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THE INFLUENCE OF CLIMATE VARIABILITY ON HADEJIA-NGURU WETLANDS, YOBE STATE, NIGERIA

Anthony Dami[1+]
Inuwa Kuchali B[2]
H. K. Ayuba[3]

[1]*Department of Geography, University of Maiduguri, Maiduguri, Nigeria*
[2]*Ruby Springfield College, Maiduguri, Borno State, Nigeria*
[3]*Department of Geography, Nasarawa State University, Nigeria*

(+ Corresponding author)

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ABSTRACT

This study assesses the trend and patterns of climate variability on the Hadejia-Nguru Wetland. The major sources of the climatic data were collected from Nguru Meteorological station and Ministry of Agriculture in Nguru, Yobe State. The climatic data include Maximum and Minimum temperature and rainfall for the period of 42 years (1970-2011) was collected. Time series analysis using linear trend model was used to analyze the data. The climatic results revealed changes in the climatic parameters especially in rainfall and maximum and minimum temperatures. It revealed that there was a little per unit increase in the mean annual maximum temperature which increased by 2.40^{0}C when the time is at origin (initial time), and the mean of mean annual maximum temperature was 34.3^{0}C. It also shows the per unit increase in the mean minimum temperature which increased by 4.33^{0}C when the time is at origin (initial time), the mean annual minimum temperature was 19.4^{0}C. Furthermore, it indicated that the per unit increase in years of the mean annual rainfall increased by 1.00mm, when the time is at origin, the mean of mean of annual rainfall was 32.8mm. As a result of decline in rainfall with continued increase in population, there has been more pressure exerted on the wetland resources. The implication of the climatic variation had greatly impacted on the environmental conditions of the region. This study therefore recommends the Management of the Hadejia Jama'are Komadugu Yobe Basin Trust Fund to put in place empowerment strategies for mitigating the current pressure exerted on the wetlands for sustainable livelihood.

Contribution/Originality: This study contributes in the existing literatures and used estimation method for assessment of climate variation. It's one of the very few studies which investigated the influence of climate variability in the area. The primary contribution has revealed climate variation. It documents mitigation strategies for sustainability livelihood.

1. INTRODUCTION

Wetlands are areas that are periodically covered with water. They are very important ecological zone that provides various resources for human use. Wetlands are "land transition between terrestrial and aquatic ecosystems, where the water table is usually at or near the surface of the earth or where land is covered by shallow water" Ravens (1998) and Enger and Smith (2006). Wetlands are highly productive ecosystems, and are able to capture energy and provide food for many animals. They provide important refuge for wildlife in times of drought. In their natural state, are beautiful places and provide opportunities for recreation activities such as boating, swimming, bushwalking and bird watching. Also they provide a natural water balance in the landscape and help to provide protection against floods. Wetland plays a role in providing water quality protection in the catchment by filtering pollutants such as sediments, nutrients, organic and inorganic matter and bacteria. Wide variety of flora and fauna, different habitats and ecosystems are equally supported by wetland which provides nursery areas for fish, and breeding grounds for wildlife, particularly water birds. Wetlands provide vital habitat for some species of threatened fauna. Moreover, they provide refuge for migratory water birds that breed in the northern hemisphere in countries such as China and Siberia. Many wetlands are of cultural significance to aboriginal people and they provide opportunities for scientific research and source of education for communities.

The area receives flood water from rivers Katagum (Jama'are) and Hadejia, which covered and drained into Lake Chad as the Yobe River. Based on the natural annual flooding, the wetlands perform a number of economic and ecological functions, which are of critical local, national and international significance. From economic point of view, the Hadejia-Nguru wetlands support about 1.5 million farmers, herders and fishermen (Enger and Smith, 2006). These people produce large quantities of rice, vegetables etc which are marketed in other parts of the country. Over 250,000 herds of cattle are supported by the wetlands and this supports a cattle trade with annual turnover of N416 million. About 6% of Nigeria inland freshwater fish catch with a market value of N45.4 million is from the wetlands. The flood water is used for drinking and for other domestic purposes. It also serves as a means of communication. Ecologically, the wetlands serve as a natural barrier to the process of desertification and play a major role in the recharge of ground water. The site is also rich in biodiversity and supports variety of wildlife pieces, particularly migrant water birds. The reports of the International Union for Conservation of Natural Resources (IUCN) and HNWCP (1997) and Bates *et al.* (2008) clearly stated the factors that brought about environmental change in the Hadejia-Nguru wetlands are many however this study only focuses on the influence of climatic variability on the environmental resources of the Hadejia-Nguru wetlands.

