parts experience bimodal rainy season peaks in July and September. Towns in the

far north experience only one peak in September. Dry season starts in November and ends in March.

Table 1: Location of the stations

Stations	Köppen classification	Latitude (^{0}N)	Longitude (^{0}E)
Benin City	Aw	6.335	5.604
Enugu	Aw	6.458	7.547
Ikeja	Aw	6.602	3.352
Ibadan	Aw	7.378	3.947
Abuja	Aw	9.077	7.399
Jos	Aw	9.900	8.858
Gombe	Aw	10.364	11.193
Kaduna	Aw	10.511	7.417

Sources of data

Observed daily rainfall data is got from the website of Nigerian Meteorological Agency., Abuja, Nigeria covering thirty four years (1986-2019). The data is for the rainy season months of June, July, August and September only. Homogeneity and randomness tests were conducted on the data. Four of the Stations (Benin City, Ikeja, Enugu and Ibadan) are in the southern part of Nigeria while rest four (Abuja, Jos, Gombe and Kaduna) are in the north.

Data Analysis

Descriptive Statistical Analysis

The World Meteorological Organization's Expert Team on Sector-Specific Climate Indices (ET-SCI) classified extreme rainfall days as Rain Days for days with more than or exactly 1mm of rainfall (R1 ≥ 1mm), Heavy Rain Days (R10) for days with 10mm of rainfall or more (R10 ≥ 10mm), Very Heavy Rain Days (R20) for days with 20mm of rainfall or more (R20 ≥ 20mm), Very Wet Days ((R95p) for days with 95 percent of rainfall or more (R95 ≥ 95 percent), Extreme Wet Days (R99p) for days with 99 percent of rainfall or more R99 ≥ 99 percent). This classification is used in this article. According to Braimah et al. (2022), there is rainfall in one day if the measurable amount of rainfall is equal to or greater than 0.1mm of rainfall scale. However, our concern is on extreme rainfall events.

We also calculated coefficients of variation (CV) and used the accepted classification as: CV < 20% (no variation), 20% < CV < 30% (moderate variation), CV > 30% (high variability), CV > 40% (very high variability) and CV > 70% (extremely high variability).

Rainfall Trend and Anomaly

Mann-Kendall (M-K) test, a nonparametric test, is used in hydrological and meteorological trend analysis. M-K test has two hypotheses: the alternate hypothesis, which assumes that there is a significant or monotonic trend, and the null hypothesis, which assumes that there is insignificant or no monotonic trend. The interpretation of the result is dependent on the P-value relative to the significance value of 5% or 0.05. If P > 0.05, the trend is insignificant and null hypothesis is accepted, but if P < 0.05, the trend is significant and alternate hypothesis is accepted. Linear plots are also used to determine the trends.

The M-K statistics S, the variance of S, Var (S), Z statistics, and probability of shifting year (P-value) are given by equations 1, 2, 3 and 4 respectively.

$$S = \sum_{i=1}^{n-1}\sum_{j=i+1}^{n} sign(x_j - x_i), \quad 1$$

where $sign(x_j - x_i) = \begin{cases} +1 \; if \; (x_j - x_i) > 0, \\ 0 \; if \; (x_j - x_i) = 0, \\ -1 \; if \; (x_j - x_i) < 0 \end{cases}$

$$VAR(S) = \frac{1}{18}\left[n(n-1)(2n+5) - \sum_{p+1}^{q} t_p(t_p - 1)(2t_p + 5)\right] \quad 3$$

where x_i and x_j are the time series of the observations in chronological order i.e. j > i, n = length of time series, q = number of groups tied and t_p is the number of data values in group P.

$$Z = \begin{cases} \frac{S-1}{\sqrt{VAR(S)}} \; if \; S > 0, \\ 0 \; if \; S = 0, \\ \frac{S+1}{\sqrt{VAR(S)}} \; if \; S < 0 \end{cases}$$

3

$$f_z = \frac{1}{2} e^{-\frac{z^2}{2}} \quad 4$$

The M-K test returns the trends h (true or false) and the slopes of p, z, Tau, S, Var(S) and Sen's slope. High positive/negative values of S statistics, variance of S, i.e. (Var(S)) and Z statistics mean increasing/decreasing precipitation trends. In-built XLSTAT software is used for all the analysis.

