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Is the Climate of Sokoto Region North-western Nigeria Experiencing a Wetter /Hotter Condition?

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ABSTRACT

Climate scientists have forecasted that the Sokoto Region will continue to be hotter/drier thus, sticking to the increasing aridity theory; others suggest it will get hotter/wetter. However, extant studies suggest that the hotter/drier climate has changed. So, the idea that the hotter/drier condition will still prevail in the area is no longer tenable. This study assessed whether the climate is still hotter/drier or wetter/hotter in the region. Consequently, this study assessed whether the climate of the area is experiencing hotter/drier or wetter/hotter condition. Annual rainfall and temperature data from 1983-2013 (30 years) were acquired from NIMET's archives were sampled from the two oldest weather stations in the region (Sokoto and Yauri) to carry out the assessment. The data were plotted as graphs into which were fitted: a 5-year moving average and a Linear Forecast trend. Rainfall data were subjected to Standardized Precipitation Index analysis to assess drought situations. The data were further subjected to Bivariate Linear Regression Analysis. The finding indicates that the Sokoto region is getting wetter/hotter on the basis of the tools used for data analyses. Farmers, herders and other stakeholders must be made aware of this changed situation so that the varietal adaptation strategies that they have tailored towards aridity are adjusted to suit the new situation.

Key Words: Hotter/Drier; Wetter/Hotter; Varietal Adaptation; Standardized Precipitation Index; Bivariate Linear Regression; Linear Regression Analysis.

I. INTRODUCTION

The IPCC Fourth Assessment Report (2013) estimated that climate risks to cropping, livestock and fisheries were expected to increase especially in Africa in the first decades of this millennium. The explanation was that most areas lack sufficient data to draw conclusions about trends in annual rainfall over the past century: - so far, the climate has been uncertain as hotter/drier interchanging with hotter/wetter regime. Figure 1 displays one of such risks/uncertainties of climate

A severe drought in Sahel of West Africa is affecting 10 million people in four countries. In Nigèr, the worst-affected country, 7.1 million are hungry, with nearly half considered highly food insecure because of the loss of livestock and crops coupled with a surge in prices. In Chad, 2 million require food aid (Guardian, June 3, 2010)

Figure 1; Livestock Toll from the 1986 Drought in Nigèr Republic
Source:**Http: //xenohistorian.faithweb.com/africa/images/Sahel.JPG**

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Consequently, several climate modellers have advised against simply extrapolating the 20th Century drying trends (those that manifested in late 1960s to early 1990s) into the 21st Century. Accordingly, the Fifth Assessment Report (2014) highlights that 'it is unclear how rainfall in the Sahel, the Guinean Coast and the southern Sahara will evolve' However, several studies (e.g. Tucker and Nicholson 1999; Eklundh and Olsson 2003; Olsson et al, 2005; Reij et al, 2005) provide ample evidence suggesting the arid climate (hotter/drier) of the Sahel has changed and the thinking that droughts are going to always afflict the climate in the area is no longer tenable. NASA has published several satellite imageries that reveal the 'greening' (vegetation regeneration) of the southern limits of the Sahara. Moreover, conducted after NASA's publication have concluded that semi-arid ecosystems at the margins of the desert have quickly recovered from droughts and desiccation with the onset of wetter conditions in the most recent times. There are also several evidences at local and regional levels to support that the trend of rainfall is on the increase in the Sokoto Region and by extension the Sahel. The Integrated Regional Information Networks IRIN has alluded to this assertion.

Hundreds of thousands of people have been rendered homeless; their property destroyed. All the countries hit by heavy rains and flooding- Chad, Niger, Nigeria, Mauritania and Senegal are among the Sahel and West African states where thousands faced severe food shortages. In Niger, rice growing fields along the River Niger are flooded, and more than 7,000 farms have flood flooding has displaced around 525,000 people and killed 81 others in Nigèr (Integrated Regional Information Networks-IRIN 2012)

Similarly, Figure 2 captured by MSF (Medicin Sans Frontière) in the Sokoto Region strongly suggest that the rainfall regime in the region has changed unnoticed and is now on an upward trend in this millennium.

