TREND OF RAINFALL IN ABEOKUTA, OGUN STATE, NIGERIA: A 2-YEAR EXPERIENCE (2006-2007)

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ABSTRACT

Rainfall influences a lot of human activities like farming, sports and open air campaigns. It also influences environmental factors like level of water bodies and erosion. A 2-year rainfall data of Abeokuta between 2006 - 2007 was analysed using various statistical applications like the Mann-Kendall non-parametric test and the parametric student t-test for two separate time series of monthly total rainfall and rainy days. The result revvealed that the pattern of rainfall rises to a peak before falling to the 'August break', and rises to a mini peak before falling again into extinction. The results also showed an increasing trend from both the non-parametric and parametric tests with a rate of increase of 3.21mm/month using the total amount of rainfall time series, aside showing the seasonality of the location which possibly would not have been revealed if yearly data of large size were considered.

Key words: *rainfall, Mann-Kendall, t-test, season, trend*

INTRODUCTION

The study of rainfall is significant to the existence of man and to the effective understanding and management of his environment and for the lives of animals and plants. Rainfall affects water levels and other characteristics such as current of water bodies like streams, lakes and rivers (Bailey, 1998; Fernandez-Illescas and Rodriquez-Harbe, 2004; Davis, 2002; Eversion, 2001). The knowledge of precipitation is beneficial to farmers to know when to grow their crops, most especially crops that need a lot of water at some stage of their lives; it has been reported that crops witness high growth rate during the first two months of rain in Maiduguri, Nigeria (Adejuwon, 2004). Also the knowledge of rainfall is needed to successfully plan and organise outdoor activities and ceremonies like games and campaigns from time to time.

Occurrence of natural disasters like landslides, floods and droughts are dependent on the intensity of rainfall (Ratnayake and Herath, 2005). Also it is speculated that the worldwide increase in floods, droughts and other water related problems like erosions is as a result of the consequences of climate change, industrialisations, population growth and densely populated urban areas and perhaps signs of end time. On global scale, rainfall trends have shown spatial and temporal variability in observations carried out (Ratnayake and Herath, 2005). At times the variations are periodic and predictions are possible (Oduro-Afriyie and Adukpo, 2006; Kane and Trivedi, 1982). However, in some cases its variations are so erratic that the study concluded that there is no specific pattern in the rainy reason and earlier predictions failed (Ati et al, 2008).

No two locations no matter how close they are to each other and having similar geographical features can have the same climate conditions and using the climatic conditions of one location to estimate that of another location could be a blunder (Udo and Aro, 1999; Paldor, 2008). Many studies on rainfall do not pick on a particular location at a given time, but rather across a country or region (e.g. Oyegoke and Oyebande, 2008; Partal and Kahya, 2006; Smadi and Zghoul, 2006). And even when that is not the case, a lot of years are considered in examining the trend of rainfall for a given location, thus certain information are 'swallowed up' in the process

(Ati et al, 2008). The aim of this work is to examine the trend of rainfall in Abeokuta, ogun State, Nigeria: A 2-year experience (2006 - 2007). However, a comprehensive research hypothesis was formulated for the study. Thus, There is no existence of trend in the monthly to be amount of rainfall during the two years period.

MATERIALS AND METHODS

A recent two- year data (2006 - 2007) for Abeokuta which lay between latitude$7^0 15^1$ N, longitude 3^0 35^1E was obtained from Nigerian Meteorological Society (MET), Oshodi, Lagos is used for this research. Two different time series are generated; one based on the monthly total amount of rainfall and the second is based on the days of rainfall. Trend test seeks to find out if there is either upward or downward change in a given data set over a period of time. On the other hand, the existence of trend annuls the belief of randomness in the distribution of a given set of data over time. In this work, two statistical tests for trend are carried out. The first is the non parametric Mann-Kendall test and the second is the parametric student t-test. While parametric test assume that the random variable is normally distributed and of a homogeneous variance, non-parametric test make no such assumption for probability distribution (Onoz and Bayasit, 2003).