The standardized Precipitation Index (SPI)

This is a tool commonly used to calculate regional rainfall fluctuations. It is used here to determine the deviations from the average rainfall. The SPI is standardized and rainfall is considered to be the only driver of meteorological drought. This ensures the consistency of extreme events at any time scales and locations. SPI is calculated using equation 5 below.

$$\text{SPI} = \frac{X - X_{mn}}{\sigma} \qquad 5$$

where X is the seasonal mean, X_{mn} is the long term mean and σ is the standard deviation.
It is interpreted as in Table 2 below:

Table 2: Classification of SPI values (McKee et al. (1993)

SPI values	Classification
≥ 2.00	Extremely wet (EW)
1.50 to 1.99	Severely wet (SW)
1.00 to 1.49	Moderately wet (MW)
0 to 0.99	Mildly wet (NN)
0 to -0.99	Mildly dry (NN)
-1 to -1.49	Moderately dry (MD)
-1.50 to -1.99	Severely dry (SD)
≤ -2.00	Extremely dry (ED)

RESULTS

Descriptive statistics of total rainfall amount

Table 3 below is the descriptive statistics of total rainfall for the period of study. Benin City recorded the highest maximum rainfall with 1892.98 mm followed by Enugu (1867.62 mm). Ibadan has more maximum rainfall than Ikeja despite the fact that Ikeja is at a lower latitude. It may be because Ibadan is in Rainforest zone and Ikeja is the industrial hub of Lagos State. Presence of vegetation or lack of it affects the formation of rain. Kaduna recorded higher amount of rainfall than Abuja and Gombe that are relatively on a lower latitude. This may be due to the closeness of Gombe to the Sahel and Abuja, being the Capital City of Nigeria, may be affected by deforestation as a result of urbanization. Only Gombe recorded zero variability while has between moderate to high variability implying that there is variability in most of the stations

Table 3: Statistical analysis of total rainfall

Stations	Maximum (mm)	Minimum (mm)	Mean (mm)	SD (mm)	CV (%)
Benin City	1892.98	477.65	1052.28	390.65	37.12
Enugu	1867.62	541.01	967.14	278.14	28.76
Ikeja	1313.86	525.55	842.38	208.12	24.71
Ibadan	1494.14	644.67	960.50	218.44	22.74
Abuja	1410.68	329.08	959.72	278.96	29.07
Jos	1182.02	240.21	778.58	262.65	33.73
Gombe	1113.89	464.98	778.48	152.25	19.56
Kaduna	1460.20	401.31	1053.71	266.39	25.28

Rainfall frequency and Regression analysis of total Rainfall

From Table 4 below, Kaduna has the highest rainfall frequency and moderate variation and Enugu has the least with zero variability. Most of the stations shows zero variability in rainfall frequency. The standard deviations are large showing that rainfall frequency is widely dispersed from the mean.

Table 4: Statistical analysis of rainfall frequency

Station	Maximum (days)	Minimum (days)	Mean (days)	SD (days)	CV (%)
Benin City	9529.65	7985.14	8944.38	689.87	7.71
Enugu	8818.88	7829.07	8220.70	437.34	5.32
Ikeja	8084.76	5284.72	7160.19	1284.95	17.95
Ibadan	9203.35	6806.81	8164.23	996.44	12.20
Abuja	9576.13	6487.30	8157.64	1269.37	15.56
Jos	8494.45	5293.28	6617.97	1494.46	22.58
Gombe	9032.27	4586.99	6617.11	1855.57	28.04
Kaduna	10881.21	6547.88	8956.57	1814.75	20.26

Regression Analysis

Only Ikeja and Ibadan have small positive slopes, the rest have small negative slopes. This means there very small changes or little variability in the rainfall (Figure 2 a-h). The values of coefficient of regression (r^2) range between zero percent and 18.7%, implying that variability can be explained by a maximum of 18.7% using r-squared.