Figure 2; A Flooded Village in Sokoto State (September 2010); **Photo by Chris Houston/MSF.http://www.msf.org.uk/sites/uk/files/7C257E4C-65C5-4CB7-B68B-562A8682A42A.jpg**

Statement of Research Problem

The most recent literatures on climatic variability in the Sahel highlight that climate modellers in general are uncertain as to how Climate Change (Global Warming) will affect the future rainfall and temperature of the Sahel (see IPCC Fifth Assessment Report, 2014: 10-11). Several climate scientists predict that the climate of the Sokoto Region in the Sahel will become hotter and drier thus 'remaining faithful' to desertification discourse (increasing aridity); others suggest it will get hotter and wetter. The research problem of this study hinges on a hypothesis that an increasing rainfall and increasing temperature in the Sahel will have an adverse effect on the adaptation methods that crop farmers and herders have hitherto adopted and have been applying as a result, their vulnerability will increase while their resilience will decrease because they might not have been and are still unaware of

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the shift from aridity to increasing wetter and hotter condition.

Aim and Objective of the Study

The aim of this study was to assess whether the climate of the Sokoto Region North-western Nigeria is experiencing a wetter/hotter condition. In order to achieve this aim the following objectives will be pursued; - To:

i. Collect long term rainfall data and subject it to trend and bi-variate analyses
ii. Collect long term temperature data and subject to trend and bi-variate analyses

Methods of Data Collection and Analysis

The problem of research requires temperature and rainfall data for a longer time span so that their trends can be determined. The Sokoto Region has only two synoptic weather stations (Sultan Abubakar International Airport and Yauri) that fulfill these requirements. These two weather stations formed the sampling frame. Annual rainfall and temperature data from 1983-2013 (30 years) were acquired from NIMET's archives of the two synoptic weather stations in the region (already defined) where long term data is available. The annual rainfall and temperature data for each station were plotted as graphs into which were fitted two types of trend lines: a 5-year moving average and a Linear Forecast trend. In addition, rainfall data were subjected to Standardized Precipitation Index (SPI) analysis to assess and monitor droughty situations. To ascertain the statistical significance of this deduction, the total annual rainfall and the temperature data were further subjected to Bivariate Linear Regression Analysis. The rainfall and temperature data were inputted as the dependent variables and time as the independent variable in the separate regression analyses run. Figure 4 demonstrate the results of data analyses. Both the rainfall and temperature graphs demonstrated increasing trends.

II. RESULT

Figures 3a and 3b demonstrate the 5-year moving average and the linear forecasting trend of the total annual rainfall for Sokoto and Yauri show an upward trend for 1983, 2013 period. In more details, Bivariate Regression Analysis the rainfall data for Yauri shows a positive and strong correlation (ANOVA) between (the observed and predicted values) rainfall and time on the basis of the following statistics: R = .491; F = 4.438; p = .021 at 2 d. f; Beta = .489; t = 2.951; p = .006. This suggests that the increasing trend in rainfall in Yauri is significant at 94% Confidence Level. Similarly; there is a positive but moderate correlation (ANOVA) between rainfall and time in Sokoto: R = .311; F = 3.110; p = .088 at 1 d. f.; Beta = .311; t = 1.764; p = .08. Conclusively, the upward trend in the rainfall in Sokoto is also significant at 92% Confidence Level. Thirdly, the linear forecasting trend of the SPI graphs (4a and 4b) corroborate the inferences drawn from the correlation between rainfall and time for the stations sampled. Notably, while the SPI was around -2 (negative 2) indicating extremely dry conditions in the early 1980s; it rose to +1(positive 1) moderately wet condition in 2000 in Yauri and later (2002) in Sokoto; by 2005 the SPI had risen to +2 (positive 2) very wet and has been technically wet ever since. Bivariate Linear Regression Analysis of the SPI data of Sokoto Station (which lies in a drier location) to determine the level of significance between SPI and time revealed the following: R = .472, F = 7.177; p = .013; at 1 d.f.; Beta = .472; t = 2.679; p = .013). It is inferable that the relationship between SPI and time is statistically significant at 99% confidence level. The objective of this study was to assess whether the climate of the Sokoto Region North-western Nigeria is experiencing a wetter/hotter condition. Going by the statistics demonstrated above, the climate of the Sokoto Region is getting wetter/hotter.