The Mann-Kendall non-parametric test is widely used to test for trend, specifically in rainfall studies (Partal and Kahya, 2006; Jayawardene et al, 2005; Smadi and Zghoul, 2006), and other environmental variables like hydrological studies for example, river (Xiong and Guo, 2004). For a total number of n>10 and for cases whereby there are not two much ties, the procedure for the Mann-Kendall test t_m (Jayawardene *et al,* 2005) is computed by first replacing the observations *xi*'s by their ranks *ki*'s such that each term is assigned a number ranging from 1 to *n* which reflects its magnitude relative to the magnitudes of all other terms. For each element *ki,* the number *Ni* is calculated as the number of *kj* terms preceding it such that *kj* > *ki.*

$$t_m = \frac{4\sum_i^{n-1} N_i}{n(n-1)} - 1 \qquad \text{.........................1}$$

$$r_m = \pm r_g \left\{ \frac{\sqrt{4n+10}}{\sqrt{9n(n-1)}} \right\} \qquad ....2$$

Where r_g is the desired probability point of the normal distribution appropriate for a two-tailed test and if t_m lies inside the range $\pm\, r_m$ then the time series does not contain a trend. The parametric student t-test, considering the linear regression on a random variable *y* on time *x* and given that the regression co-efficient of best fit is b, having a degree of freedom of n-2, then the t-test is given as in (Oloyo, 2001);

$$t_s = \frac{b}{\sqrt{\frac{s_{yx^2}}{\sum_{i=1}^{n} x_i}}} \qquad ....(3)$$

where

n	=	the sample size,
Syx^2	=	the standard deviation of residuals
$\Sigma_{i=1}\, x_i$	=	the sums of squares of the independent variable (time in trend analysis).

The null hypothesis is rejected if $|t| > t_\alpha(n-2)$, the critical value at the 0.05 level of significance.

RESULTS AND DISCUSSION

From elementary statistics, the driest month is December while June is the month of heaviest rain from the monthly sums of the period under review. In arriving at the level of dryness or determining the rainy season from the dry season, the monthly mean total value was subtracted from the respective total for each month. Those that fell below the mean total rainfall for the two years consecutively are classified as dry months while those above the bench mark for the two years are classified into rainy season (fig 2). The periods of dryness are the months of November, December, January, and February. December recorded no rain at all for the two years considered.

However in January of 2007 there was no rain through out while it rained twice in the same month of the previous year. Expect for those cases, there was not a month that rain did not fall. Rain is at maximum in either the month of June or July though the rainy season ranges from March to October. The pattern that rainfall occurs is such that it arises and gets to the peak before falling into the 'August break', it will then rise again to a lower peak before falling to a stop. In 2006, the August break was as if it were that of the dry season. However when the rain picks up in Septembers, it comes heavy and not as if it were beginning afresh as the periods of March through April. During those two months (March and April), the rain takes a path of gradual increase. The range for the monthly total precipitation is from 0 to 415.3 mm. The test for trend and other statistical evaluations were carried out at $\alpha = 0.05$ and for two-tail correlation.

Table 1: Result for total rainfall (mm) analysis

SD	CV	Mean	Max	Min	Mann-Kendall		Pearson correlation		Slope
					t_m	r_m	t-test	r_p	
110.7	0.94	117.7	415.3	0.0	0.978	0.14	-4.638	0.205	3.211

From the Mann-Kendall test carried out on the time series of total amount of rainfall, the value of tm(0.978) is greater than the absolute value of rm(0.14) hence a trend exist. If tm were to be in the range of ± rm, then the test would have indicated no trend or failed to establish any trend. The critical value of t-test at a degree of freedom of about 46 is equal to 2.013. The second test for trend which is the student t-test has an absolute value of 4.638 and since that is greater than 2.013, hence it is accepted that a trend does exist in the monthly total amount of rainfall during the two years era. The Pearson correlation coefficient reveals that the amount of total rainfall does not depend on the passages of time; it's 0.205, a value less than 0.5. Since the slope is 3.211, therefore the trend was increasing at that rate during the period under review. The co-efficient of variation (CV) which is the measure of the ratio of standard deviation (SD) to the average value, stands as 0.94 for the total precipitation.

