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TREND ANALYSIS OF CLIMATE CHANGE FACTORS AND YIELD OF YAM IN BAYELSA STATE, NIGERIA

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ABSTRACT
The main objective of this study is to conduct trend analysis of change of climatic factors 1971-2009 and yield of yam1999-2009 in Bayelsa state. Multistage sampling procedure was employed in the random s election of local government areas, communities and rural farming households for the study. Annual mean time series data of temperature and rainfall were collected from Nigerian Meteorological Agency (NIMET). Annual mean time series data on yield of yam were collected from Bayelsa State Agricultural Development Programme (ADP). Data were analyzed using trend analysis and growth model for the prediction of change in climatic factors and yield of yam. Finding reveals that the projected future values witnessed an increasing trend in temperature and rainfall, while statistical yield data recorded a decreasing trend in yield of yam in the state. It is recommended that increased awareness be created and disseminated through agricultural extension services and advocacy on the challenges of climate change. Climate change adaption and mitigation measures as they specifically relate to yam production in Bayelsa State should as a matter of priority guide policy makers in the state in particular and Nigeria in general. Emphasis must be renewed for increased yam production in the state to forestall hunger and food insecurity situation.
Keywords: *Climate Change, Trend, Yield of yam, Temperature, Rainfall, Bayelsa State.*
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INTRODUCTION
Bayelsa State has a peculiar feature of having about 97% of its communities being rural. It is an undisputable fact that the communities are highly susceptible to different environmental shocks. Its terrain is difficult for infrastructural development and the state ranks among the lowest in poverty indices such as income per capita (Okoh e*t al* 2011). Apart from being endowed with arable farmlands and rich biodiversity, Bayelsa State is a major Oil and Gas producing area contributing over 30% of Nigeria's Oil and gas production. Due to the presence of oil and gas producing companies, the area is usually prone to environmental shocks like oil spillage that render farmland useless for agricultural production. Bayelsa State is under serious threat with the impact of climate change as observed by Okoh et al (2011). There is frightening effect of climate change on the entire environment which has even reached a global dimension.

Bayelsa State which is one of the states that make up Niger Delta Region is exposed to flooding including in the farmlands. As the flood recedes soil erosion and collapse of

riverbank are regular annual occurrence. Prolonged flooding occurs mostly as a natural phenomenon along the flood plains of the state. The disadvantage is that over 700,000 hectares of land are rendered useless due to annual floods in Bayelsa State and Niger Delta at large (NDDC, 2006).

Climate change was defined by Miller and Edwards (2010) as changes in the earth's atmospheric process and other parts of the earth such as the oceans. Mavi (2004) identified the basic causes as human activities such as deforestation and gas flaring related activities which result to accumulation of the greenhouse gases. Climate change leads to gradual changes in mean temperatures and rainfall that will lead to loss of biodiversity and ecosystem functioning of natural habitats. It will also lead to loss of arable land due to increased aridity and associated salinity, ground water depletion and sea level rise as well as changes in the suitability of land for different types of crops and pasture. It also brings about changes in the incidence and vectors of different types of pests and diseases as well as changes in health and productivity of forests. Other changes are in the distribution, productivity and community composition of marine resources as well as changes in livelihood opportunities which can lead to internal and international migration (FAO 2008).

The European Union report on climate change (2008) showed that global warming followed the pattern predicted by earlier scholars. The report stated that the earth's temperature has undergone an annual increase of 0.6 degrees Celsius in the past 10 years as a result of the accumulation of the green house gases. The EU report on climate change (2008) also showed that there is need to understand the nature of the problem of climate change in different specific regions of the world even though it is a global problem. Although the warming effect has been significant, and real, "its rate and intensity has always varied from year to year, decade to decade, region to region and from zone to zone"(EU, 2008).

The suitability of the environment to provide all life support systems and the materials for fulfilling all developmental aspirations of man and animal is dependent on the stability of the climate which is undergoing constant changes (Obioha, 2009). The effect of these changes is posing threat to food security in Nigeria as a whole and Bayelsa State in particular due to the coastal nature of its location. Adverse effect of climate change that resulted in flooding and erosion and the washing away of the top soil, destroys roads, affects fresh water resources and destroys household food crops is already manifesting in Bayelsa state. The consequence of all these is low agricultural yield and food insecurity (Okoh et al, 2011).

