SPATIO-TEMPORAL VARIATION IN RAINFALL OVER SOUTH-WESTERN NIGERIA

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ABSTRACT

This study is on the spatio-temporal variation in rainfall over south-western Nigeria. The study adopts the ex-post facto research design. Three grand stations (Oshogbo; Ibadan and Ikeja) of the five in the region were selected for this study. Secondary annual rainfall data for two climatic normal were collected from the archive of NIMET. The Analysis of Variance (ANOVA) was adopted for the purpose of data analysis. Findings include that in the first decade (1955-1965), the rainfall amount for ikeja was 1718.25mm, Ibadan is 1375.36mm and Oshogbo is 1636.28mm. The decade 1965-1975, Ikeja recorded rainfall amount of 1745.47mm; but the amount of rainfall generated for Ibadan was more than that of Oshogbo as they both recorded 1381.61mm and 1345.41mm respectively. Furthermore, Lagos seem to have experienced dryer conditions in the decade 1985-1995 as the amount (1280.139mm) of rainfall generated for that decade was lower than that of Oshogbo (1393.42mm). In terms of anomalies, the individual stations in the study showed that while some periods are anomaly wet others are dry. However, in the display of anomalies in the observed rainfall patterns, the last decades in all the stations are anomaly wet, thereby creating a departure from the trends. However, the ANOVA model is significant at P (0.001) < 0.05. This signifies that there is a statistical significant variation in the rainfall amounts generated among weather stations in the region for the two normal of interest.

Keywords: Spatio-Temporal; Variation; South-West; Rainfall

INTRODUCTION

Rainfall and temperature are important weather fundamentals that give relevant information on the quality of an environment (Afangideh *et al.,* 2010; Ozabor, 2014). A decreasing and/or rising rainfall may be rather useful for different aspects of the human and natural systems. According to Ayoade (2004) and Ozabor (2014), rainfall is an aqueous deposit derived from the atmosphere, which appear in solid, liquid and gaseous state in our environment. On the other hand, Rainfall Regime is a term that comprises many components, including: mean and other statistical measures of annual rainfall total, its temporal distribution, the length of the rainy season, distribution of rain-spells and their yields, distribution of dry-spells, etc. The most expected rainfall regime in a certain location reflects all these parameters (Paz & Kutiel, 2003; Afangideh *et al.,* 2010). Once the most expected rainfall regime (MERR) is defined, it is then possible to analyse how well a season, or any other period in history, varies from the MERR and enumerate extreme values of its numerous

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components, or in other words, quantify the degree of the Rainfall Regime Uncertainty-RRU. Recent studies have indicated that, human activities have caused intense and unparalleled changes in the worldwide chemical and physical environment, including clear statements about increases in atmospheric carbon dioxide (CO_2) concentration and mean annual temperature (Karl & Knight, 1998; New *et al.*, 2001; IPCC, 2007). If greenhouse gas emissions continue to increase at present rates, atmospheric CO_2 concentrations will more than double preindustrial levels during the current century, and general circulation models (GCMs) predict additional increases in mean global temperature of between 1.1 and 6.4 degrees Celsius (IPCC, 2007). Alterations in patterns of global atmospheric circulation and hydrologic processes are predicted to modify mean annual precipitation and to increase the inter- and intra-annual variability of precipitation (Easterling *et al.*, 2000; Schär *et al.*, 2004; Seneviratne *et al.*, 2006; IPCC, 2007). The combined effects of increased atmospheric CO_2, elevated global temperatures, and altered precipitation regimes represent a rapid and unprecedented change to the fundamental drivers of chemical and biological processes within ecosystems (Amundson & Jenny, 1997; Boye & Yakubu 2011).

