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Research Paper

Quantitative analysis of rainfall variations in north-eastern region of Nigeria

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Abstract. Rainfall data spanning a period of 30 years (1981 to 2010) for 6 stations in North-eastern Nigeria were used to determine trend and variation in rainfall for the region. Analysis of Variance and multiple regression were used to analyze the pattern and variation of rainfall over the study period. Rainfall in the study area are in the order of Yobe < Borno < Bauchi < Adamawa < Gombe < Taraba.Yobe recorded the least average rainfall over the years across the study are while the highest average rainfall was recorded in Taraba State. There was visible pattern of rainfall fluctuations with periodic trends in all the locations. Quantitatively rainfall increased at the rate of 40.59 to 132.67 mm/month and decreased at a rate of 2.918 to 9.673 mm/month in the studied area. The decadal means were compared. Evidence from the six stations considered show that there is significant increase in annual rainfall amount in the last decade of the study. It means, therefore, that we are experiencing wetter conditions in the north eastern zone of Nigeria. It was recommended that environmental agencies in Nigeria, like the Nigerian Meteorological Agency in collaboration with the Nigerian National Bureau of Statistics should work assiduously toward keeping an up to date records of climate and weather indicators and also making it available and accessible to researchers and general public free of charge.

Keywords: Rainfall pattern, variation, climate change, North-eastern Nigeria.

INTRODUCTION

Rainfall is a climate parameter that affects the way and manner man lives. It affects every facet of the ecological system especially flora and fauna (Obot et al., 2010). The rainfall received in an area is an important factor in determining the amount of water available to meet various demands, such as agricultural, industrial, domestic water supply and for hydroelectric power generation (Sharad and Vijay, 2012). Declining rainfall has adverse effect on water resources, agricultural output and economy (Markand and Kishtawa, 2014). Availability or non-availability of rainfall which determines the level of wetness or dryness during the growing season makes rainfall the single most important element of climate affecting agriculture and water management in any region (Olatunde, 2012). The frequent occurrences of dry spell have led to the concern that the region might be undergoing climatic shift towards aridity. Although some climate parameters have shown distinct trend globally, rainfall behavior varies depending on the location (Ghahraman and Taghvaeian, 2008). Obioha (2005) reported that the Sahelian zone of north-eastern Nigeria has been experiencing a change in its climate, characterized by reduction in rainfall and increase in the rate of dryness and heat. Abaje et al. (2010) observed similar trend of change from 1900 to 2005 in many places like Eastern North America, Eastern South America, Northern Europe, Central Asia, Southern Africa and Southern Asia.

Eludoyin et al. (2009) studied monthly rainfall distribution in Nigeria between 1985-1994 and 1995-2004 and noticed some fluctuations in most months within the decades. Ayansina et al. (2009) also investigated the seasonal rainfall variability in Guinea savannah part of Nigeria and concluded that rainfall variability continues to be on the increase as an element of climate change. This implies that rainfall trend all over the world varies with location, distance and time. The pattern of rainfall in North-Eastern Nigeria is highly variable in spatial and temporal dimensions with inter-annual variability of between 15 and 20% which often results in climate hazards, especially floods and severe droughts with devastating effects on food production and associated calamities and sufferings (Uduak and Ini, 2012; Adebayo and Oruonye, 2013). Tomlinson (2010) observed rainfall trend in Northern Nigeria and concluded that there will be reduction of about 4 mm/year over the next 100 years at the Nigeria edge of Sahel. Ishaku and Majid (2010) in a study that focused on rainfall pattern and variability in north eastern Nigeria, observed that the mean annual rainfall for the north east region does not decrease with distance from the coastal areas of southern Nigeria to the semi-arid land of the northern part as widely speculated, but pattern of rainfall is likely to create water shortage in lakes, rivers, dams for domestic, irrigation and industrial purposes. Several studies have shown that temperature is rising and rainfall frequency and intensity is fluctuating (Ozor and Cynthia, 2010; Juddy et al., 2013; Christiana and Amanambu, 2013; Mohammed et al., 2013). The evidence of climate change includes delayed onset date of rains, increase in number of dry days during the raining season and increase inmaximum temperature (Oruonye, 2014). In the present study analysis of rainfall variation has been considered. To identify changes in seasonal variation of rainfall and the effects of variation of rainfall in the study area.