Table 2: Result of analysis for rain days

SD	CV	Mean	Max	Min	Mann-Kendall		Pearson correlation		Slope
					t_m	r_m	t-test	r_p	
6.24	0.76	8.2	19.0	0.0	0.949	0.14	2.272	0.154	0.136

The standard deviation SD is 6.24 for the time series of monthly total of rainy days while it is 110.7 for total precipitation. The total amount of rain and the number of days of rain do not always have the same trend (Smadi and Zghoul, 2006), hence the need to examine both parameters differently. In this particular case, there are some 'slight' differences between the total amount of rainfall and the rainy days (see figs. 3 and 4).

Also the statistical results from both analyses are different as evident in the two tables. Nonetheless, the tests for trend indicate that there exists a trend in time for number of days of rain but the increasing trend in this case is quite less compared to that of amount of rainfall. In the Mann-Kendall test, t_m is greater than r_m and for the t-test the calculated value (2.272) is greater than the critical value of 2.013. The slope gives a value of 0.136, which goes further to confirm the minute increasing trend in the number of rain day's time series over the two-year term evaluation.

CONCLUSION

The period considered witness an increasing trend in rainfall, much in the total amount of rainfall while the tests for trend showed little increase in the case of the total number of rain days. The seasonality of the location is apparently established which could have been hidden if large data size of yearly magnitude were used. It still remains to see whether this trend will stand out or fade away when yearly data of lengthy period are used. However, it is imperative to state that the amount of total rainfall does not depend on the passages of time.