Furthermore, projections have been consistent for intensified intra-annual precipitation regimes (through larger individual precipitation events) with longer intervening dry periods than at present (Easterling *et al.*, 2000; IPCC 2007). Less frequent but more intense precipitation events may increase the severity of within-season drought, significantly alter evapotranspiration, and generate greater runoff (Fay *et al.*, 2003; MacCracken *et al*, 2003). These intra-annual modifications to the hydrological cycle are distinct from the better known alterations in inter annual precipitation variability associated with large-scale climate dynamics (e.g., the El Niño Southern and Pacific Decadal oscillations), although both intra- and inter annual changes lie along a continuum of altered temporal patterns in hydrology. On the other hand change in rainfall regime, may as well have significant impact on crop yield; human outdoor activities which range from business to recreational activities; supply and discharge of hydroelectric power, which is Nigeria's major source of power; ecosystems change, which in turn give rise to ecosystem species selection, succession or extinction. Thus when the changes in rainfall regime are not properly monitored there may be some far reaching effects (social and economic) on the local dwellers (Ozabor, 2014). The situation is even worse in locations where there are little or no efforts to monitor these rainfall changes, which is the case of Nigeria's southwest.

Generally several attempts have been made by scholars to investigate rainfall regime in Nigeria, Abaje *et al*,(2010) analyzed the trends of rainfall in Kafanchan using rainfall data for 35years (1974-2008). The skewness and kurtosis statistics was used to analyze the rainfall data so generated. However, only rainfall data for the months of April to October were investigated. The study thus lacked relevance to any other sector other than the agricultural sector. In another development, Ayansi and Odeyemi (2009), used GIS approach to investigate seasonal variability of rainfall in Guinea Savanna belt of Nigeria, using rainfall data for 30years. This work could only speak in terms of a single climatic normal, since only data for one climatic normal. Afangide *et al* (2010) made a preliminary investigation into the annual rainfall trend and patterns for selected towns in south Eastern Nigeria; 35years data was used (1971-2006); the regression test was used as a tool for analysis in the study. However, the study was limited, based on the fact that only the eastern region was investigated. Again Ismail and Oke (2012) examined precipitation trends in Birnin-kerbbi using rainfall data of 92years (1915-2007) and the rank correlation statistics was used to analyze the data. The study lacked the ability both to compare and to predict future rainfall events in the area studied. However, recent rainfall disasters in Nigeria, suggests that, studies on rainfall regime are inadequate (Odidi, 2012). From literature reviewed above, it is obvious that some previous works (Abaje *et al*,2010; Ismail and Oke ,2012) have concentrated on investigating rainfall regime by using a climatic normal, while others (Ayansi and Odeyemi , 2009; Afangide *et al* 2010) have failed to adopt predictive statistical tools such as the time series analysis in their investigation. Again, although NIMET makes both monthly and annual prediction of rainfall regimes in the country, the relative poorly publicized and short term notice make such efforts futile; since the people to use the information still fall prey to rainfall hazards. This study therefore seeks to address these problems listed above. Hence the study aims to investigate spatio-temporal variation in rainfall over south-western Nigeria.

MATERIALS AND METHOD

In trying to carry out the study, the climate system concept is adopted. The concept was designed by the intergovernmental panel on climate change (IPCC, 2010). The climate system is distinct as a functional entity consisting of five major aspects: the atmosphere; the hydrosphere; the cryosphere; the land surface and the biosphere; forced or influenced by various external forcing mechanisms; the most important of which is the Sun. Also the direct effect of human activities on the climate system is considered an external forcing (IPCC, 2010). It is this external forcing that creates the need for the inclusion of this concept as a foundation for this study. This is because the assumption is that, any change, whether natural or anthropogenic, in the components of the climate system and their interactions, or in the external forcing, may result in climate variations, rainfall inclusive (IPCC, 2010; Ozabor, 2014). So that the concept synchronises several ideas such as; when there is a change in the steady state of an environment the rainfall regime of that environment will change. Nigeria has witnessed terrain change in general and the western region of Nigeria in particular; and secondly the terrain is not uniform; the various anthropogenic activities over the Nigerian geo-space have altered the natural environmental systems, thus it is expected to cause changes in the rain regimes over the western region of Nigeria.