METHODOLOGY

Data were collected on rainfall for a period of 30 years (1981 to 2010). These data were supplemented by Nigeria Meteorological Agency (NIMET) at Abuja and Maiduguri. The data collected were processed into monthly and annual mean values for all the locations based on the formulae:

$$X = \frac{\Sigma(x_i)}{n} \quad (1)$$

The integrity of the data was determined by collecting the data from each of the data source and checking for inconsistencies and missing gaps using linear regression to estimate the missing values using the available values (Hammond and McCullagh, 1978). It may be written as:

$$y = a + bx \quad (2)$$

Where:

$$b = \frac{n\,\Sigma xy - (\Sigma x)(\Sigma y)}{n\,\Sigma x^2 - (\Sigma x)^2} \quad (3)$$

$$a = \frac{\Sigma y}{n} - \frac{b\Sigma x}{n} = \bar{y} - b\,x \quad (4)$$

a is the intercept; b, the regression coefficient or slope; y, the temperature values; x, the time in years; x, the mean time, and $\bar{y}$ is the mean temperature value.The data collected were subjected to statistical analysis using the analytical software, Statistix Version 8.0 (Microsoft, 2003) to determine the mean annual and monthly values of temperature across locations, using analysis of variance, based on the formulae:

$$S^2 = \frac{1}{n}\sum(X_t - X)^2 \quad (5)$$

The Analysis of Variance (ANOVA) was used to test for variation among the monthly and annual rainfall of the six locations by comparing their means to see if there are any statistically significant differences among themand means were compared using least significant difference (LSD) at 5% probability level among locations, years and months base on the formulae:

$$LSD = t_\alpha \times \sqrt{MSE/r} \quad (6)$$
$$t_\alpha = 0.05$$

Multiple regression analysis was used to generate model equation for predicting rainfall in the studied areas.

RESULTS AND DISCUSSION

Analysis of variance indicated significant ($p < 0.05$) difference in the rainfall regime of the different locations, over months and years. Mean rainfall of the studied area ranged from 33.1 to 152.9 mm (Table 1). These variations observed could result from the land resources degradation, sand dune, flood plain and basement nature of the study area. Taraba received significantly higher rainfall than the other locations. WhileYobe had the least rainfall recorded (Table 2). Figure 1 showed highly significant variation in rainfall over 30 years period with the highest rainfall record in 1999, while the amount received in most years was statistically similar. From 1982 to 1987 and especially in 1991 and 2002 rainfall was low. There was a highly significant difference in

Table 1. Mean annual rainfall across the 6 locations in North-eastern Nigeria.

Location	Gombe	Adamawa	Taraba	Yobe	Borno	Bauchi
Mean rainfall (mm)	70.8	72.8	152.6	33.1	47.0	86.7

Table 2. Mean annual rainfall for 3 decades in 6 locations in N/E Nigeria (mm).

Location	Average rainfall (mm)		
	1981 – 1990	1991 – 2000	2001 – 2010
Gombe	61.66	72.15	78.61
Adamawa	74	76.78	67.67
Taraba	141.97	161.09	151.22
Yobe	27.28	36.37	34.54
Borno	35.59	49.79	55.63
Bauchi	74.51	91.41	94.28
Range	27.28 – 141.99	36.37 – 161.09	34.54 – 151.22