Climate Change as noted by IPCC (2001) is any change in climate over time whether due to natural variability or as result of human activity. It equally threatens the stability of wetlands by increasing decomposition rates due to higher temperatures and lowering of water tables. Climate Change also reduces carbon store, increased flux of Co_2 and CH_4, and contribute to further amplification of greenhouse gas production. Disruption of intact wetland surfaces increase the generation of coloured water with potential effects on aquatic ecology, the breeding cycles of important fish species and flood control. The impacts of climate change on inland aquatic ecosystems are generally caused by the direct effects of rising temperatures and CO_2 concentrations to indirect effects caused by changes in the regional or global precipitation. The United Nation Development Programme (Diyam, 1987; United Nation Development Programme (UNDP), 2009) views climate change as a scientifically proven phenomenon that includes any change in the climate, whether due to its natural variability or as a result of human activity. It further affirmed that the term climate change is commonly used interchangeably with "Global Warming" and "Green House Effect" but is more of a descriptive term. It refers to the build-up of man-made gasses in the atmosphere that trap the solar radiation causing changes in weather patterns on a global scale. The green house gases of most concern are carbon dioxide, methane, and nitrous oxides. IPCC (2001; 2007) noted that, although climate is a natural phenomenon that has always been dynamic and varies at a global scale of time and space current concern for this changes in climate aroused because of the unprecedented human industrial and development activities of the past two centuries that have caused changes over and above natural variation while, the climate variability could simply be viewed as the seasonal and annual variations in temperature and rainfall patterns and their distribution within and between regions or countries.

The most important greenhouse gases carbon dioxide (CO_2), chlorofluorocarbons (primarily CCL_3F and CCL_2F_2), methane (CH_4), and nitrous oxide (N_2O). Carbon dioxide (CO_2) is the most abundant of the greenhouse gases. It occurs as a natural consequence of respiration. However, much larger quantities are put into the atmosphere as a waste. Electricity for industrial processes, home heating and cooking. Another factor contributing to the increase in the concentration of carbon dioxide in the atmosphere is deforestation. Tress and other vegetation remove carbon dioxide from the air and use it for photosynthesis. Since trees live for a long time, they effectively tie up carbon in their structure. Cutting down trees to convert forested land to other uses releases this carbon, and a reduction in the amount of forest lessens its ability to remove carbon dioxide from the atmosphere. The combination of these factors (fossil-fuel burning and deforestation) has resulted in an increase in the concentration of carbon dioxide in the atmosphere.