In terms of methods, the study adopts the ex-post facto research design. Three grand stations (Oshogbo; Ibadan and Ikeja) of the five in the region were selected for this study. Ikeja is selected because it is a coastal community; Oshogbo is selected because it is a boundary community to the eastern part of the region; Ibadan is selected in the region because it boarders the region to the north. Secondly, the stations were selected, due largely to the fact that the stations have consistent and complete data for the period of interest i.e. 1955-2014. After selections of the stations, secondary annual rainfall data for two climatic normal were collected from the archive of NIMET. NIMET is consulted because it is the body that is certified by

Nigeria to regulate climate data. Furthermore, data generated were presented in tables and statistical diagrams. However to test for statistical significant variation in rainfall in the region the Analysis of Variance (ANOVA) was adopted. Similarly, to visualize the rainfall variation within a station the anomaly graphs was used.

PRESENTATION OF RESULT

Decadal Patterns of Rainfall in South-Western Nigeria

Table 1: Decadal Patterns of Rainfall in South-West Nigeria

DECADES	IKEJA	IBADAN	OSHOGBO
1955-1965	1718.25	1375.36	1636.28
1965-1975	1745.47	1381.61	1345.41
1975-1985	1353.87	1309.5	1231.85
1985-1995	1280.139	1208.16	1393.42
1995-2005	1516.7	1226.84	1298.07
2005-2014	1493.108	1331.15	1451.74
Mean	1517.923	1305.437	1392.795