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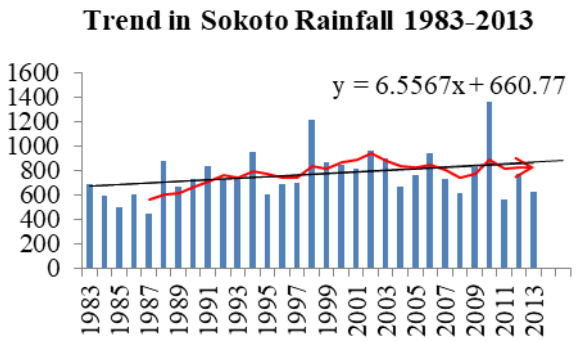

Figure 3a: Trend Analysis of Rainfall Sokoto

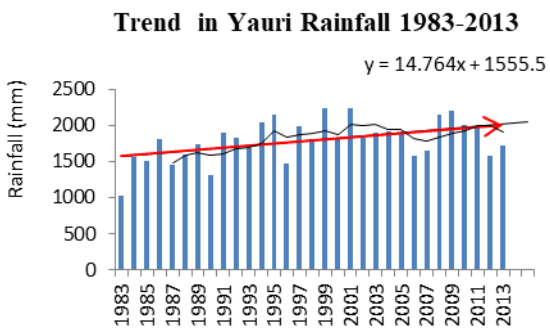

Figure 3b; Trend Analysis of Rainfall Yauri

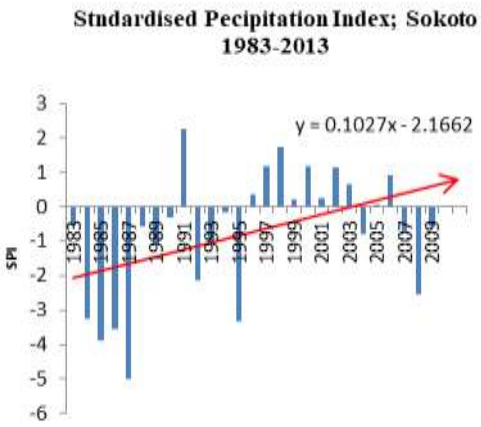

Figure 4a; SPI analysis, Sokoto

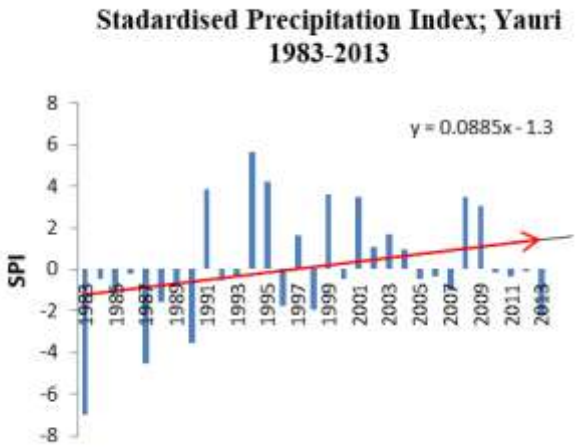

Figure 4b; SPI analysis, Yauri;

Figures 5a and 5b demonstrate the 5-year moving average and the linear forecasting trend of the annual temperature for Sokoto and Yauri show an upward trend for 1983-2013 epochs. In more details, Bivariate Regression Analysis the temperature data for Yauri shows a positive and strong correlation (ANOVA) between (the observed and predicted values) rainfall and time on the basis of the following statistics: R = .336; F = 4.329; p = .045 at 1 d. f; Beta = .336; t = 2.081; p = .045. This suggests that the increasing trend in temperature in Yauri is significant at 95% Confidence Level. Similarly; there is a positive but moderate correlation (ANOVA) between rainfall and time in Sokoto: R = .350; F = 4.745; p = .036 at 1 d. f.; Beta = 0.350; t = 2.178; p = .036. Conclusively, the upward trend in the temperature in Sokoto is also significant at 96% Confidence Level.