Climate change is creating increased uncertainty about future temperature and precipitation regimes which makes investments in agriculture and other weather – dependent livelihoods riskier. The risk absorption capacity of poor people especially in the Bayelsa State is such that they are unlikely to be able to cope with the added risk imposed by climate change (FAO, 2008). The study and analysis of the trend of climate change factors and yield of yam is of high importance in order to determine whether the climate change factors (temperature

and rainfall) will be increasing or decreasing for the suitability of agricultural production especially yam production which is one of the major occupations in the state. The following research questions were addressed:

1) What is the trend of climate change factors in the state?
2) What are the projected future values of climate change factors in the state?
3) What is the trend of yam production in the state?

Objectives of the study

The broad objective of the study is to conduct trend analysis of climate change factors and yield of yam in Bayelsa State, Nigeria. The specific objectives are to

i) Describe the trend of climate change factors in the state;
ii) estimate and describe future values of climate change factors (temperature and rainfall) in the state;
iii) estimate and describe the trend of yam production in the state; and
iv) make recommendations based on the finding.

METHODOLOGY

The Study Area

Bayelsa State is in the southern core Niger Delta region, between Delta State and Rivers State of Nigeria. Its capital is Yenagoa. The language spoken here is Ijaw language and dialects of the Ijaw language such as Nembe, Atissa, Akassa, Ogbia, etc. However, like the rest of Nigeria, English is the official language. The state was formed in 1996 from part of Rivers State and thus, it is one of the most recently created states of the Nigerian federation. A lot of the communities are almost (and in some cases) completely surrounded by water, making these communities inaccessible by road, (Nigeria Exchange, N.D.).The entire state is characterized by abandoned beach ridges and due to many tributaries of the River Niger in this plain, considerable geological changes still abound. The lower Delta plain is believed to have been formed during the Holocene of the quaternary period by the accumulation of sedimentary deposits. Sedimentary alluvium is the major geological characteristic of the state (Online Nigeria, 2003).

Bayelsa State covers a total land area of about 11,007 km^2 with a population of about 1,703,358 (NPC, 2006). More than three quarters of this area is covered by water, with a moderately low land stretching from Ekeremor to Nembe. The area lies almost entirely below sea level with a maze of meandering creeks and mangrove swamps. The network of several creeks and rivers in the South, all flow into the Atlantic Ocean via the major rivers such as San Bartholomew, Brass, Nun, Ramos, Santa Barbara, St. Nicholas, Sangana, Fishtown, Ikebiri Creek, Middleton, Digatoro Creek, Pennington and Dobo, (Bayelsa State Union of Great Britain and Ireland, N.D.**).**

The state experiences equatorial type of climate in the southern part and tropical rain towards the northern parts. Rain occurs generally every month of the year with heavy downpour. Precipitation in the state is high but this decreases from north to south. Akassa town in the state has the highest rainfall record in Nigeria. The amount of rainfall is adequate for all-year-round crop production. (Online Nigeria, 2003.)

Bayelsa State was created on October 1, 1996 out of the old Rivers State. The name, Bayelsa, is an acronym of three former Local Government areas (LGAs) – Brass, Yenagoa and Sagbama. The then Brass LGA has been divided into the present Nembe, Brass and Ogbia Local Government Areas while the then Yenagoa LGA consist of the present Yenagoa, Kolokuma/Opokuma and Southern Ijaw Local Government Areas. Sagbama and Ekeremor Local Government Areas were created from the old Sagbama LGA. (Bayelsa State Due Process and e-governance DSP Information Technology Center N.D.).

Sampling Technique

Multistage sampling procedure was employed in the randomly selection of local government, communities and rural farming households for the study. Firstly, two local government areas were selected from the state. Secondly, two communities from each of the local government areas were selected, making it 4 communities. Finally, fifty rural farming households were randomly selected from each of the sampled communities making it a total of 200 households.

Data Collection

Data for this study were obtained using personal interview and structured questionnaire survey and out of the 200 respondents 186 were utilized for this study. Annual mean time series data of temperature, and rainfall were collected from Nigerian Meteorological Agency (NIMET). Also the annual mean time series data for yield of yam were collected from the Bayelsa State ADP.

METHOD OF DATA ANALYSIS

Trend Analysis

Climate change factors (temperature, and rainfall) trend in Bayelsa state was determined using line graph.

Growth Model

Climate change factors (temperature, and rainfall) future values were predicted using the Growth model. This model was specified as linear, quadratic and cubic equations. The equations are as follows:

$CH_f = a(1+i)^t + e$ (Linear) ……. i

$CH_f = a(1+i)^t + b(1+i)^{2t} + e$ (Quadratic)…….ii

$CH_f = a(1+i)^t + b(1+i)^{2t} + c(1+i)^{3t} + e$ (Cubic)……iii

Where CH_f = climate change factors (Temperature and Rainfall).

i	=	Rate of growth
t	=	Time horizon (integer values starting from 1 to 38 years)
e	=	Error term
a,b,c, and d	=	Coefficients of the model.