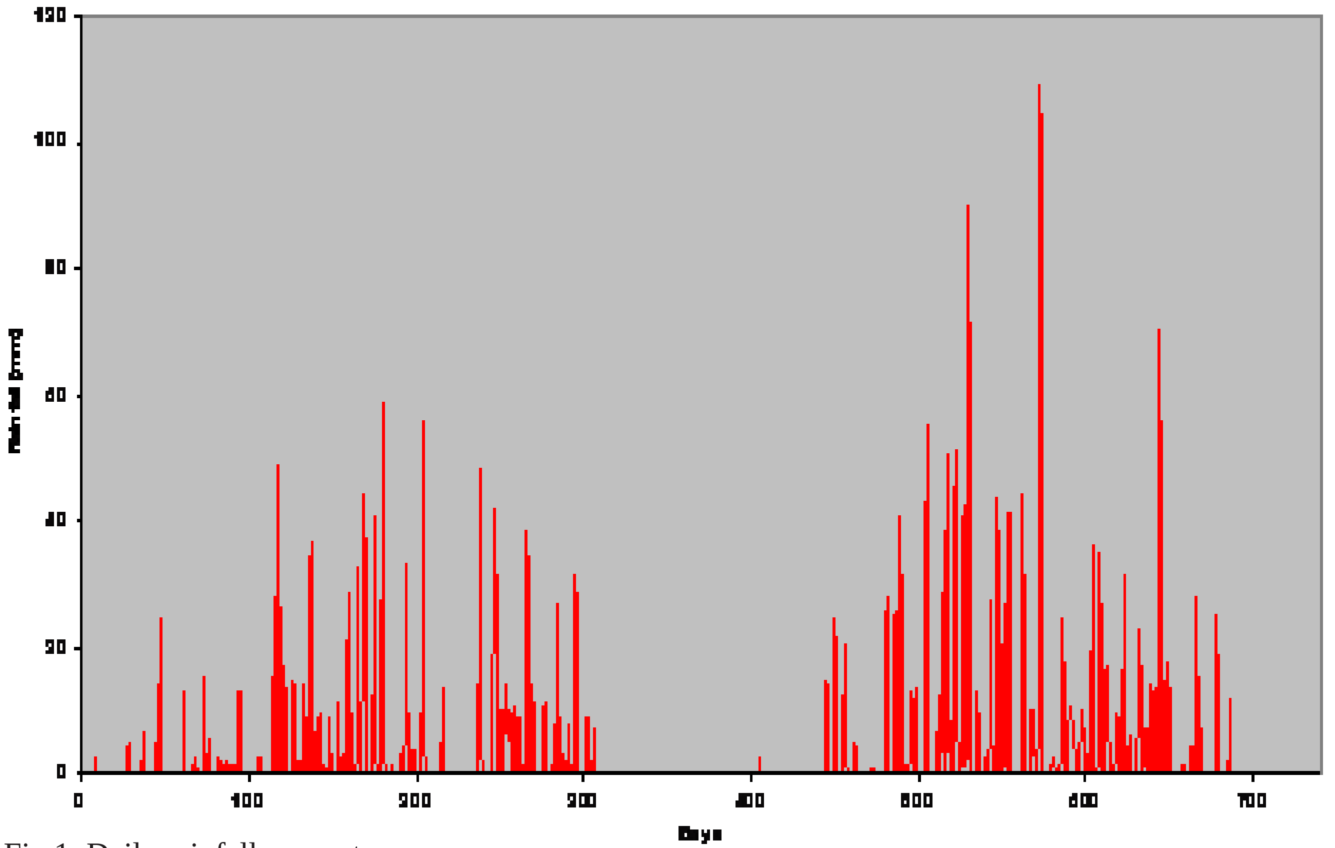

Fig 1: Daily rainfall amount

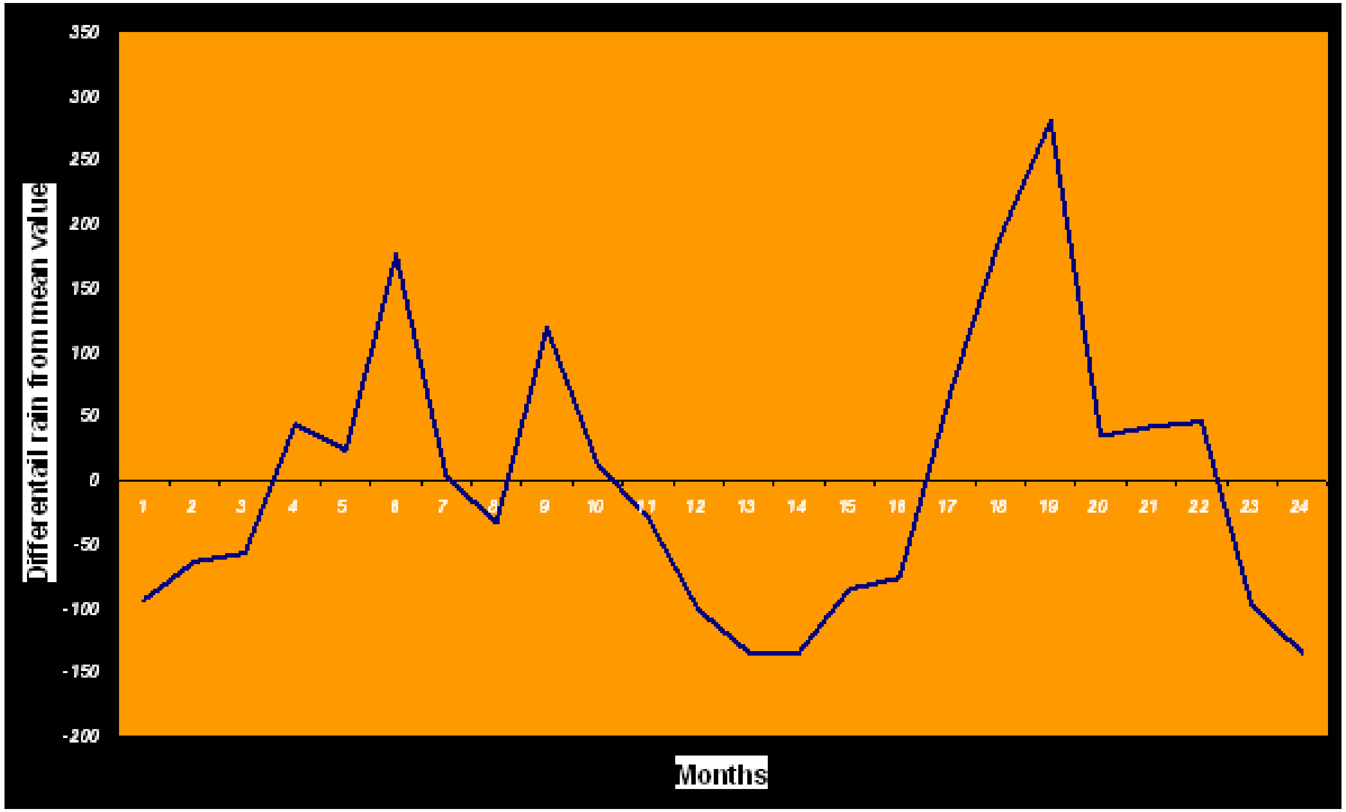

Fig 2: Monthly variation of