DOI: 10.20472/IAC.2015.015.005

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ASSESSMENT OF CLIMATE CHANGE IN THE SAVANNAH SUGAR PROJECT AREA, ADAMAWA STATE, NIGERIA

Abstract:

The Savannah Sugar Company was established in 1984 to boost local production of sugar in the country. To ensure all year production, the Kiri dam was built on the Gongola River to supply irrigation water to the sugar estate. This study assessed the pattern of climate change in the Savannah Sugar project area over the last thirty six years. The climatic variables examined were rainfall, minimum and maximum temperature. Monthly climatic data were collected from the company's meteorological station at Gyawana. The temporal scales used are before and after the sugar project, and 1975 – 2010 (36years). The data were subjected to descriptive analysis, trend analysis and t-test. The results of the t- test indicated that there are significant differences in the means of all the climatic elements except rainfall before and after the commencement of the sugar project. Trend analysis showed that all climatic variables except rainfall exhibited upward movement. Rainfall was declining by about 5mm/year while temperature (maximum and minimum) were increasing by about 0.08 – 0.090C per decade. This implies that the project area is becoming warmer and drier partly due to the land use and other activities relating to the sugar manufacturing company. Sustainable tree planting is recommended to mitigate the adverse effect of the rising temperature.

Keywords:

assessment, temperature, rainfall, climate change, trend analysis, Savannah Sugar company, Kiri dam, Nigeria

 ISBN 978-80-87927-08-3, IISES

INTRODUCTION

In Nigeria, the river basin development initiative had led to a number of water capture and agro-industrial projects in the late 1970s. Among these was the Kiri dam on the river Gongola in Adamawa State, Nigeria. The dam was purposely built to irrigate sugarcane fields of the Savannah Sugar Company at Gyawana, Dams and irrigation sites are well known for their environmental impacts such as population displacement, loss of biodiversity, deforestation, loss of downstream water pools and fishing grounds, increased evaporation and multiplication of water borne pests and diseases. Others include changes in crops grown, reduced farm sizes and output as previously reported for the study area by Adebayo and Timothy (2000), Shelleng (2007) and Shallangwa (2009). Most of these studies were mainly socioeconomic oriented project impact studies that used local knowledge, accumulated experiences and opinions of the communities in the study area. The second approach is the one in which the physical or environmental data were obtained by means of remote sensing, meteorological instrumentations or other environmental monitoring equipment. Multi temporal satellite imagery data for land cover change detection have been used for parts of the study area (Tukur and Mubi, (2002), Tukur, Musa and Mubi (2006), and Erasmus, (2008).They reported land cover changes such as between vegetation, water body and built up areas, and between bare surfaces and marshes or simply changes in channel morphology.

A notable research gap left by these studies is the climate change perspective from meteorological data. In Nigeria, several studies have been carried out on climate change e.g. Ayoade (1983, Bello (1998) and Adebayo (2010). However, not much has been documented on climate change in the study area. Hence, the purpose of this study is to assess the pattern of climate change in the Savannah Sugar project area over the last thirty six years. The climatic variables examined were rainfall, minimum and maximum temperature.

The Study Area

The study area (Figure 1) is located between latitude $9^0$30'N to $10^0$0'N, and longitude $11^0$45'E and $12^0$05'E and it comprises of the Savannah sugar farms and factory, the Kiri dam and southern parts of the Lunguda plateau. It is bounded in the north by Guyuk town, in the east by Shelleng town, in the west by Lamurde town, and in the south by the northern bank of the river Benue. Administratively, the study area cuts across five local government areas of Adamawa State namely Demsa, Guyuk, Shelleng, Lamurde and Numan. It covers a total land surface area of about 20km^2 distributed in the following proportions: Lamurde (32.5%), Numan (30.5%), Guyuk (16%), Demsa (8.5%) and Shelleng (3.5%).