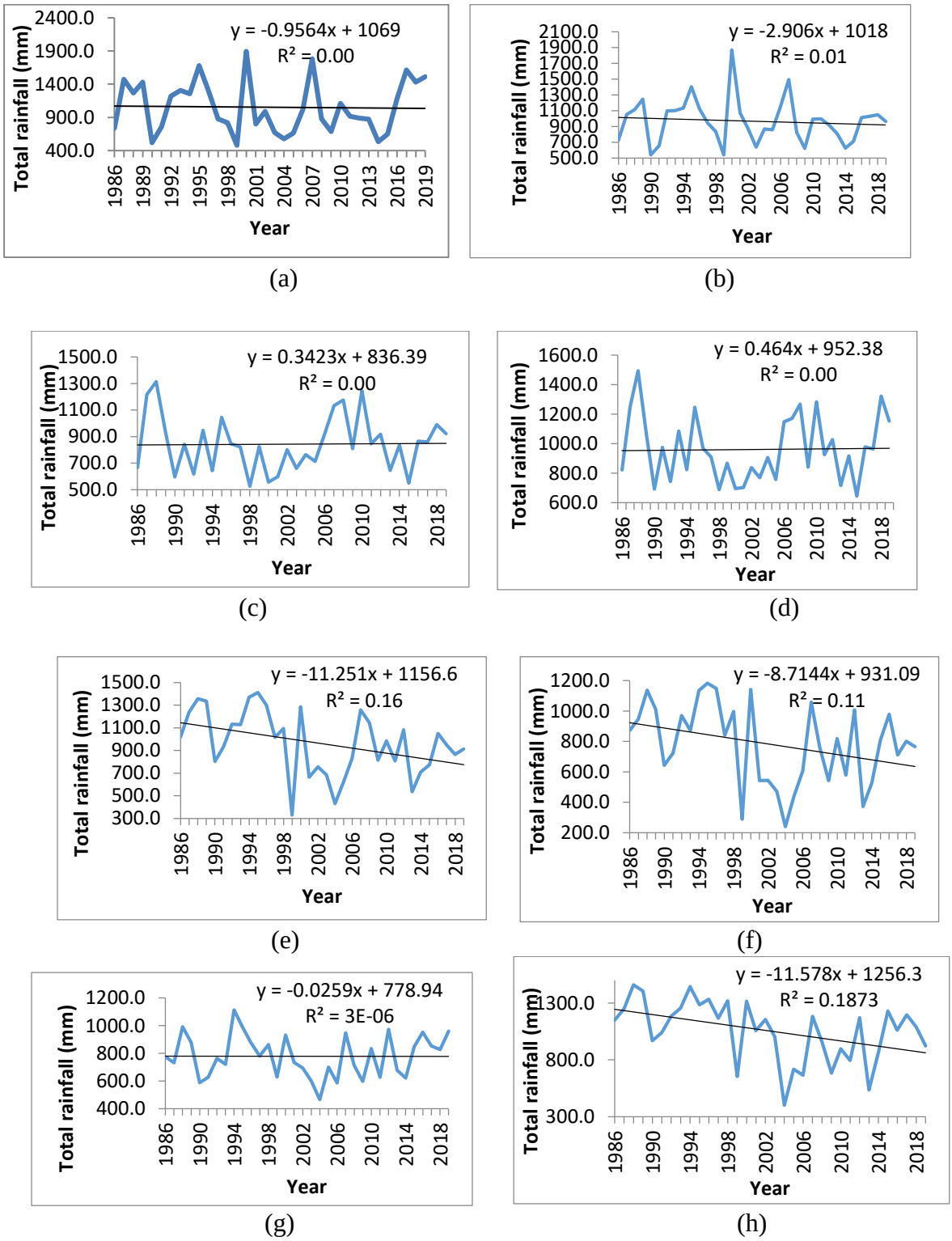

Figure 2: Linear plots (a) Benin City (b) Enugu (c) Ikeja (d) Ibadan (e) Abuja (f) Jos ((g) Gombe (h) Kaduna

Mann-Kendall Trend Test

Table 5 shows the results of the M-K trend tests for total rainfall. There is monotonic increase in annual rainfall in Abuja and Kaduna only ($P < 0.05$). There are insignificant trends in other stations ($P > 0.05$). Values of Sen's slope, Z-statistic and S-statistic are small. Therefore, the increasing trends are small but they are evidence of climate change. This indicates no significant rainfall changes at the 5% level of significance ($P > 0.05$).