2. THE STUDY AREA

The Nguru wetlands is located between latitudes 11^0 71'N to 11^0 69'N and longitudes 11^0 07'E to 11^0 55' E which is part of Hadejia Nguru wetlands (HNW) and lies in the middle of the Komadugu Yobe basin in North Eastern Nigeria. They are watered by the Hadejia and the Jama'are river and their tributaries. The two main rivers join at the eastern edge of the wetlands to form the Yobe River which drains into the Lake Chad. The basin falls within the Guinea/Sudan and Sahel savannas. The wetlands is a seasonally inundated lowland plain of 355,000 hectares within the Chad formation located in the Sahel savanna belt between latitudes 12^0 $15'$ to 13^0 $00'$ and longitudes 10^0 00' to 11^0 00' and thus is surrounded by dry lands. The Nguru wetlands lies on the Chad Formation geological series which are post-Eocene sediments overlying cretaceous sediments which in turn are underlain by the basement complex rocks. The types of vegetation in the Nguru wetlands include trees (*Guiera* scrub savanna or *Acacia albida* parkland on established cultivated sites) or grasslands of *schizachyrium exile* with *Aristida ssp*. Inter-dune depressions contained *Hyphaene* palm bush with *Zizphus* and *Acacia* tree and shrub savanna, or grasslands predominantly of *Sporobolus helvolus*. Spillplains *Acacia /Balaniites* tree savanna or *Ziziphus/Acacia* scrub savanna, with *Vetiverial/*Andropogon alluvial grasslands and *Echinochloa ssp. swamp grasslands*. The annual rainfall of the area is on the average approximately 500mm per annum but varies widely from year to year .The wet season begin late May and usually ends in September. Day-time temperatures range from a maximum of 45^oc during winter season (Schultz, 1976). The wetlands is inhabitated with the population of about 150,632 (National Population Commission, Yobe State), which include the Kanuri, Bade, Hausa and Fulani people (Bawden *et al.*, 1972). The Fulani are principally occupied with cattle rearing; the Kanuri, the Bade and the Hausa are primarily engaged in arable farming while the other minorities depended on part-time fishing activities. During the dry season the area hosts large groups of transhumance Fulani who seek favourable grazing conditions in the rain-fed farming forms the main arable agriculture activity (June-October) with the main staple crops grown being sorghum and millet. A much more profitable farming system is practiced on the areas liable to flooding which are locally called *fadama*. Using the waters of the up-coming floods, Rice is grown from June to December. This practice is known as flood farming. After harvesting the rice, a whole range of other crops (eg.cow pea, groundnut, roselle) are planted which make use of the residual moisture left behind in the soil by the inundation. Irrigation is made possible by the release of water from the large upstream. Before the large reservoirs were constructed the area did not know irrigation farming except for traditional irrigation making use of small permanent water bodies with help of *shadoofs*. The Hadejia-Nguru wetlands are renowned for the fisheries industry it maintains. Fishing is a year-round activity which peaks during the seasons of up-coming and receding floods.