The history of the Kiri dam in Shelleng Local Government Area and Savannah Sugar projects in Numan Local Government Area can be traced to Nigeria's import substitution policy of the 1960s to 1970s leading tthe North Eastern State Government to commission a study on the area near Numan. Following this, the Upper Benue River Basin Development Authority (UBRBDA) was mandated to build a dam on the lower

Gongola River to supply water by gravitational irrigation to the 29,000ha sugar project of Gyawanna. The dam was commissioned in 1980. The dam has a length of 1,250meters, a height of 20meter, and a surface are of 1.34km^2. The dam came to be known as the Kiri dam because of the settlement at the point of embankment of the river in a natural gorge. The dam and the sugar estate are connected by a 30km main canal carrying irrigation water to the sugar cane farms.

METHODOLOGY

Monthly data on climatic elements namely rainfall, maximum and minimum temperature, for 36years, from 1975 to 2010 were collected from the archive of the Sugar company. The climate data were subjected to various statistical analysis. These include descriptive analysis, t-test and trend analysis.

RESULTS AND DISCUSSION

Before and After Rainfall and Temperature Analysis

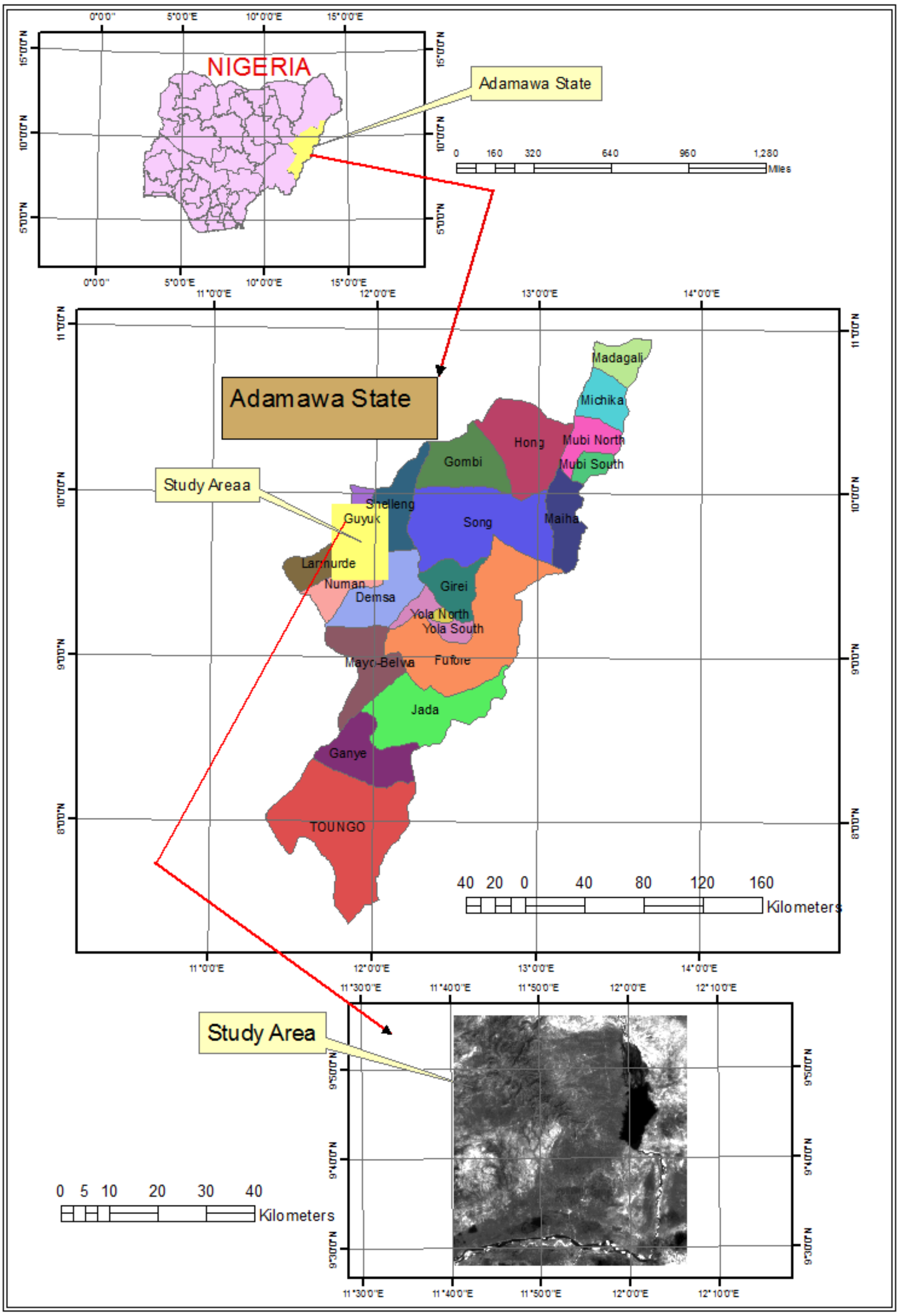
Table 1 displays the relative wetness of the before period of 1975 – 1984 which is having the highest mean of the three periods. The after period (1985 – 2010) was relatively drier with a mean of 788mm. Relative wetness as measured by number of years with above long term mean rainfall shown in the table also confirms the relative dryness of the latter period. Whereas 70% of the years before the project have mean values above the long term mean, only 27% of the years after are above the long term mean. On the other hand, 73% of the years after are below the long term mean as against 30% of the years before.