Table 5: M-K trend result for total annual rainfall

Stations	Trend	P-Value	Z	S	Slope (mm/season)
Benin City	No trend	0.86	-0.18	-13	-1.83
Enugu	No trend	0.44	-0.77	-53	-3.06
Ikeja	No trend	0.53	0.62	43	1.90
Ibadan	No trend	0.55	0.59	41	1.82
Abuja	**Increasing**	**0.03**	**-2.19**	**-149**	**-10.88**
Jos	No trend	0.08	-1.75	-119	-7.88
Gombe	No trend	0.88	-0.15	-11	-0.56
Kaduna	**Increasing**	**0.02**	**-2.43**	**-165**	**-10.82**

There are no trends in rainfall frequency in all the stations for the period studied (Table 6). Also, the values of S-statistic and Z-statistic are very small indicating a very small change which are not monotonic.

Table 6: M-K Test for rainfall frequency

Station	Trend	P-Value	Z	S	Slope (days/season)
Benin City	No trend	1.00	0.00	0.0	-188.10
Enugu	No trend	0.09	1.70	6.0	308.65
Ikeja	No trend	0.73	-0.34	-2.0	-384.05
Ibadan	No trend	0.73	0.34	2.0	208.68
Abuja	No trend	0.73	0.34	2.0	942.66
Jos	No trend	0.73	0.34	2.0	719.32
Gombe	No trend	0.73	0.34	2.0	1351.53
Kaduna	No trend	0.73	0.34	2.0	1044.24

M-K Trend Test Results for the seasons

Table 7a-7d are the results of M-K tests for the various seasons as classified by ET-SCI. Table 7a shows that the number of days with rainfall greater or equal to 1 mm is on a monotonic increase

in Benin City, Enugu, Abuja, Jos and Kaduna ($P < 0.05$). The slopes are generally negligible which shows a very gradual change in the number of rain days but it still indicates climate change.

Heavy rain days (R10) is on monotonic increase Abuja and Jos only. Other stations exhibited insignificant trends (Table 7b). R20 is on is on the small positive monotonic trend in Abuja, Jos and Kaduna. Because of the very small values of Sen's slope, S-statistic and Z-statistic, it can be concluded that very heavy rain days are increasing at a small rate in those stations (Table 7c).
Very wet days (R95p) are increasing significantly in most of cities. They include Ibadan, Abuja, Jos and Kaduna where $P < 0.05$ (Table 7d). Again, the values of Sen's slope and Z-statistic are small but relatively high values S-statistic, implying a bit higher change in R95p. Extremely very wet days is on a monotonic increase in Enugu only (Table 7e).
In summary, Jos has been receiving extreme rainfall in most of the ET-SCI seasons. But this does not necessarily translate to very high annual rainfall amount. Ikeja and Gombe, on the other hand, show insignificant trend in any of the ET-SCI classification. It is clear that these changes are small and gradual. However, any change is indicative of climate change.

Table 7a: M-K trend test results of Rain Days (R1)

Station	Trend	P-Value	Z	S	Slope (days/season)
Benin City	**Increasing**	**0.00**	**-3.398**	**-255805**	**0.0**
Enugu	**Increasing**	**0.00**	**-2.726**	**-226705**	**0.0**
Ikeja	No trend	0.87	0.162	11668	0.0
Ibadan	No trend	0.86	-0.182	-14310	0.0
Abuja	**Increasing**	**0.00**	**-13.163**	**-1080361**	**-0.0**
Jos	**Increasing**	**0.00**	**-9.704**	**-722874**	**-0.0**
Gombe	No trend	0.24	-1.173	-90799	0.0
Kaduna	**Increasing**	**0.00**	**-12.242**	**-1031399**	**-0.0**

Table 7b: M-K trend test result for Heavy rainfall days (R10)

Station	Trend	P-Value	Z	S	Slope (days/season)
Benin City	No trend	0.92	0.10	1357	0.0
Enugu	No trend	0.12	1.56	18388	0.0
Ikeja	No trend	0.65	0.46	3956	0.0
Ibadan	No trend	0.11	1.59	18021	0.0
Abuja	**Increasing**	**0.02**	**2.43**	**30487**	**0.0**
Jos	**Increasing**	**0.00**	**3.21**	**24097**	**0.0**
Gombe	No trend	0.07	1.83	12646	0.0
Kaduna	No trend	0.43	0.80	12274	0.000