total amount of rainfall from the mean value

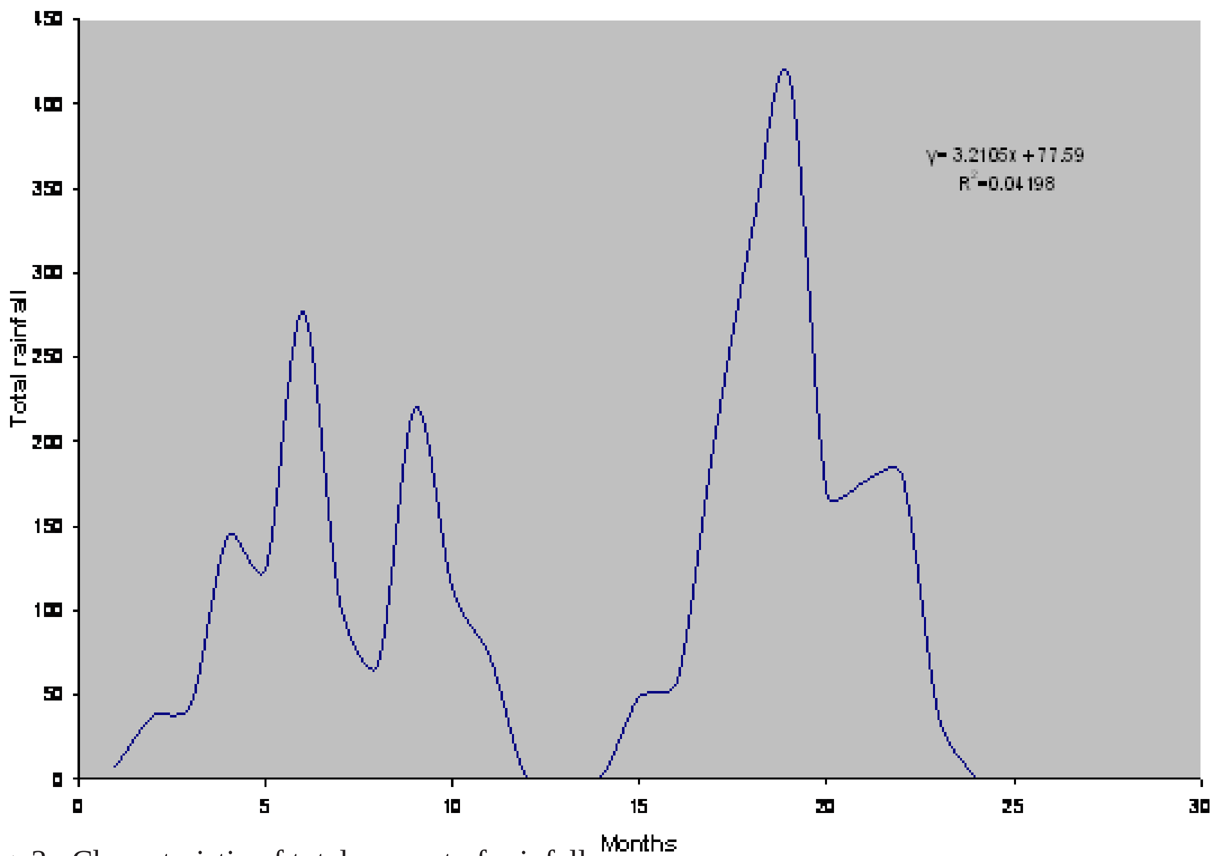

Fig. 3: Characteristic of total amount of rainfall