Table 1: Annual Rainfall Means (mm) for Before and After Periods

Period	Mean	Years Above 36 years mean	Years Below 36 years mean
1975- 2010 (36years)	833		
1975 – 1984 (before)	876	7 (70)	3 (30)
1985 – 2010 (16 after)	788	7 (27)	9 (73)

Values in parenthesis are percentages
Source: Authors computation

Figure 1: Location Map of the Study Area



Source: Authors' analysis

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Corresponding to the wetness/dryness analysis of rainfall is the warming/cooling analysis for temperature. Table 2 indicates changes in the means of the temperature records of the study area.

The table also shows the relative coolness of the "before" period 1975 – 1984 when assessed against both the 36 years mean and "after" period of 1985 – 2010 averages and clearly pointing towards a warming trend. This finding is further buttressed by the table which shows that the 1975 – 1984 period had 90% of the time being below the 36year means for both the maximum and the minimum scales, which points to relative coolness. On the other hand, changes in the more recent period (1985 – 2010) point to a warming trend.

It is apparent therefore that the rainfall and temperature records of the study area have patterns that conform to known global changes of the warming trend, and relatively dryness trend. These findings agree with those reported by Adebayo *et al* (2012), Umar (2011), and Odjugo (2009) for Nigeria.

Table 2: Maximum and Minimum Temperature Means

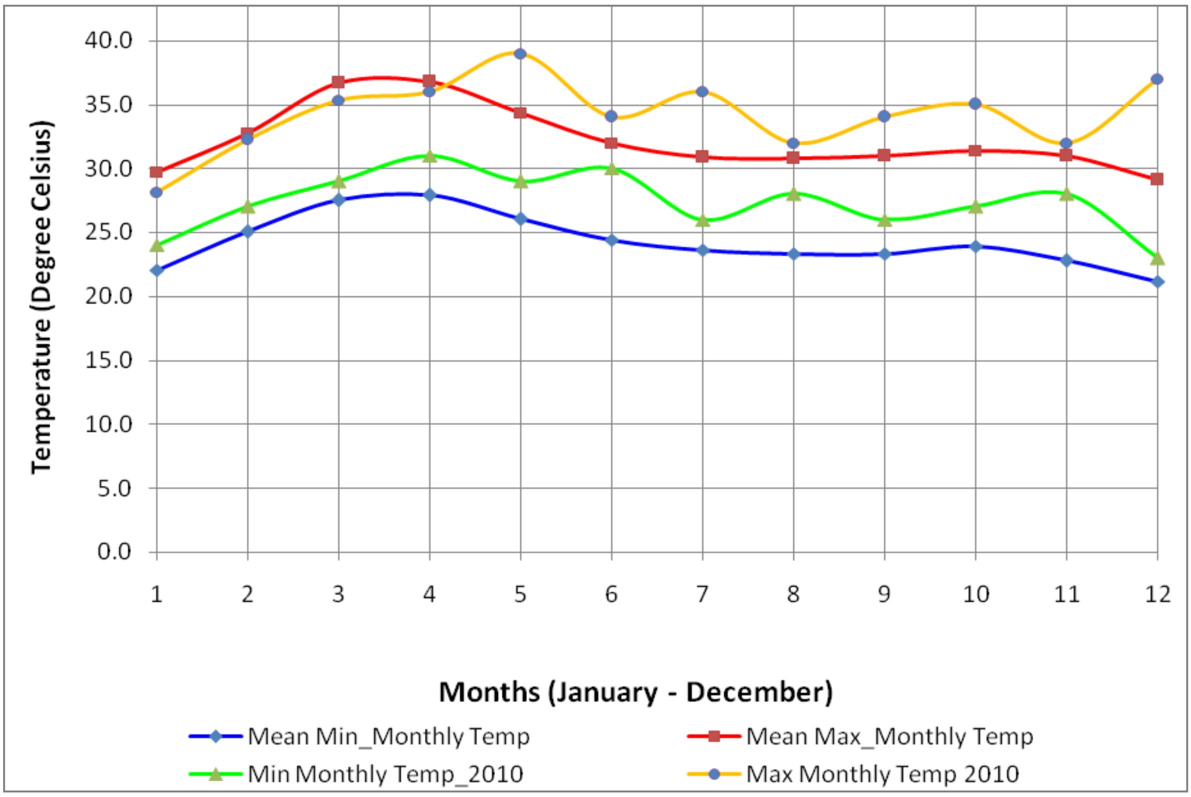
	Maximum Temperature			Minimum Temperature		
Period	**Mean**	**Years Above 36 years mean**	**Years Below 36 years mean**	Mean	**Years Above 36 years mean**	**Years Below 36 years mean**
1975 – 2010 (36 years)	32.2			24.2		
1975 – 1984 (before)	31.0	1 (10)	9 (90)	23.3	1 (10)	9 (90)
1985 – 2010 (after)	32.9	22 (85)	4 (15)	24.9	18 (69)	8 (31)

Source: Authors' computation

2010 Temperatures and the 36 years mean

Figure 2 shows the graphical relationship between the 2010 mean monthly minimum and maximum temperature and their 36 years mean, 1975 – 2010, averages. The graph shows that on the minimum scale the 2010 minimum is consistently above the 36 years mean average, while on the maximum scale the 2010 mean is above the 36 years mean average from about April to December. This result suggests that the warming trend is more on the diurnal (maximum) than the nocturnal (minimum) scale.