Table 7c: M-K trend test results for Extremely Heavy Precipitation Days (R20)

Station	Trend	P-Value	Z	S	Slope (days/season)
Benin City	No trend	0.83	-0.21	-522	0.00
Enugu	No trend	0.30	1.03	1480	0.01
Ikeja	No trend	0.68	0.41	538	0.00
Ibadan	No trend	0.60	0.53	878	0.00
Abuja	**Increasing**	**0.01**	**2.52**	**2598**	**0.01**
Jos	**Increasing**	**0.00**	**3.17**	**2013**	**0.03**
Gombe	No trend	0.60	0.52	310	0.00
Kaduna	**Increasing**	**0.02**	**2.41**	**3454**	**0.01**

Table 7d: M-K Trend Test results for Very Wet Days (R95p)

Stations	Trend	P-Value	Z	S	Slope (days/season)
Benin City	No trend	0.12	1.54	7299	0.00
Enugu	No trend	0.59	0.54	1705	0.00
Ikeja	No trend	0.50	0.67	1847	0.00
Ibadan	**Increasing**	**0.01**	**2.59**	**8717**	**0.01**
Abuja	**Increasing**	**0.00**	**3.52**	**10119**	**0.01**
Jos	**Increasing**	**0.01**	**2.59**	**4358**	**0.01**
Gombe	No trend	0.91	0.11	169	0.00
Kaduna	**Increasing**	**0.01**	**2.69**	**9932**	**0.00**

Table 7e: M-K Trend Test results for Very Wet Days (R99p)

Stations	Trend	P-Value	Z	S	Slope (days/season)
Benin City	No trend	0.19	1.32	806	0.02
Enugu	**Increasing**	**0.02**	**2.36**	**689**	**0.05**
Ikeja	No trend	0.86	0.18	46	0.01
Ibadan	No trend	0.26	1.13	369	0.03
Abuja	No trend	0.36	0.92	146	0.04
Jos	No trend	0.40	0.84	73	0.07
Gombe	No trend	0.27	1.11	60	0.25
Kaduna	No trend	0.69	0.41	63	0.01

SPI Results

Table 8: SPI values for total rainfall

Year	Benin City	Enugu	Ikeja	Ibadan	Abuja	Jos	Gombe	Kaduna
1986	-0.77	-0.81	-0.87	-0.62	0.21	0.34	-0.08	0.39
1987	1.06	0.30	1.79	1.31	1.00	0.78	-0.17	0.74
1988	0.53	0.52	**2.26**	**2.44**	1.42	1.35	1.36	1.52
1989	0.95	0.99	0.41	0.46	1.35	0.87	0.65	1.32
1990	-1.38	-1.54	-1.24	-1.26	-0.56	-0.54	-1.30	-0.32
1991	-0.66	-1.13	-0.05	0.04	-0.10	-0.23	-1.07	-0.06
1992	0.41	0.47	-1.12	-1.02	0.62	0.71	-0.15	0.49
1993	0.63	0.48	0.47	0.55	0.61	0.34	-0.44	0.76
1994	0.50	0.59	-1.01	-0.65	1.47	1.35	**2.16**	1.46
1995	1.60	1.56	0.95	1.30	1.62	1.53	1.39	0.87
1996	0.58	0.56	-0.02	0.02	1.21	1.40	0.57	1.04
1997	-0.41	-0.09	0.00	-0.18	0.21	0.22	-0.05	0.42
1998	-0.63	-0.48	-1.40	-1.20	0.48	0.82	0.55	0.99
1999	-1.50	-1.54	-0.03	-0.38	**-2.26**	-1.89	-0.60	-1.51
2000	**2.27**	**3.24**	-1.43	-1.24	1.17	1.37	1.23	0.98
2001	-0.67	0.37	-1.23	-1.21	-1.06	-0.92	-0.36	0.01
2002	-0.19	-0.35	-0.24	-0.58	-0.74	-0.85	-0.42	0.38
2003	-1.02	-1.19	-0.93	-0.90	-0.98	-1.12	-1.24	-0.19
2004	-1.24	-0.36	-0.36	-0.24	-1.90	**-2.08**	-1.98	**-2.45**
2005	-0.85	-0.27	-0.49	-0.90	-1.20	-1.29	-0.55	-1.26
2006	-0.11	0.69	0.34	0.84	-0.46	-0.66	-1.34	-1.46
2007	1.86	1.89	1.37	0.95	1.07	1.05	1.06	0.48
2008	-0.49	-0.53	1.58	1.40	0.66	-0.10	-0.50	-0.35
2009	-0.97	-1.25	-0.20	-0.57	-0.52	-0.92	-1.16	-1.39
2010	0.15	0.08	1.99	1.47	0.08	0.16	0.32	-0.59
2011	-0.38	0.10	0.01	-0.18	-0.54	-0.79	-1.06	-0.98
2012	-0.45	-0.19	0.33	0.29	0.44	0.86	1.23	0.44
2013	-0.39	-0.57	-0.78	-1.00	-1.52	-1.55	-0.73	-1.95
2014	-1.23	-1.24	0.00	-0.22	-0.90	-0.89	-1.11	-0.69
2015	-1.08	-0.92	-1.43	-1.43	-0.67	0.10	0.40	0.66
2016	0.31	0.15	0.08	0.06	0.33	0.74	1.09	0.03
2017	1.46	0.21	0.12	0.04	-0.04	-0.28	0.53	0.53
2018	0.95	0.28	0.76	1.75	-0.34	0.10	0.54	0.14
2019	1.16	-0.02	0.35	0.87	-0.16	0.00	1.25	-0.47