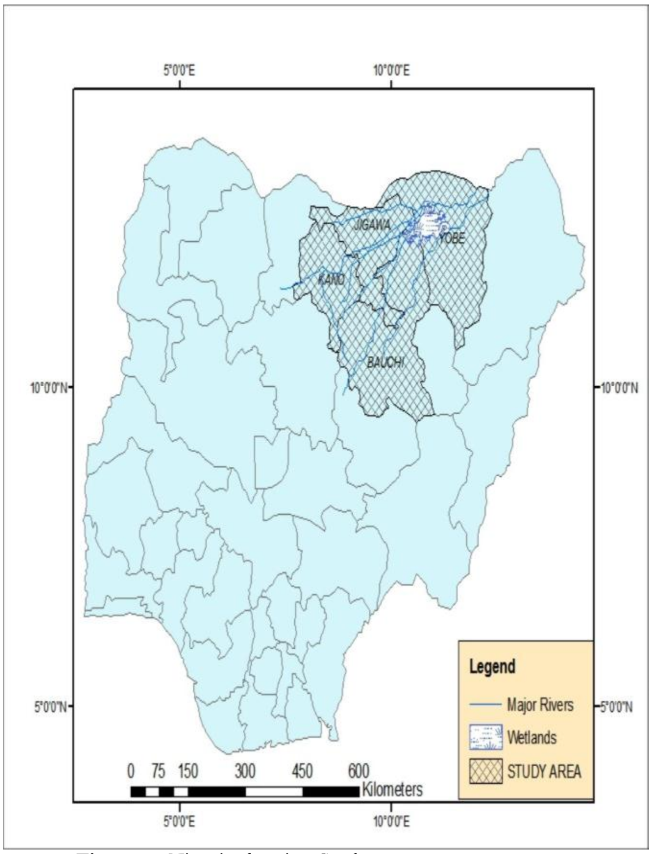

Figure-1. Nigeria showing Study area

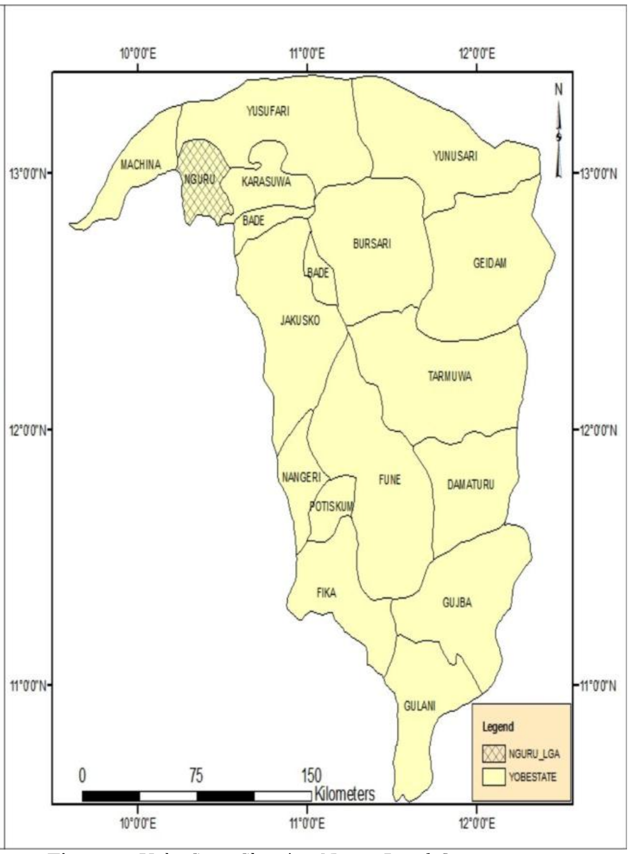

Figure-2. Yobe State Showing Nguru Local Government

Source: Inuwa (2016)

