



EVALUATION OF RAINFALL TRENDS DUE TO CLIMATE CHANGE: A CASE STUDY OF SAMARU, ZARIA

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ABSTRACT

Rainfall is the major source of water for agricultural activities in Nigeria, but there has been a major variation due to climate change. This study is to assess the change in rainfall trend due the impact of climate change in Samaru, Zaria Kaduna State. Rainfall data from 1981 – 2018 (38 years) were collected from the Nigerian Meteorological Agency (NIMET). The data was analyzed using Excel and XL-Statistics to evaluate the mean, standard deviation and coefficient of variation of monthly and annual rainfall and other statistical parameter. The study revealed that there is a significant change in the trend of annual rainfall as the highest rainfall was recorded in year 1994 with a value of 1487 mm and lowest rainfall in 1999 as 440 mm. The highest average monthly rainfall data is between July to September and a peak rainfall in August with an average value of 547 mm. This analysis provide useful information to farmers which can be used a basis for planning annual crop planting and also water resources planning such as in irrigation scheduling.

Keywords: Analysis, Climate Change, Farmers, NIMET and Rainfall

INTRODUCTION

Rainfall has been the most favourable source of water for Agricultural purposes in Nigeria. Recently, the impact of Climate change in respect to delay in the onset of rainfall as well as excessive rainfall has affected the planting date of various crops across the country (APS, 2021). This may lead to food insecurity if appropriate measures are not put in place. The effect of climate change has been experiences in many parts of the world of which Nigeria is not left out of this especially in their Agricultural sector. The activities of farmers have been greatly altered as there is delay in the onset of rainfall especially in Northern Nigeria, thus delay in the planting as well as maturity and harvesting of crops, while excess of it in Southern Nigeria results to Flooding (APS report, 2019/2020/2021). As reported by Akinsanola(2014); A study was conducted by Adefolalu (1986) on rainfall trends for periods of 1911–1980 over 28 meteorological stations in Nigeria with 40 years moving average which shows a decline in rainfall. Also, Eludoyin et al. (2009) studied monthly rainfall distribution in Nigeria between 1985-1994 and 1995-2004 and observed some fluctuations in most months within the decades. In an investigation by Ayansina et al. (2009) to determine the influence of rainfall as an element of climate change, the seasonal rainfall variability in Guinea savannah part of Nigeria and it variability was observed to continuously be on the increase. Therefore, understanding the trends in rainfall across the country has become a must, unfortunately, climatic data are not readily available to researchers and Farmers. The change in rainfall due to the impacts of climate change has led to some socio-economic implications of dry spell, flooding and prolonged dry season across Nigeria(APS, 2021). A large part of Nigeria agricultural and economic sector is dependable on it natural resources which is obviously vulnerable to climate change of which many Nigerians are unaware due to the lack of awareness and knowledge (Ishaya and Abaje, 2008). The objective of this study is to evaluate the change in trend of rainfall due to climate change. This analysis will provide useful information for farmer needed for annual crop

planning and management of rain fed agricultural activities, as well as water resources planner. It will also predicts the magnitude and occurrence of extreme events like floods, droughts due to rainfall variability.

MATERIALS AND METHOD

Study Area

Samaru, Zaria lies between 11°11'N and 7°11'N (Yunus et.al, 2010) and at an altitude of 686 m above the sea level. The climate of Samaru is described as dry; sub-humid with severe deficit of rainfall from October to May and a surplus from June to September with an annual rainfall of 1000 mm. It experiences a cool dry harmattan season between November and April (Igbadun, 1997).

Data Type and Data Source

The data for this study is a secondary data obtained from Nigeria Meteorological Agency over a period of 1981-2018.

Data Analysis

Microsoft Excel and XLSTAT tool were used to evaluate the trend in rainfall data. Mean and standard deviation were used to examine the rainfall parameters. An analysis of variance (ANOVA) at a confidence level of 95% i.e. a significant level $\alpha = 0.05$ was used to determine significant difference in the rainfall data. A linear regression was used to identify the trend in the rainfall data. The effective Rainfall needed by some plants as determined by their crop water requirement v over the years was estimated using equation 1 and 2 (Floyd et al., 2016). Effective rainfall is the amount of rainfall effectively used by the crops. The effective rainfall in the study area is calculated using the formula (Arvind et al, 2017);

$$R_e = 0.8 * P - 25, \quad \text{if } P \geq 75\text{mm} \quad (1)$$

$$R_e = 0.6 * P - 10, \quad \text{if } P < 75\text{mm} \quad (2)$$

Where: R_e is the Effective Rainfall in millimeters, P is the Total Monthly Rainfall in millimeter

RESULTS AND DISCUSSION

Statistical Analysis

The results of statistical analysis performed on rainfall dataset from 1981 to 2018 are shown in Table 1. Generally peaked distribution occurred in most cases which shows a positive coefficient of skewness which is an indication that the mean annual rainfall is greater than the median. Hence the mean, media and Mode are all a positive. A positive coefficient of kurtosis was also observed which is an indication that the distribution of rainfall is peaked with a Leptokurtic distribution(a heavy tailed distribution) . The minimum amount of rainfall measured in a year was observed to be 440.50 mm and a maximum annual rainfall of and 1487.60 mm from 1981 to 2018.