The cubic functional form fitted the data best and was therefore selected for analysis.

RESULTS AND DISCUSSION

The Trend Analysis of Climate Change Factor (Temperature) in Bayelsa State

Statistical data of temperature from 1971 – 2009 recorded an increasing trend with maximum temperature (31.93^0C) recorded in the year 1987 and minimum temperature (30.23^0C) recorded in the year 1976 (Table 2). The mean value and its standard deviation recorded over the period (1971 – 2009) are 31.27^0C and 0.41^0C respectively. This implies that there is a fair variability of temperature within the time (Table 1). The trend coefficient is 0.48 (^{0}C/year) and it is statistically significant at 0.05 level. The graph equation as depicted in Figure 1 is BT=16.26 + 0.48T, where BT is Bayelsa Temperature (^{0}C); T is Time (years). The trend line had a positive slope of 0.48 indicating that over the time period 1971 to 2009, the annual mean temperature in Bayelsa State rose by 0.48^0C per unit change in the time period.

The Trend Analysis of Climate Change Factor (Rainfall) in Bayelsa State

Rainfall data from 1971 – 2009 in Bayelsa State in Niger Delta region, Nigeria shows a minimal increasing trend with the lowest volume (151.37mm) recorded in 1983 while the highest volume (239.05mm) was recorded in 2006 (Table 1). The mean rainfall volume and standard deviation are 190.53mm and 20.49mm respectively. This indicates that there is a large variability (10.75) in the amount of rainfall yearly. The trend coefficient is 0.01 and is not significant at 0.05 level. This confirms that there were slight increasing trend in rainfall volume from year to year. The graph equation as shown in Figure 2 is BR = 188.29 + 0.01T. The meanings of the parameter in the equation are given as: BR = Bayelsa Rainfall (mm) and T = Time (years). The trend line had a slope of 0.01 indicating that over the time period 1971 to 2009 annual mean rainfall in Bayelsa State rose by 0.01mm per unit change in the time period.

Predicted Future Values of Climate Change Factors (Bayelsa State)

The future values of climate change factors (temperature and rainfall) projections are predicted as stated in the analytical framework. Table 2 shows that the temperature of Bayelsa State is projected to have a value of 31.71^0C by 2015, and 31.81^0C by 2020, 31.91 by 2025, 32.01^0C by 2030, 32.11^0C by 2035, 32.21^0C by 2040, 32.31^0C by 2045 and 32.41^0C by 2050. The projected future values show an increasing trend in temperature. Table 2 also shows that rainfall is projected to have the following values 197.88mm, 199.76mm, 201.66mm, 203.58mm, 205.52mm, 207.08mm, 207.48mm, 209.45mm and 211.44mm in

2015, 2020, 2025, 2030, 2035, 2040, 2045 and 2050 respectively. The predicted rainfall values also show an increasing trend.

Trend Analysis of Yield of Yam in Bayelsa State

Statistical yield data from 1999-2009 recorded a decreasing trend in yield of yam in Bayelsa State. The mean and standard deviation of yield of yam was 6948.10 kg and 208.32 kg respectively (Table 3). The coefficient of variation was low. Special attention and emphasis must be placed on yam production in the state due to this decreasing trend. With the population of the state on the increase, hunger and food insecurity situations are imminent if the trend is allowed to continue.

Predicted Future Values of Yield of Yam in Bayelsa State

The projected future values of yield of yam for the period (1999 – 2009) in Bayelsa State are 6951.36 Kg/Ha, 6954.48 Kg/Ha, 6957.94 Kg/Ha and 6961.41 Kg/Ha for the years 2020, 2030, 2040 and 2050 respectively (Table 4). The trend shows a slight increase. When this is viewed against the prediction of USAID (2010) that "from now to 2050, the world's population is expected to grow by more than 30%, resulting in an estimated 2.3 billion more mouths to be fed", it is seen that the food security of the rural farming households is at risk considering the annual increase in population relative to projected food output.