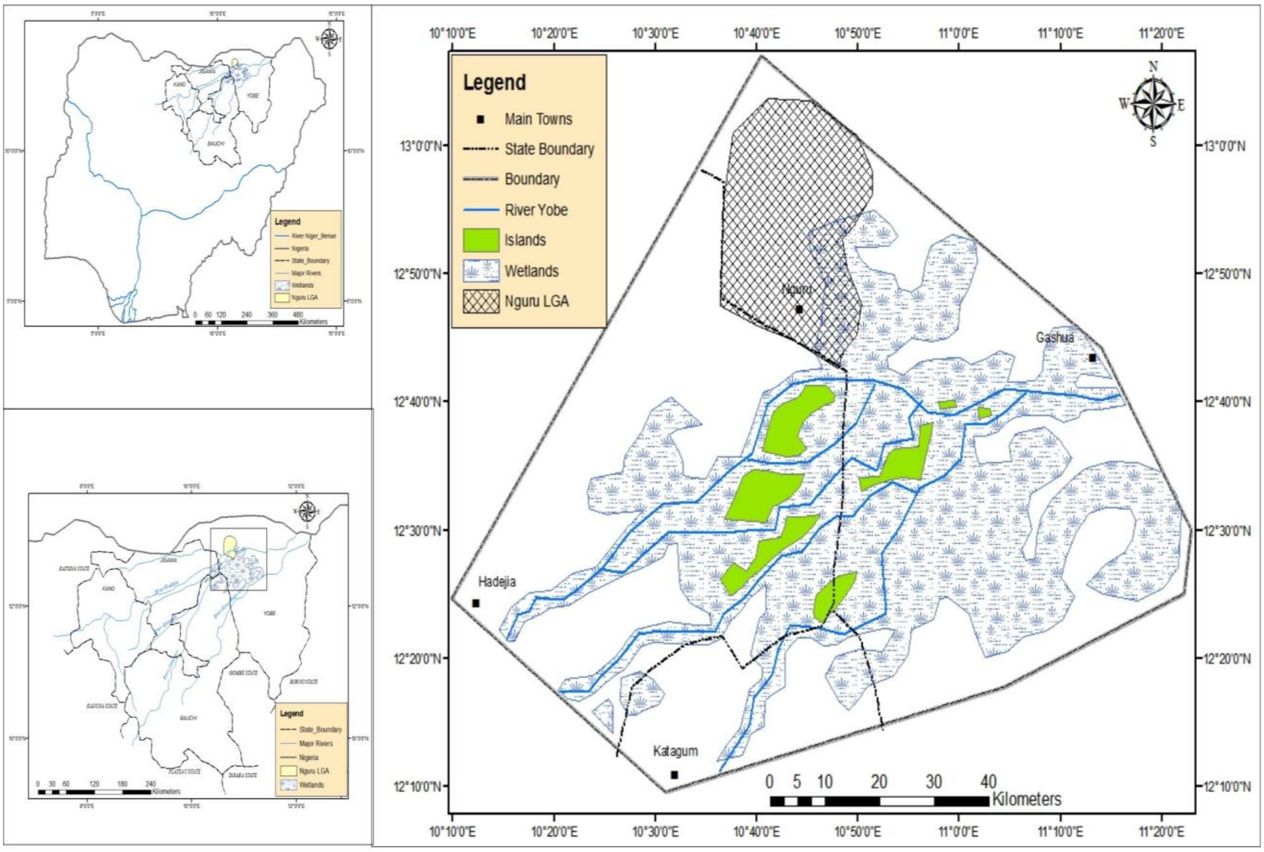

Figure-3. Yobe state Basin showing Hadejia-Nguru Wetlands and study Area.

Source: Inuwa (2016)

3. METHODOLOGY

3.1. Sources and Analysis of the Climatic Data

The major sources of the climatic data were collected from Nguru Meteorological station, Ministry of Agricultural in Nguru, Yobe State. The climatic data include: Maximum and Minimum temperature and rainfall for the period of 42 years (1970-2011) was collected. It was used to address the climatic trends and patterns of the study area. The Microsoft Excel 2007 package was use for the data processing, where the Time series analysis using linear trend model was performed to analyze the data using simple descriptive statistics such as frequencies, percentages and charts to capture the trend and factors responsible for environmental changes in the area.

Generally, the indices used for assessing the environmental change could either be: climate change or climate variability, human pressure (overgrazing, poaching, deforestation, fishing and farming), drainage system (flooding and up-stream damming), and institutional policy. However, for this study the two concepts: climate change or climate variability was used interchangeably for simplification.

4. RESULT AND DISCUSSION

4.1. Climatic Trends and Patterns

The climatic data was analysed to obtain climatic trend of maximum temperature and minimum temperature and rainfall. The result has revealed the climatic trends over a long period of time in the area.

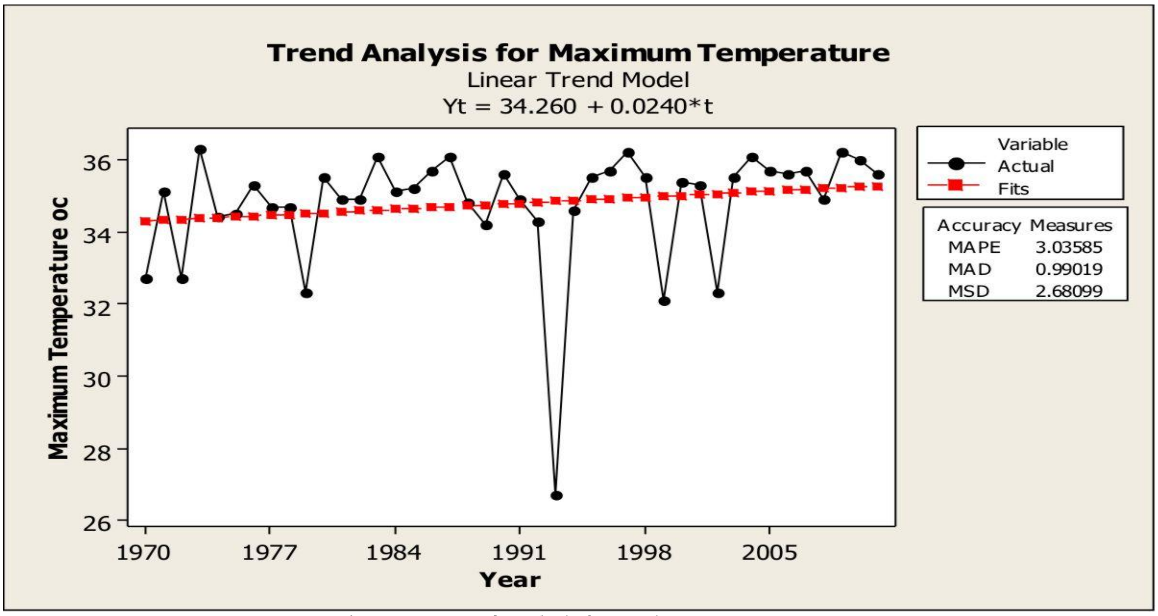

Figure-3.1. Trend Analysis for Maximum Temperature

Source: Inuwa (2016)