In the analysis of the SPI (Table 8 above), Benin City, Enugu, Ikeja, Ibadan and Gombe have an EW. In 2000, Enugu's SPI was the highest (3.2). There are incidences of ED in Abuja, Jos, and Kaduna. SWs and SDs are many. The year 1994 and 1995 are the driest years within the period studied while 2000 and 2007 appear to be the wettest years. It not surprising that extreme weather features like flood and droughts have been reported in Nigeria within the past few decades. Some of these extreme weather events may not be caused by near-absence or excess of rainfall. For instance, flooding may be exacerbated by poor town planning, inappropriate agricultural practices and poor drainage systems. Hence incidences of drought and floods are frequent in these zone.

CONCLUSION

A statistical study of rainfall dynamics and trend in central Nigeria for thirty four (34) years has been carried out. The central Nigeria falls into the tropical savanna climate zone (Aw). Using the ET-SCI classification of rainfall rainy season was studied. We found that total rainfall variability ranges between moderate variability in Gombe and high variability in Benin City. The maximum total rainfall is highest in Benin City and least in Gombe. Variability in the frequency of rainfall during the period varies between zero variability in Benin City and moderate variability in Gombe. In general, the variability in total and seasonal rainfall, and rainfall frequency appears to be dependent on latitude. Unfortunately, regression analysis can only explain about 19% of precipitation variability.

Annual rainfall amount and frequency show latitudinal dependency (Ibeabuchi and Abu, 2023). Benin City has the highest seasonal rainfall (236.41 days) and Kaduna the lowest (55.18 days) in all seasons. Benin City is located in the rainforest area with thick forests and is closest to the equator. This may be the cause of very high seasonal rainfall. Surprisingly, Kaduna has a high amount of annual rainfall but the maximum seasonal rainfall is low. This may be due to the effect of the Kaduna River and vegetation cover. Ikeja also has less rainfall than expected. Ikeja is the industrial centre of Lagos State and this may affect the amount of rainfall recorded during the study period.

Rainfall trend analysis shows that seasonal rainfall rises monotonically in all seasons in Jos except R99p season. There are a few other incidences increasing significant trends in almost all the stations except Ikeja and Gombe. In all the stations, there are small changes in trend but these changes are very small or mostly insignificant. Any increase or decrease in trend is an evidence of climate change.

During the preparation of this work the author(s) used [Writefull] in order to [improve the grammar and readability of the article]. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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OJU was involved in data acquisition, conceptualization, designing and manuscript review.

Conflict of Interest
The authors declare no conflict of interests.