Table 1: Statistical Analysis of Annual Rainfall

Parameters	Statistics
No. of observations	38
Minimum	440.5000
Maximum	1487.6092
Sum	33614.2412
Mean	884.5853
Variance (n)	47310.9482
Standard deviation (n)	217.5108
Variation coefficient	0.2459
Skewness (Pearson)	0.7162
Kurtosis (Pearson)	0.6806
Mean absolute deviation	169.6327

The commencement of rainfall from 1981 to 2018 is usually in the month of April which gradually increases and peaked in the August and then decreases by October until no rainfall from November as shown in Table 2 and Figure 1. The highest amount of rainfall was recorded between July and August while no rainfall was recorded in the months of January/ March and November/December over the 38years. The mean monthly rainfall ranges from 0.22mm to 267.59mm over the 38 years while positive skewness and kurtosis was observed for all the months except in July with negative values of skewness and kurtosis.

Table 2: Statistical summary of monthly rainfall data of Samaru Zaria.

Parameters	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
mean	0	0	0	17.01579	77.68951	123.2342	196.0234	267.5987	170.4632	32.33421	0.226316	0
SE	0	0	0	3.519502	6.480529	9.493302	9.066502	17.0243	16.26896	7.534049	0.226316	0
Median	0	0	0	6.05	75.52685	119.1	194.85	272.65	158	14.05	0	0
SD	0	0	0	21.69567	39.94866	58.52065	55.88967	104.9448	100.2886	46.443	1.395104	0
SV	0	0	0	470.7019	1595.896	3424.666	3123.655	11013.42	10057.8	2156.952	1.946316	0
Kurtosis	0	0	0	0.18799	0.893385	1.124905	-0.19415	1.710408	0.020803	4.494038	0.38	0
Skewness	0	0	0	1.218945	0.641512	0.605663	-0.1904	0.325145	0.533423	2.154044	6.164414	0
Count	38	38	38	38	38	38	38	38	38	38	38	38

SE = Standard Error, SD = Standard Deviation, SV= Sample Variance

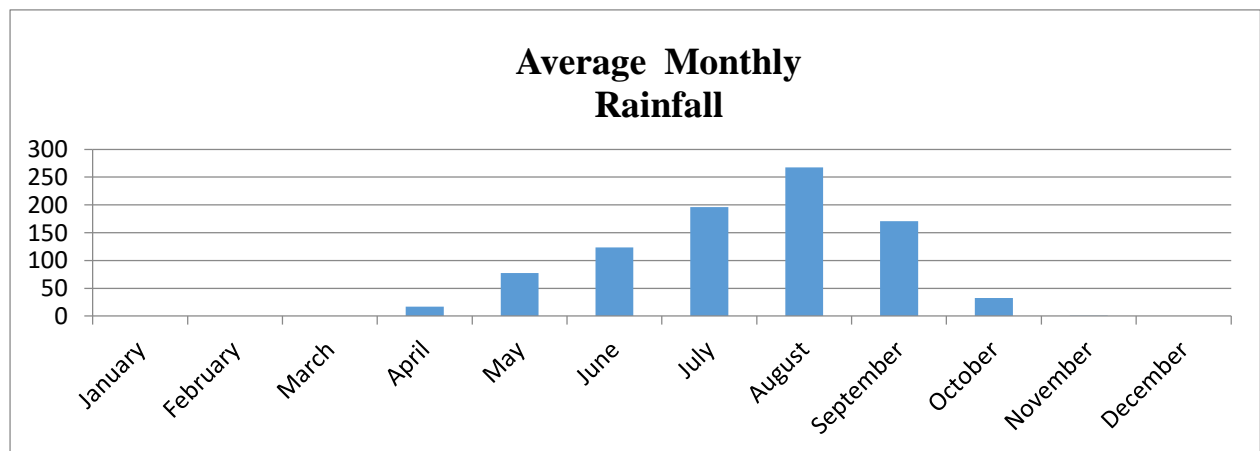


Figure 1: Average Monthly Rainfall from 1981 to 2018

Rainfall Trend

The trend analysis was done by using the Mann-Kendall test and Sen's slope method, The Sen's slope estimated was at 0.032, $P = 0.4064$ and at a significant level of 0.05. The p-value was computed using exact method and was found to be greater than the significance level $\alpha=0.05$. Hence, the null hypothesis H_0 which state that "there at is no trend in the rainfall was accepted at a risk of 19.26%. However, as shown in Figure 2, there is a monotonic increase or decrease in annual rainfall trend. However, an increasing trend in

annual rainfall was experienced between 1990 to 1994 and between 2001 to 2005, While a decreasing trend has been experienced from 2005 till date, this could be as a result of impact of climate change. A continuous decrease in rainfall trend from 2005 till date could lead to some ecological repercussions such as dry spells and drought which is affecting overall crop production in the zaria as well as the sustainability of surface water resources and groundwater recharge.