From the result obtained a linear trend model was used to determine the change in the climate of the study area. It was observed that the per unit increase in years is the mean annual maximum temperature increases by 2.40^{0}C when the time is at origin, the mean of mean annual maximum temperature is 34.3^{0}C (Figure 3.1). The model adequacy was obtained using the Mean standard deviation (MSD) between the actual and the fitted values. From the model the Mean Standard Deviation is 2.68^{0}C. This also indicates a small difference between the fitted and the Actual Mean Maximum Temperature. Furthermore, this model can be used to forecast or to observe the pattern or behavior of the Annual Maximum Temperature changes. The result also revealed that the year 1993 has the lowest Mean Maximum temperature while 1973 has the highest Mean Maximum Temperature.

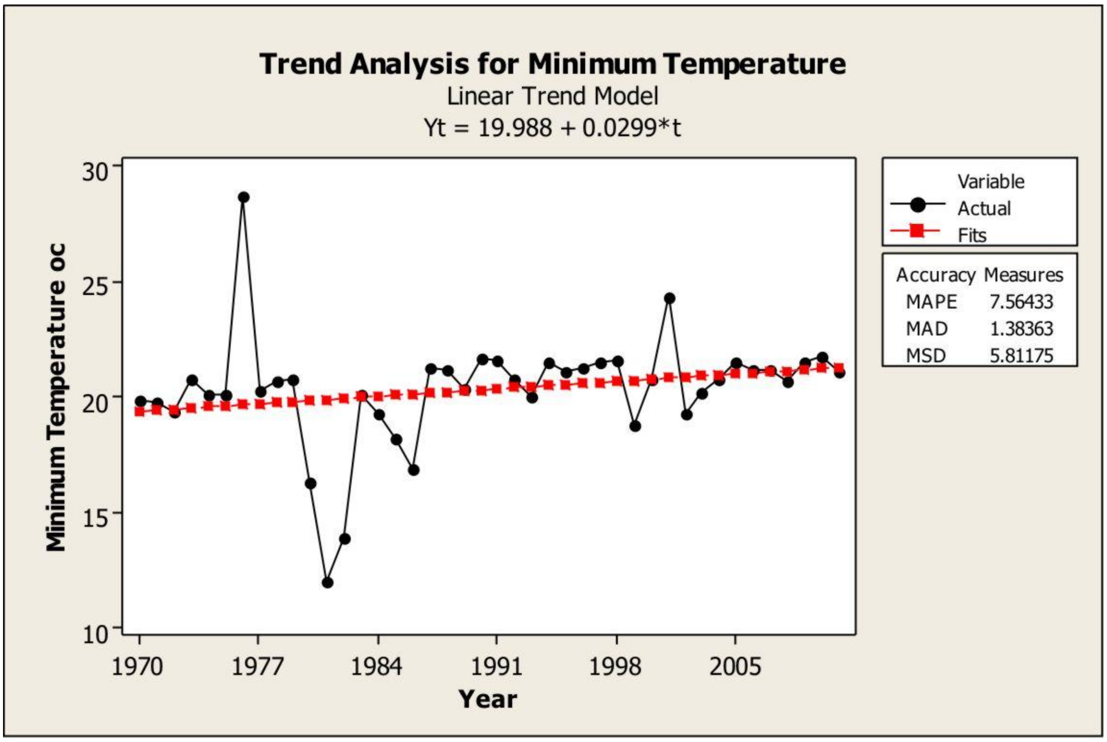

Figure-3.2. Trend Analysis for Minimum Temperature

Source: Inuwa (2016)