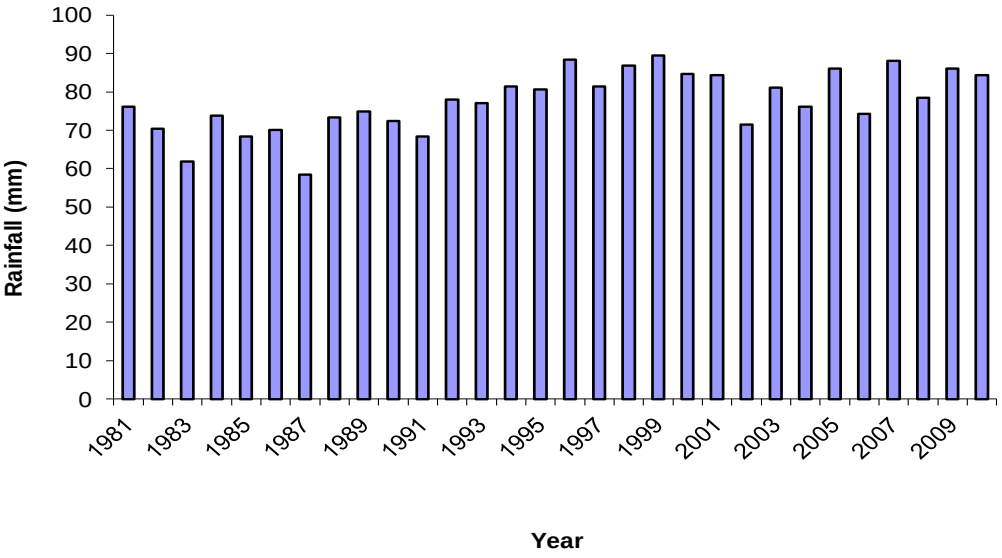

Figure 1. Relative mean rainfall over the year in different locations.

mean precipitation on monthly basis with July and August being district in term of high precipitation (Figure 2). These changes observed could be attributed to element of climate change as observed by Ayansina et al. (2009). In particular and in all the locations under study, the monthly series trend show significant variation over the years (Figure 3). The explanations for these variations can be attributed to some climatic factors such as relief, rainfall intensity and proximity to the receding Lake Chad soil condition among others. As expected for a semi-arid region.

Location vs. year interaction was significant with peak rainfall for Taraba, Gombe, Bauchi, Adamawa, Borno and Yobe recorded in 1997, 2010, 2000, 1999, 2000 and 1994 (Figure 3), respectively. In general, there was noticeable recent increase in rainfall in Bauchi, Borno and Yobe, in contrast to a decrease in Gombe, Adamawa and Taraba (Table 2). In general, there was significant increase in rainfall in the last decade which is in contrast to Tomlinson (2010) observation of reduction in rainfall over the next 100 years at the Nigeria edge of Sahel.

Location vs. month interaction was significant, with peak rainfall occurring in July at Adamawa, in August at Bauchi, Gombe, Borno and Yobe and in September at Taraba (Figure 2). Figure 4 show mean annual variation in rainfall across the region that tends to fluctuate inter-annually for the period of study.