CONCLUSION AND RECOMMENDATION

The trend line of temperature had a positive slope of 0.48 indicating that over the time period of 1971 to 2009 annual mean temperatures in Bayelsa State rose by 0.48^0C per annum. The trend line of rainfall had a slope of 0.01 indicating that over the time period 1971 to 2009 annual mean rainfall in Bayelsa State rose by 0.01mm per unit change in time. The projected future values witnessed an increasing trend in temperature and rainfall in the state. Statistical yield data from 1999-2009 recorded a decreasing trend in yield of yam in the state. It is therefore recommended that increased awareness be created and disseminated through agricultural extension services and advocacy on the challenges of climate change. Climate change adaption and mitigation measures as they specifically relate to yam production in Bayelsa State should as a matter of priority guide policy makers in the state in particular and in Nigeria in general. Special emphasis must be placed on yam production in the state due to its decreasing trend in output while population is on the increase. This will help to avert future hunger and food insecurity among the rural households in the state.

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Table 1: Trend Analysis of Climate Change Factors (Temperature and Rainfall) in Bayelsa.

	Temperature	Rainfall
Mean	31.27(^{0}C)	190.53(mm)
Standard Deviation	0.41(^{0}C)	20.49(mm)
Max. Temperature	31.93(^{0}C)	239.05(mm)
Min Temperature	30.23(^{0}C)	151.37(mm)
Trend of Coefficient	0.48(^{0}C/yr)	0.01(mm/yr)
Coefficient of Variation (CV) (%)	1.32%	10.75(%)

Source: NIMET and Author computed result, 2011.

Table 2: Predicted Future values of Climate Change Factors in Bayelsa State.

Year	2015	2020	2025	2030	2035	2040	2045	2050
Temperature (^{0}C)	31.71	31.81	31.91	32.01	32.11	32.21	32.31	32.41
Rainfall (mm)	197.88	199.76	201.66	203.58	205.52	207.48	209.45	211.44

Source: NIMET and Author computed projected values, 2011

Table 3: Trend Analysis of Yield of Yam in Bayelsa State.

Yield	Yam
Mean (Kg/Ha)	6948.10
Standard deviation (Kg/Ha)	208.32
Maximum yield (Kg/Ha)	6964
Minimum yield (Kg/Ha)	6585
Coefficient of Variation (%)	3.00

ADP and computed result, 2011

Table 4: Predicted Future Values of Yam Yield (Kg/Ha) in Bayelsa State.

Years	2020	2030	2040	2050
Yam Kg/Ha	6951.36	6954.48	6957.94	6961.41

ADP and computed projected values, 2011

Figure 1: Trend of Temperature Data for Bayelsa State (1971 – 2009).

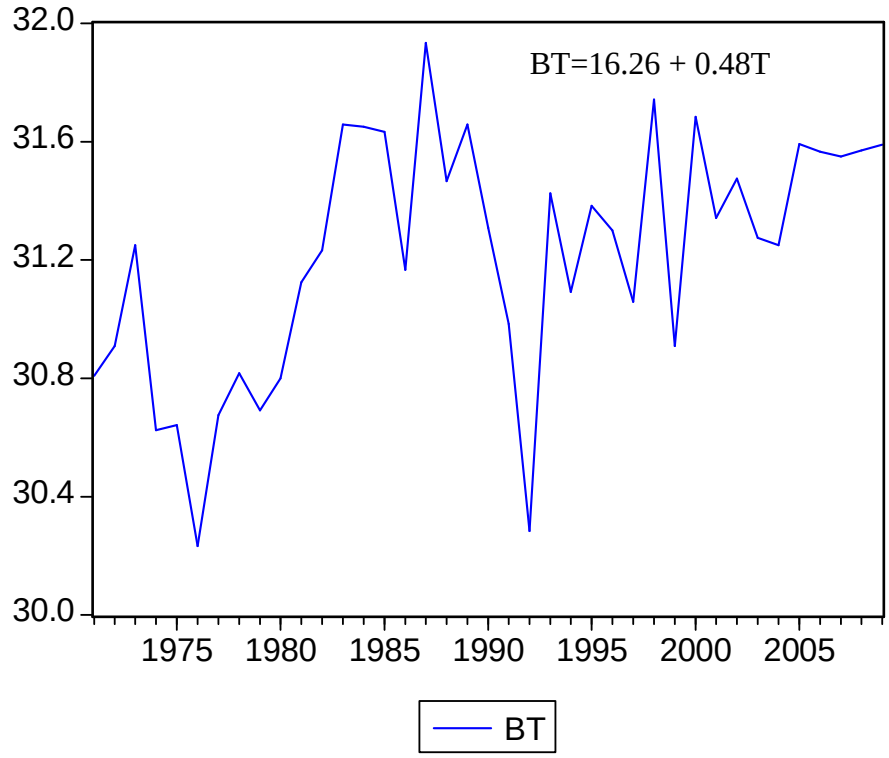

Figure 2: Trend of rainfall data for Bayelsa State (1971 – 2009).