Figure 2: 2010 Temperatures and the 36 years Mean



Source: Authors' analysis

Temporal Analysis of Climatic Elements

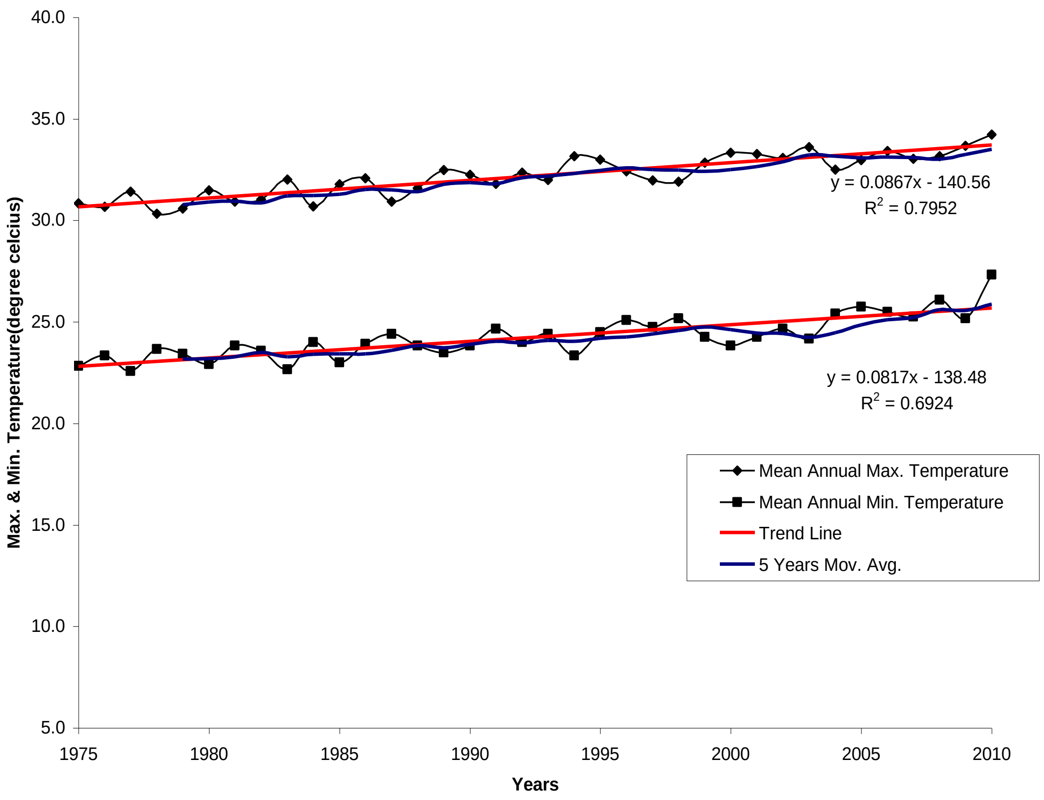
Figures 3 and 4 display the graphical trends for temperature and rainfall. The graphs consist of five measures of trends – the mean annual, the five year moving average, the trend line, the trend equation, and the coefficient of determination (R^2). From the graphs minimum and maximum temperatures indicate an upward trend while rainfall shows a downward trend. The upward trend for temperature means a warming trend, while the downward trend for rainfall implies a drying trend.

Table 3 presents an extract of the trend statistics shown by the graphs, namely, the slope, and R^2. Mean annual rainfall tends to decline by about 4.6mm annually and that only about 27% of these changes is associated with the independent variable (time). On the other hand, mean maximum temperature tends to rise by about 0.09^{0}C and about 80% explained by the independent variable (time).

The trend in rainfall decline of about 5mm/yr agrees with the results reported by Olaniran (2002) of a decline in the Yola – Enugu axis of 50 – 75mm in the 1971 – 2000