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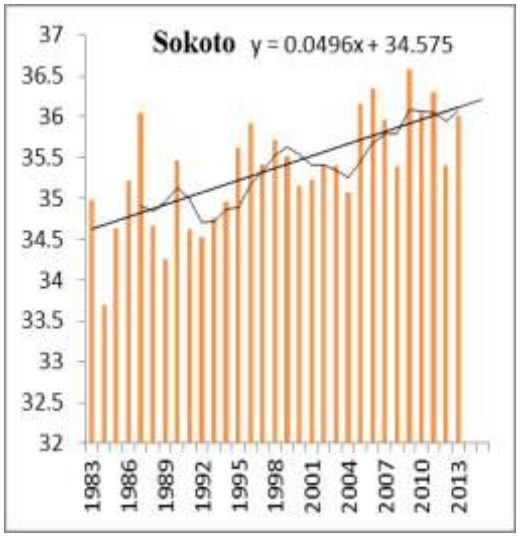
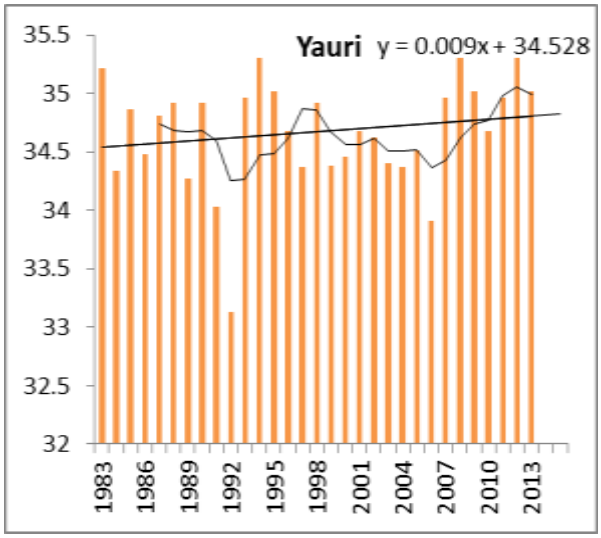


Figures 5a; Linear Trend of Temperature, Sokoto



Figures 5b; Linear Trend of Annual Temperature, Yauri;

III. DISCUSSION

There is statistical evidence in this study to demonstrate that the Sokoto region is getting wetter/ hotter. This finding corroborates with what Trenberth et al, (2003) and other non-adherents of the desertification discourse have already argued that global warming would increase environmental temperature and potential evapo-transpiration and therefore increase moisture availability in the atmosphere in the Sahel and as a result, increase the trend of rainfall and temperature. This indicates that varietal adaptation defined by the IPCC (Fifth Assessment Report; IPCC, 2014:1). as the ' process of adjustment to actual or expected climate and its effects and to moderate the harm of current and future climate risks or take advantage of new opportunities' from the foregoing discussion it is therefore expected that, the present adaptation methods by farmers, herders and other land users should move from hotter/drier to hotter/wetter adaptation measures.

IV. CONCLUSION

The study has literary evidence to prove that the observed rainfall trend towards aridity in the Sahel reversed during the mid-1990s. Generally the rainfall is increasing and is becoming wetter; however the distribution may be poor over the month also, the temperature in the Sokoto Region. Hence, farmers and herders and other stakeholders must be made aware that the existing varietal adaptation strategies that they have tailored towards aridity are no longer effective. Similarly, urban dwellers should expect more heat and discomfort associate with increasing temperatures. Moreover, fire outbreaks might become frequent in urban settings; flash flooding should be expected to upsurge just as increase in hot weather-related diseases e.g. malaria, typhoid fever, cholera, CSM etc.

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