Effects of rainfall

The effect of rainfall trend for the region is described by

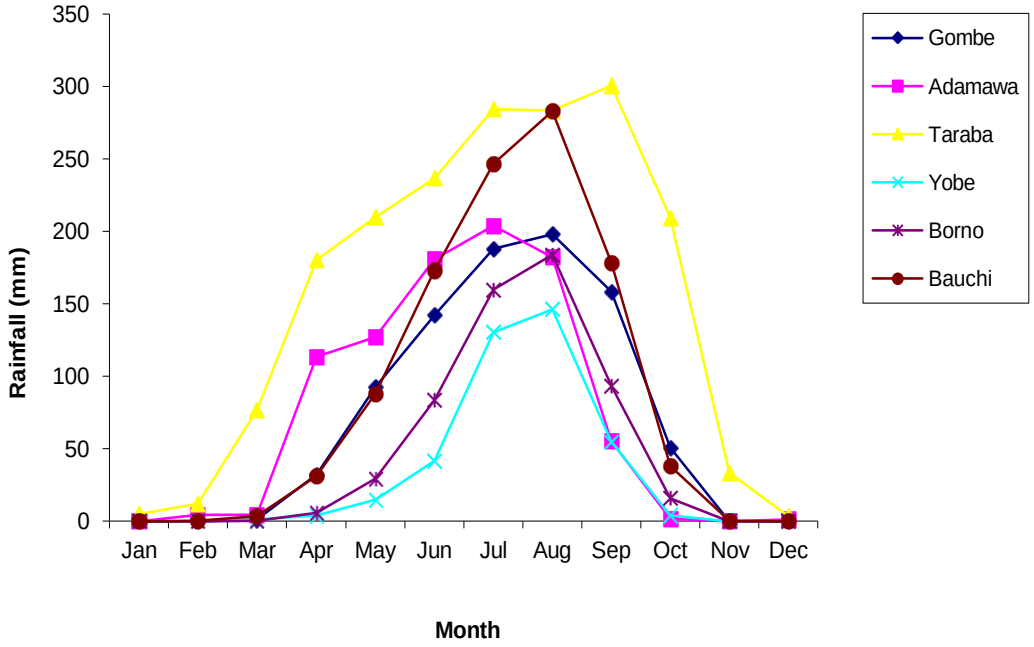

Figure 2. Pattern of changes in rainfall over the month in different locations.

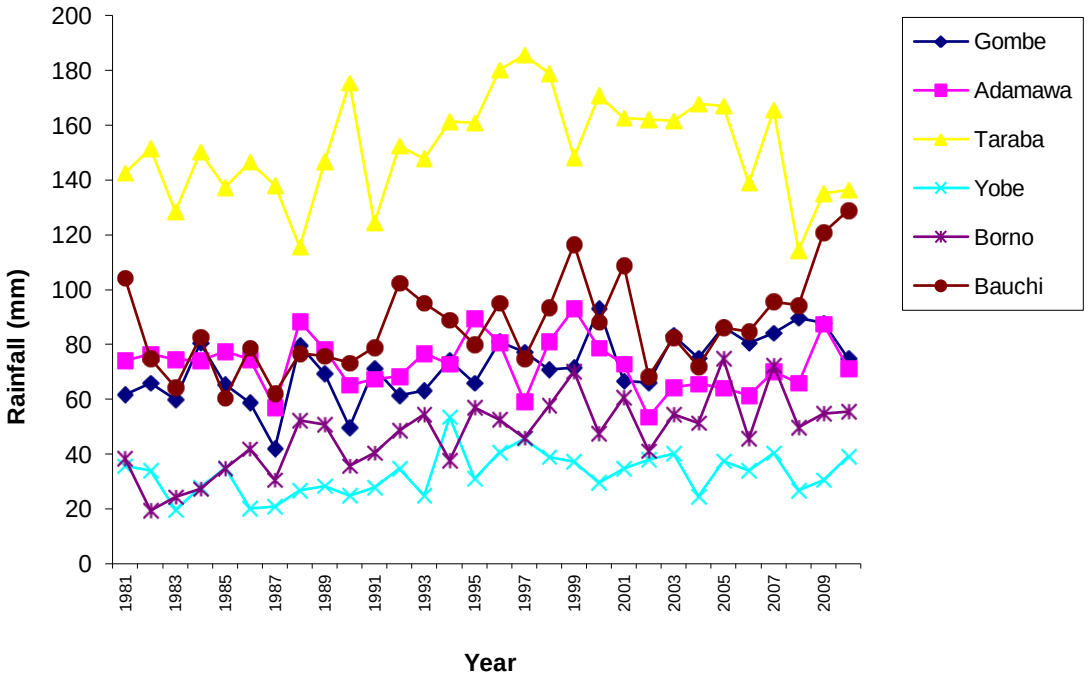

Figure 3. Pattern of changes in rainfall over the 30 years in each of the locations.

the 2nd order regression (Figure 5). The quantitative changes in rainfall showed anincrease at a rate of 40.59 to 132.67 mm/month until it reached in July to September, and later decreased at a rate of 2.918 to 9.673 mm/month in all the locations showing quantitative increase in rainfall in the last decade resulting from climate change effects (Table 2).