Source: Authors work, 2015

RAINFALL ANOMALIES IN SOUTH-WESTERN NIGERIA

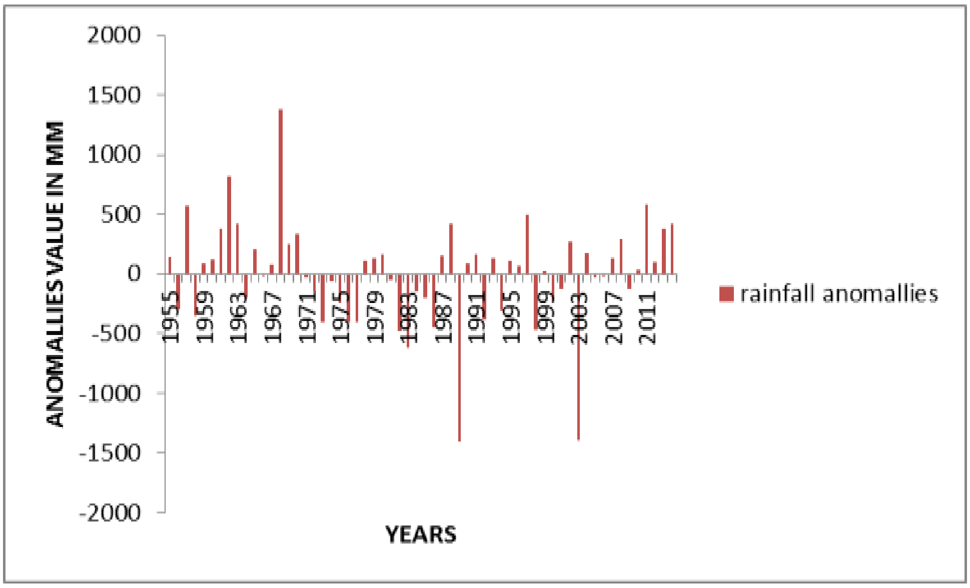

FIG 2: Rainfall Anomally for Ikeja
Source: Authors work, 2015

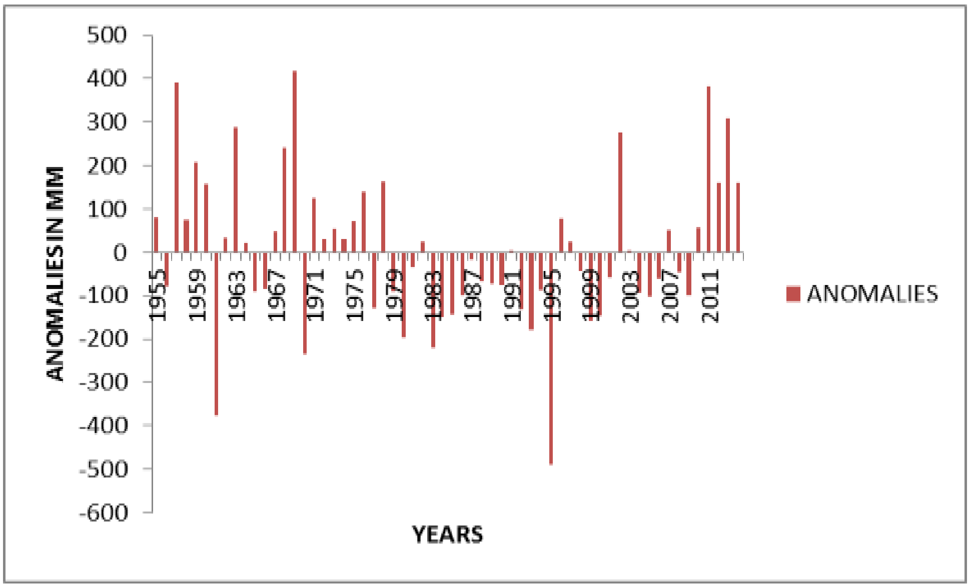

FIG 3: Rainfall Anomaly for Ibadan
Source: Authors work, 2015

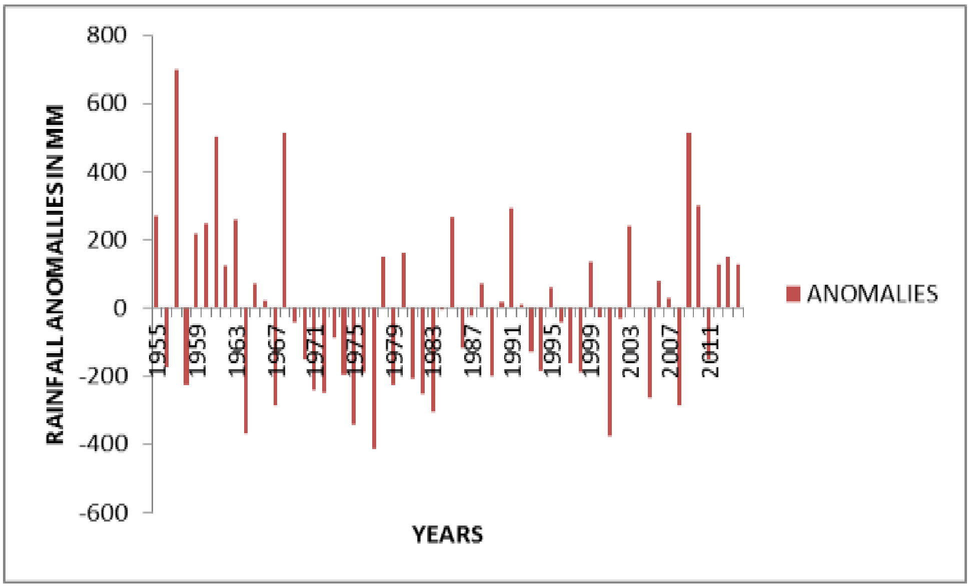

FIG 4. Rainfall Anomaly for Oshogbo
Source: Authors work, 2015

RAIANFALL TRENDS IN SOUTH WESTERN NIGERIA

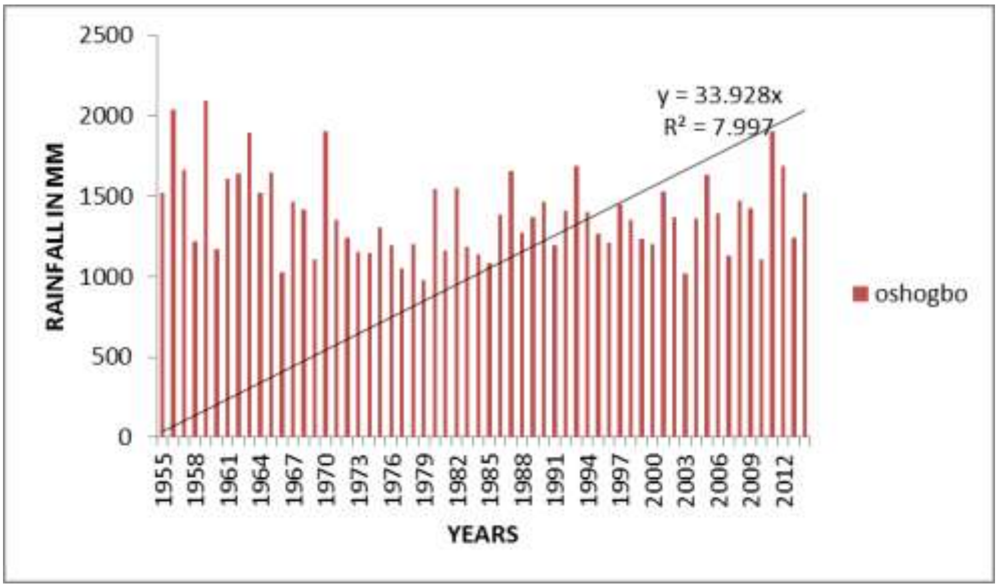

FIG 5: Raianfall Trends in Oshogbo
Source: Authors work, 2015

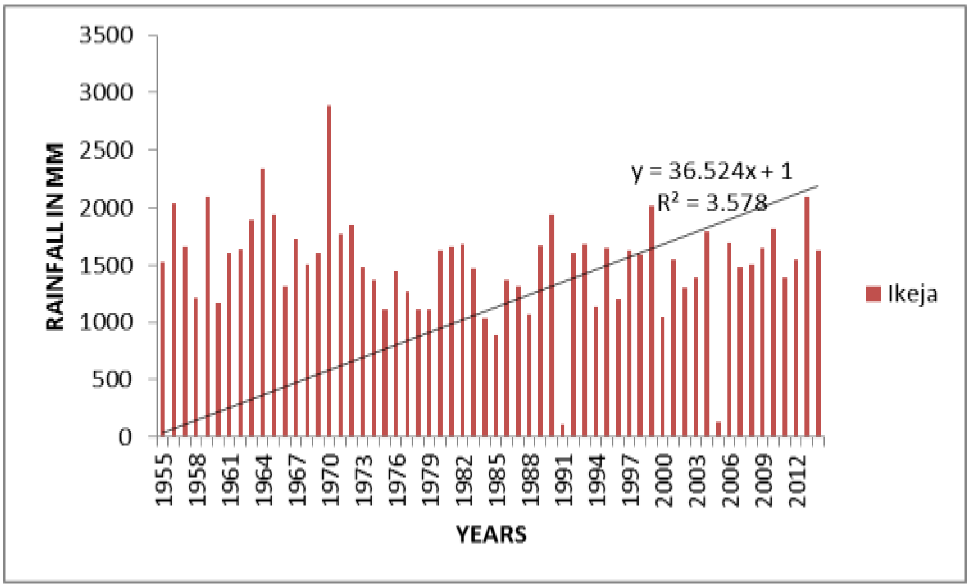

FIG 6: Raianfall Trends in Ikeja
Source: Authors work, 2015

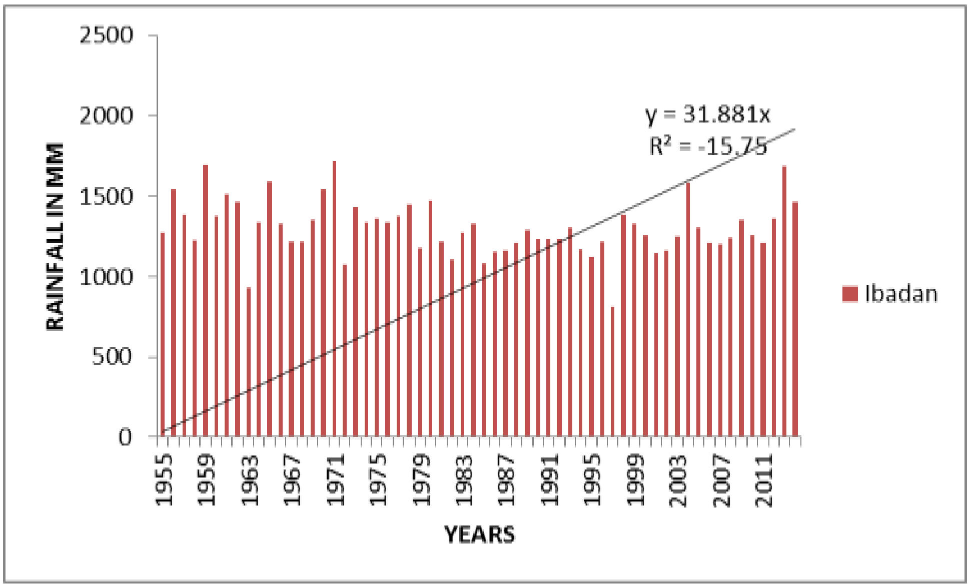

FIG 7. Raianfall Trends in Ibadan
Source: Authors work, 2015

SPATIAL VARIATION IN RAINFALL AMOUNT IN SOUTH-WEST NIGERIA

Table 2: Output of the ANOVA Analysis

ANOVA

RAINFALL

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1368775.732	2	684387.866	7.242	.001
Within Groups	1.673E7	177	94501.078		
Total	1.810E7	179			

Source: Authors work, 2015

Table 3: Post Hoc test for the ANOVA

RAINFALL

Duncan[a]

IDENTIFIERS	N	Subset for alpha = 0.05	
		1	2
Ibadan	60	1305.4367	
Oshogbo	60	1392.7950	
Ikeja	60		1517.9228
Sig.		.121	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 60.000.