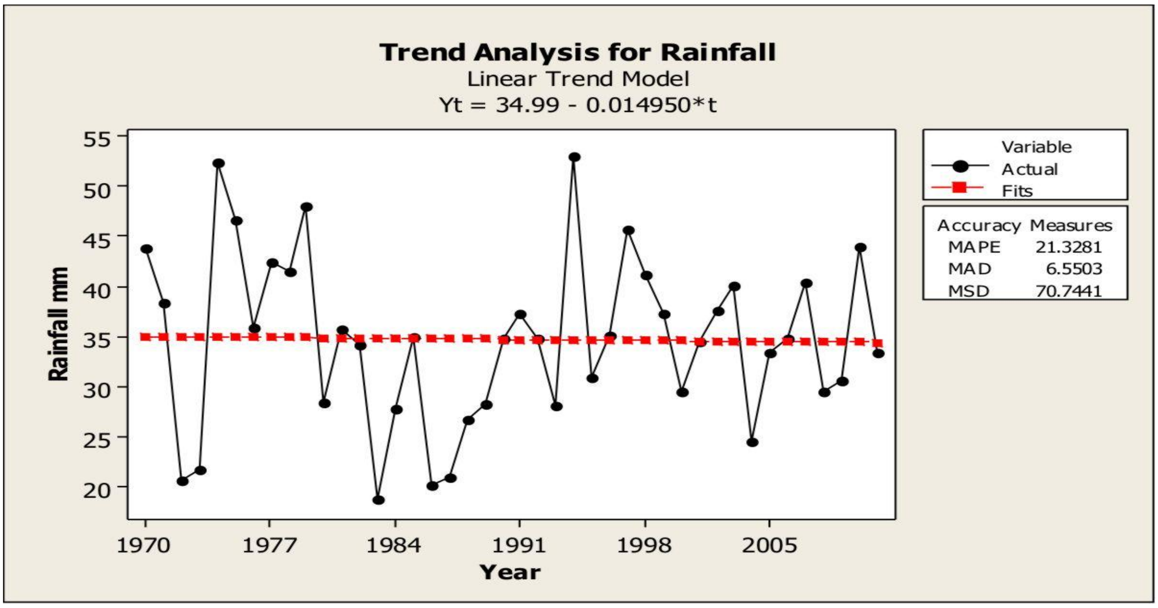

Figure-3.3. Trend Analysis for Rainfall

Source: Inuwa (2016)

The analysis shows a linear trend model, it was formed in order to determine the changes in the climate of the region. From the result it was revealed that the per unit increase in years in the Mean Minimum temperature increases by 4.33^{0}C when the time is at origin (initial time), the mean of mean annual minimum temperature is 19.4^{0}C (Figure 3.2). The model adequacy was obtained using the Mean Standard Deviation (MSD) between the actual and the fitted values. From the model the Mean Standard Deviation is 2.12^{0}C. This is indicating that there is a small difference between the fitted and the actual mean minimum temperature in the study area. Furthermore, this model can be used to predict or observe the pattern or behavior of the Annual Minimum Temperature changes. The result revealed that the year 1982 has the lowest Mean Minimum Temperature of 13.9^{0}C while 2010 has the highest Mean Minimum Temperature of 21.8^{0}C.

From the Figure 3.3 results, a linear trend model was formed to determine the changes in the area. It was also observed that the per unit increase in years of the mean annual rain fall increases by 1.00mm when the time is at origin, the Mean Annual rainfall is 32.8mm. The model adequacy was also obtained using the Mean Standard Deviation (MSD) between the actual and the fitted values. From the model, the mean standard deviation is 73.23mm. This indicates that there is a small difference between the fitted and the Actual Mean Annual rainfall. Furthermore, this model can be used to forecast or observe the pattern or behavior of the mean annual rain fall changes. The results indicated that the year 1983 has the lowest Mean Annual rainfall of 18.7mm while 1994 has the highest Mean Annual rainfall of 53.0mm.

5. SUMMARY AND CONCLUSION

In summary, considering the global climatic change, the area of study falls within the sahelian environment, which is directly associated with high temperatures and less rainfall. Due to the high temperature, there has been a greater increase in the evaporation rate in the area. It was observed that the per unit increase in years of the mean annual rainfall is very low or insignificant to encourage general vegetative growth. However, human activities are more concentrate around water bodies in order to meet up with the increasing demand of the increasing population of the area. The implication of the climatic variation therefore had greatly impacted on the environmental conditions of the region. In conclusion, this study recommended that the Yobe State Government and the Management of the Hadejia Jama'are Komadugu Yobe Basin Trust Fund put in place empowerment strategies for mitigating the pressure currently being exerted on the wetlands resources for sustainable livelihood.

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Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

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