Conclusion

This study provides valuable insight on the spatial and temporal patterns of rainfallin North-eastern Nigeria. The results revealed that there is significant increase (positive trend) in rainfall. Also, rainfall has been on the increase within the year of consideration. The rainfall anomaly

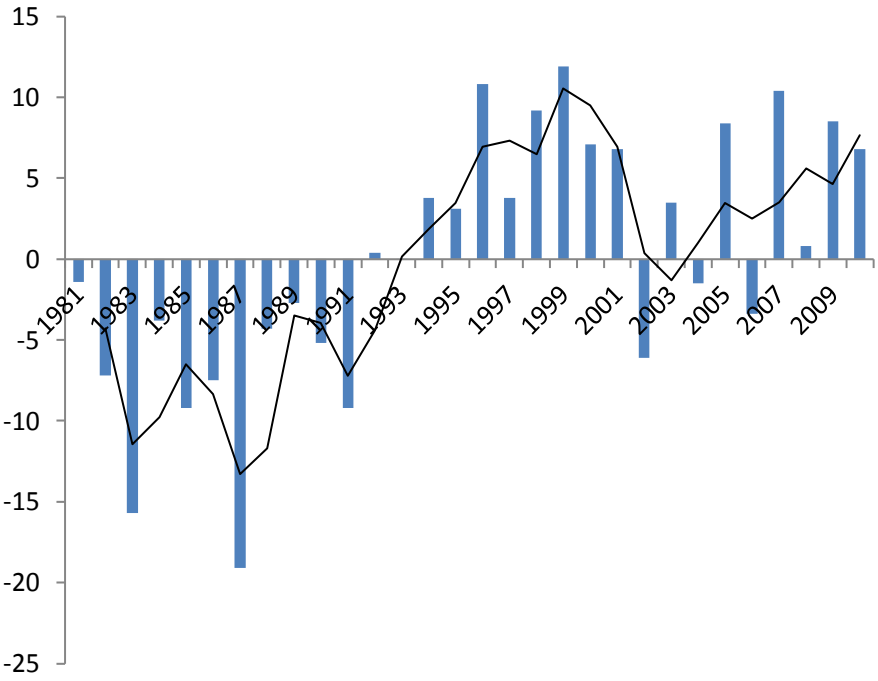

Figure 4. Change in rainfall over 30 year in 6 location in N/E Nigeria.

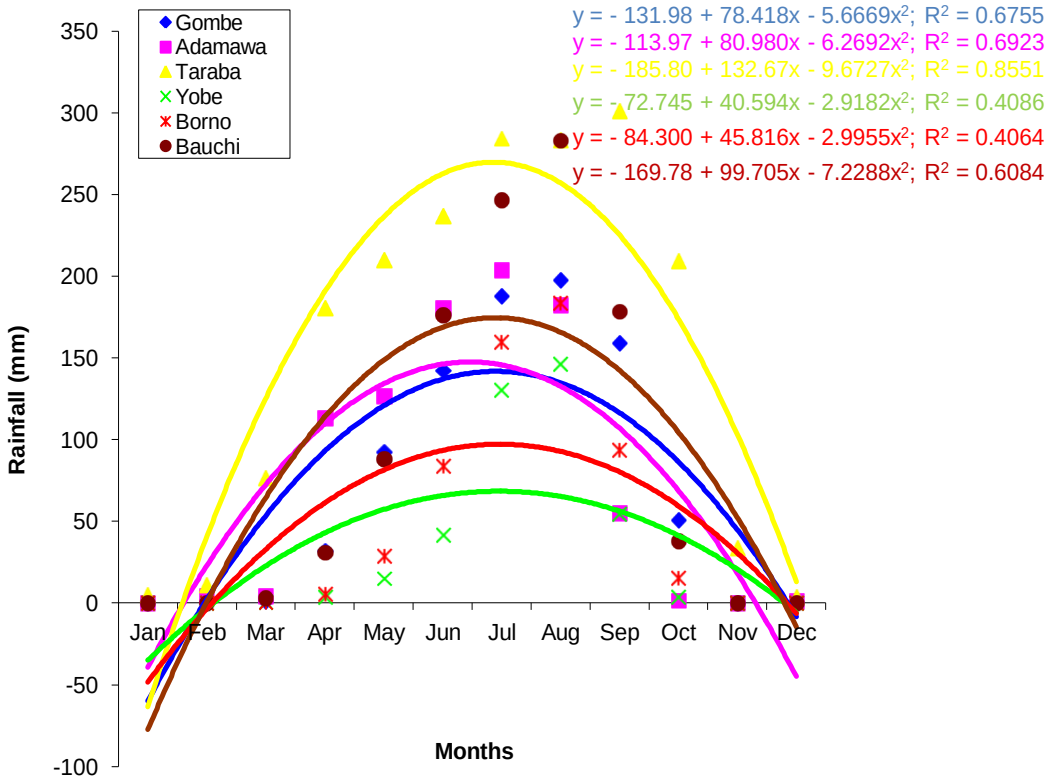

Figure 5. Mean monthly trend of rainfall across the 6 location in N/E Nigeria.

over all the stations revealed that there was a composite nature in which rainfall varies in the different months and the different years as evidenced in the graphs. Therefore, an understanding of thechanging patterns in rainfall is a

basic and importantrequirement for the planning and management of water resources in the studied area.