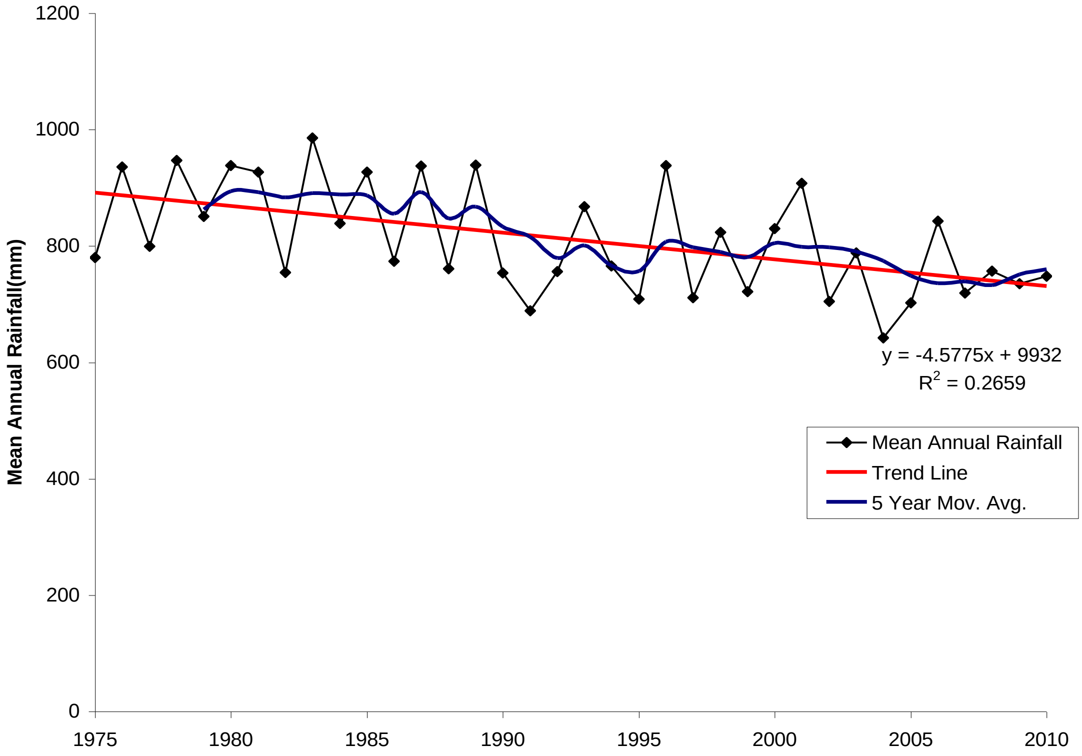
Nigerian rainfall data. In general terms, it also agrees with the findings reported by Bello (1998) of a shorter Sahel rainy season for 1962 – 91 data. On the temperature changes, our finding of a rise of about 0.841^{0}C/decade agrees with 0.867^{0}C/decade for Yola, Nigeria reported by Adebayo 2010.

Figure 3: Trends of Minimum and Maximum Temperature



Source: Authors' analysis

Figure 4: Trends of Mean Annual Rainfall



Source: Authors' analysis

Table 3: Trend Statistics for the Climatic Elements

Element	Slope	R^2	Significance
Rainfall	-4.5775	0.2659	.035*
Temp Max	0.0867	0.7952	.000**
Temp Min	0.0817	0.6924	.000**

*** Significant at 0.01 level (2 tailed),* Significant at 0.05 level*
Source: Authors' analysis

Before and After t-test Analysis

To support the trend analysis, the paired t-test was applied to the before and after periods of the study. The result of the t test in table shows that there was no significance difference in annual rainfall before and after the project. However, temperature values showed a significant difference between the two periods.

Table 4: Paired t-test for the Climatic Elements

Climatic Elements	T value	Significance
Rainfall After and Rainfall Before	-1.579	$.143^{NS}$
Temperature After and Temperature Before	6.441	.000**

*** Significant at 0.01 level (2 tailed), NS: Not Significant*
Source: Authors' analysis

CONLCUSION

Rainfall has been declining by about 5mm/year which means in the next 10 years the total annual rainfall will decrease by 50mm. Temperature is warming by 0.08^0C in a decade, so in the next ten years the mean will increase by about 1^0C. Both rainfall and temperature had been more variable in the last two decades than before. Trends analysis showed an upward trend for minimum and maximum temperature while rainfall was decreasing. Similarly, the t-test analysis of the elements before (1975 – 84) and after (1985 – 2010) showed a significant difference for minimum and maximum temperature but not for rainfall. It could be concluded that the project area is becoming warmer and drier partly due to the land use changes and other activities relating to the sugar manufacturing company. Sustainable tree planting is recommended to mitigate the adverse effect of the rising temperature.

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