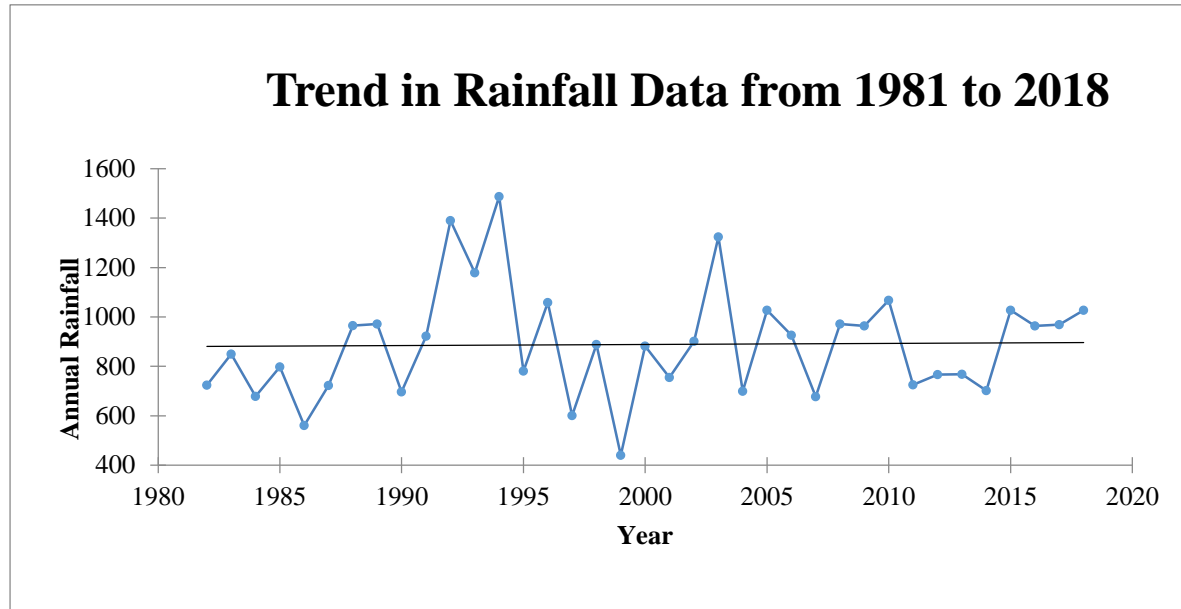


Figure 2: Rainfall Trend Line from 1981 -2018

Effective Rainfall for Crop Production

The effective rainfall from each year base on crop water requirement was computed from equation 1 and is shown in Table 3. The highest effective rainfall was obtained in year 1994 and a lowest effective rainfall in 1999 this variation could be due to the impact of climate change.

Table 3: Effective Rainfall Over 38 year

Years	Annual Rainfall	Effective Rainfall
1981	759.176	582.341
1982	723.649	553.919
1983	850.088	655.071
1984	678.562	517.85
1985	797.7	613.16
1986	560.144	423.115
1987	722.8	553.24
1988	965.278	747.222
1989	970.8	751.64
1990	696.699	532.359
1991	922.396	712.917
1992	1390.7	1087.56
1993	1179.19	918.352
1994	1487.61	1165.09
1995	780.23	599.184
1996	1057.93	821.347
1997	601.05	455.84
1998	888.46	685.768
1999	440.5	327.4
2000	881.879	680.503
2001	754.355	578.484
2002	901.419	696.135
2003	1324.35	1034.48
2004	698.541	533.833
2005	1026.97	796.576
2006	926.354	716.083
2007	677.323	516.859
2008	970.754	751.603
2009	963.481	745.785
2010	1067.55	829.036
2011	725.021	555.017
2012	766.03	587.824
2013	767.951	589.361
2014	702.4	536.92
2015	1027.6	797.08
2016	963.1	745.48
2017	969	750.2
2018	1027.2	796.76

A regression analysis was also carried out between Annual rainfall and effective rainfall as shown in Figure 3. The R^2 is

0.99 which means there is a strong relation between Annual rainfall and effective rainfall i.e. as the annual rainfall

increases the effective rainfall will also increase. The slope of regression describes the trend as a positive trend.

CONCLUSION

From the study, a minimum and maximum annual rainfall of 440.50 mm and 1487.60 mm, respectively, from 1981 to 2018 was estimated. Also, the linear regression analysis shows a strong correlation between the annual rainfall and effective rainfall needed and a variation in trends of annual rainfall over the years. This shows that there is a significant effect of climate change on the annual rainfall trend in Zaria which may have lead to decrease in rainfall from recent years till date. The result corresponds to what was reported by Akinsanola (2014) i.e. a decrease in rainfall trend in Kaduna state in general. The effective rainfall over the years may not be suitable for some crops except there is supplement from irrigation. The information provided by this study can be use for agricultural planning and government policies in assessing the impact of the climate variability on crop yields.

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