REFERENCES

Abaje IB, Ishaya S, Usman SU (2010). An analysis of Rainfall Trends in Kafanchan, Kaduna State, Nigeria. Res. J. Environ. Earth sci. 2(20):89-96.

Adebayo AA, Oruonye ED (2013). An Assessment of Climate Change in Taraba State,Nigeria. Nigerian J. Trop. Geography 4(2):602-612.

Ayansina A, Ogunbo S (2009). GIS Approach in Assessing Seasonal Rainfall Variability in GuineaSavanna Part of Nigeria, 7th FIG Regional Conference, Vietnam, 19-22 October 2009. p. 16.

Christiana NE, Amanambu CA (2013). Climate Variation Assessment Based on Rainfall and Temperature in Ibadan, South-Western, Nigeria. J. Environ. Earth Sci. 3(11):32-46.

Eludoyin (2009). Monthly variation in the 1985-1994 and 1995-2004 rainfall distribution over five selectedsynoptic stations in western Nigeria. J. Meteorol. Clim. Sci.7:11-22.

Ghahraman B, Taghvaeian S (2008). Investigation of Annual Rainfall Trend in Iran. J. Agric. Sci. Technol. 10:93-97.

Hammond R, McCullagh P (1978). Quantitative Techniques in Geography: An Introduction.

Ishaku HT, Majid MR (2010). X- Raying Rainfall Pattern and Variability in North eastern Nigeria: Impacts Access to Water Supply. J. Water Resour. Protect. pp. 2952-2959, J. Geo. 8(1):40-47.

Juddy NO, Aondover AT, Muthiah P (2013). Study of Climate Change in Niger River Basin, West Africa: Reality Not a Myth. http://dx.doi.org/10.5772/55186, London: John Wiley Press.

Markand O, Kishtawa CM (2014). Spatial analysis of Indian summer monsoon rainfall.

Mohammed D, Kwaghe PV, Bukar U, Umar J (2013). Economic of Adaptation to ClimateChange among Crop Farmers in Adamawa State, Nigeria. IOSR J. Agric. Vet. Sci. 5(4):61-66.

Obioha EE (2005). Climate Change, Population Drift and Violent Conflict Over Land Resources in North Eastern Nigeria. Paper presented at International Workshop on Human Security and Climate Change in Asker, Near Oslo.

Obot NI, Chendo MAC, Udo SO, Ewona IO (2010). Evaluation of rainfall trends in Nigeria for 30 years (1978-2007). Int. J. Phys. Sci. 5(4):2217-2222.

Olatunde AF(2012). The Intensity of wet years in the Sudano-Sahelian Region of Nigeria between 1941 and 2008. Cont. J. Environ. Sci. 6(2):44-53.

Oruonye ED (2014). An Assessment of the Trends of Climatic Variables in Taraba State Nigeria. Glob. J. Sci. Frontier Res. H Environ. Earth Sci. 14(4):1-15.

Ozor N, Cynthia N (2010). Difficulties in Adapting to Climate Change by Farmers in Enugu State, Nigeria. J. Agric. Ext. 14(2):106-122.

Sharad KJ, Vijay K (2012). Trend analysis of rainfall and temperaturedata for India. Curr. Sci. 102(1-10):37-50.

Tomlinson J (2010). Observed Trend in Rainfall: Northern Nigeria. J. Failure Anal. Prevent. 11(2):97-109.

Uduak CU, In DE (2012). Analysis of Rainfall Trends in Akwa-Ibom State, Nigeria. J. Environ. Earth Sci. 2(8):60-72.