Source: Authors work, 2015

DICUSSION OF RESULT

The study shows that in the first decade (1955-1965), the rainfall amount for ikeja was 1718.25mm, Ibadan is 1375.36mm and Oshogbo is 1636.28mm. The decade 1965-1975, Ikeja recorded rainfall amount of 1745.47mm; but the amount of rainfall generated for Ibadan is more than that of Oshogbo as they both recorded 1381.61mm and 1345.41mm respectively. Furthermore, Lagos seem to have experienced dryer conditions in the decade 1985-1995 as the amount (1280.139mm) of rainfall generated for that decade is lower than that of Oshogbo (1393.42mm) (see, table 1). In terms of anomalies, the individual stations in the study showed that while some periods are anomaly wet others are dry. However one thing is worrisome in the display of anomalies in the observed rainfall patterns, and that is that the last decade in all the stations are anomaly wet, thereby creating a departure from the trends(see fig, 2,3and 4). Similarly, the rainfall trends show that rainfall amount in the area is increasing, thus partly explaining the flooding events experienced in pockets of places in the region (see fig, 5,6 and 7). However, the ANOVA model is significant at P (0.001) < 0.05 (see, table 2). This signifies that there is a statistical significant variation in the rainfall amounts generated among weather stations in the region. However, to tell where this variation lie, table 3 is consulted. In the Duncan output we can see that while there is no statistical significant variation between the rainfall amount in Oshogbo and Ibadan; there exist a statistical significant variation between Ikeja and Oshogbo; Ibadan. So the Ikeja station experiences more rainfall than the other weather stations in the region.

Based on the findings of this study, it is recommended that;

- More grand stations which should act as weather information gathering base be established so that more accurate weather information and recommendations on climate change related issues can be made
- Adjustments be made in the Agricultural sectors to help accommodate the changes in the rainfall/climate systems of the region
- Urban friendly climate be established via the introdution of the green city concepts in the major cities in the region. This is premissed on the fact that the area with the highest amount of rainfall in the area is the most urbanised; coastal area notwithstanding

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