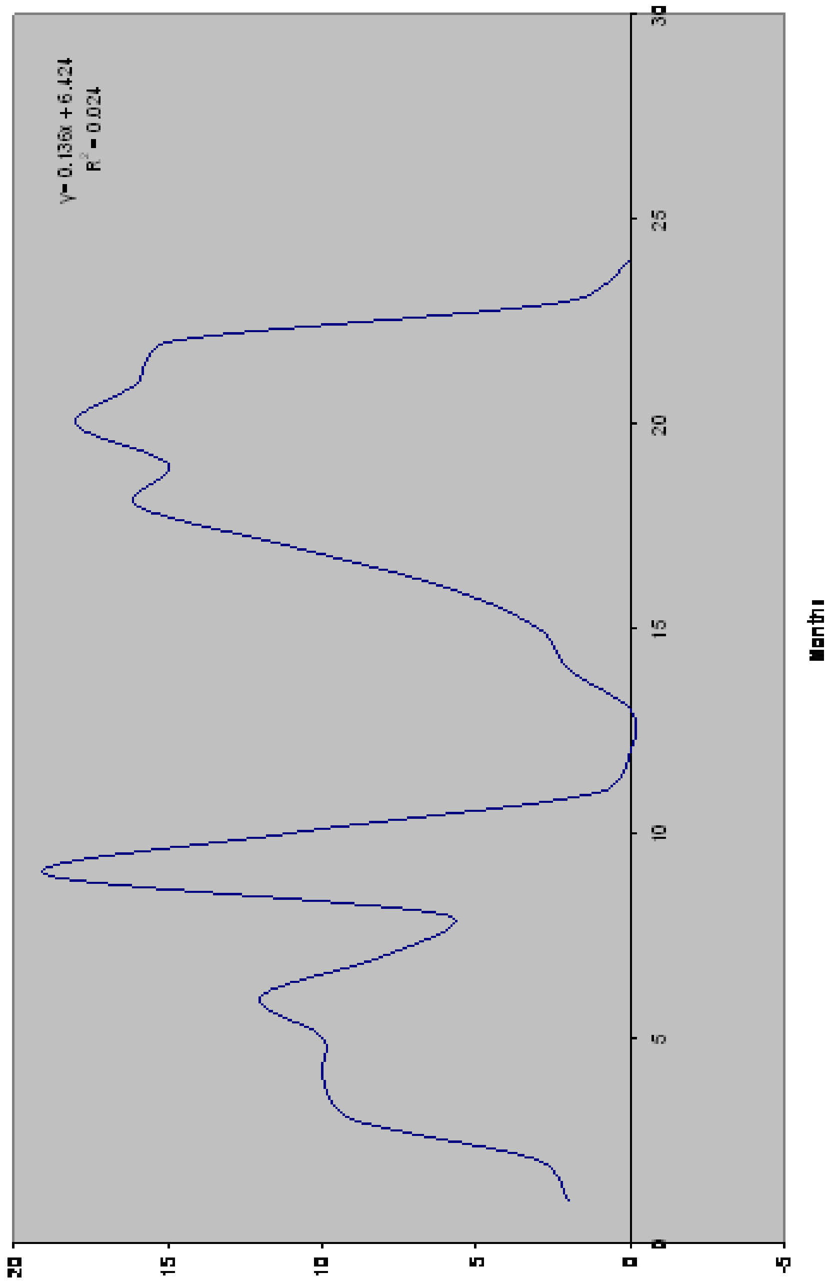

Fig. 4: Characteristic of total number of rainy days

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