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An Assessment of the Trend and Projected Future Values of Climatic Variables in Niger Delta Region, Nigeria

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Abstract: This study assessed the trend and projected future values of climatic variables in the Niger Delta Region. Annual mean time series data of climatic variables from 1971 to December 2007 were collected from Nigerian Meteorological Agency (NIMET) for the study. Multistage sampling techniques were used in the random selection of states, local government, communities and rural farming households. Data were analyzed through the use of descriptive statistics to describe the socio-economic characteristics of the rural farming households in the region. Line graph was used to determine the trend of the climatic variables (temperature, and rainfall) and Growth model was used to predict the future values of climatic variables (temperature, and rainfall) in the Niger Delta Region. Most rural farming households were married and headed by male with a mean household size of 10 persons. Primary school level of education dominated rural farming households with a low annual income of N73, 896 ($480) per annum. There was an increasing trend in mean annual temperature but a decreasing and increasing trend in mean annual rainfall values. The statistical projected future values of mean annual temperature and mean annual rainfall show an increasing trend in the Region. It is recommended that Meteorological station units should be established in the rural farming area especially in the Niger Delta region where accessibility is extremely difficult. This will make available meteorological data (information) to the reach of the poor rural farming household for their Agricultural production and for the attainment of food security status in the Region.

Key words: Climate change, climatic variables, Niger Delta, trend

INTRODUCTION

Climate change is defined as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (United Nations Framework Convention on climate change (UNFCCC, 1992). Climate change according to IPCC (2007) refers to changes in modern climate which are 90-95% likely to have been in part caused by human action.

Climate change leads to gradual changes in mean temperatures and rainfall that will lead to loss of biodiversity and ecosystem functioning of natural habitats, loss of arable land due to increased aridity and associated salinity, ground water depletion and sea level rise, changes in the suitability of land for different types of crops and pasture, changes in the incidence and vectors of different types of pests and diseases, changes in health and productivity of forests, changes in the distribution, productivity and community composition of marine resources, changes in livelihood opportunities and can also lead to internal and international migration (FAO, 2008).

Climate change has become more threatening to the sustainable development of agriculture globally. The "mean global temperatures have been increasing in line with precipitation increases since 1850, mainly due to the accumulation of greenhouse gases in the atmosphere" (FAO, 2007). This situation is not favourable to Agricultural production and may lead to food insecurity situation in Nigeria which mostly depends on climate for Agricultural production. This is as observed by Adejuwon (2004), that Nigerian Agriculture depend highly on climate because temperature, sunlight, water, relative humidity are the main drivers of crop growth and yield.

Climate shocks can also permanently affect people's health and education, leading to low agricultural activities and hunger. Higher temperatures are likely to increase cardiovascular illness, especially in the tropical countries (Confalonieri *et al*., 2007). Climate change is creating increased uncertainty about future temperature and precipitation regimes which makes investments in agriculture and other weather-dependent livelihoods inherent more risky (FAO, 2008). Apart from increase in temperature, the Niger Delta Region in also faced with the incidence of oil spillage as reported by Civil Liberties Organization (CLO, 1996) that between 1976 to 1990, the

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region experienced 2676 cases of oil spills and annual average spills in Rivers, Bayelsa and Delta States are 300 cases. The devastating impact of this incidence resulting from the activities of oil industry on the farmlands, crops, economic trees, creeks, lakes, fishing equipment is such that the people can no longer engage in productive farming and fishing. Food insecurity and hunger are eminent in the region. The risk absorption capacity of poor people especially in the Niger Delta region is such that they are unlikely to be able to cope with the added risk imposed by climate change.

A variety of crops such as maize, yam and cassava produced in the Niger Delta region depend on rainfall for their optimum performance. But in line with IPCC (2007) reported that precipitation levels are on the downward trend. The decrease and irregular rainfall pattern pose a problem that need to be addressed to save the Niger Delta region from low agricultural production. This is in line with the prediction reported by IPCC (2007) that climate change would severely compromise agricultural production and access to food. The following research questions were addressed:

- What is the trend of climatic variables in the Region?
- What are the projected future values of climatic variables in the Region?

MATERIALS AND METHODS

The study area: The Niger Delta area was focused for this study due do to its vast gas flaring related activities and climate change events that frequently occurred in the area. The Niger Delta is a coastal environment that is located in the Atlantic coast of Southern Nigeria where River Niger divides into numerous tributaries. It is the second largest delta in the world with a coastline spanning about 450 km terminating at the Imo entrance (Awosika, 1995). The region spans over 20,000 km^2 and it has been described as the largest wetland in Africa and among the three largest in the world. It is richest wetland in the world (Iyayi, 2004). The region (Niger Delta) is divided into four ecological zones namely coastal Inland zone, Mangrove swamp zone, freshwater zone and low forest zone (ANEE, 2004). The Niger Delta region has the high biodiversity characteristics of extensive swamp and forest areas, with many unique species of plants and animals. The Niger Delta is rich in oil and several decades of oil companies' activities in the area had much demand on the ecosystem of the region, furthermore, gas flaring as a component of climate change is a huge issue in the region. Okecha (2000) showed that human activities contributed to climate change and other related health and socio-economic problems.

The Niger Delta region is made up of nine states namely, Cross River, Edo, Delta, Abia, Imo, Bayelsa, River, Akwa-Ibom and Ondo States (Table 1). The region is with 25% of the Nigerian population of total of about 140 million people (2006 Census). The Niger Delta region land mass represents 12% of Nigeria's total surface area (NPC, 2006).

Table 1: States in Niger delta region, land area and population

States	Land area (km^2)	Population
Abia	4,877	2,833,99
Akwa Ibom	6,806	3,920,208
Bayelsa	11,007	1,703,358
Cross River	21,930	2,888,966
Delta	17,163	4,098,391
Edo	19,698	3,218,332
Imo	5,165	3,934,899
Ondo	15,086	3,441,014
Rivers	10,378	5,185,420
Total	112,110	31,224,587

National Population Commission (NPC, 2006)

More than 31 million people of more than 40 ethnic groups including the Annang, Ibibio, Efik, Ijaw and Igbo people speaking some 250 dialects live in the present day Niger Delta region (Jike, 2004). The Niger Delta has been described as heterogeneous, multi-cultural and ethnically diverse region (Akoroda, 2000). The Niger Delta lie predominantly in the tropics having two seasons-the wet and dry seasons. The wet season begins from May to September, while the dry season begins in October and ends in April. The Niger Delta is located on latitude 4º15′N and 4º50′N and longitude 5º25′E and 7º37′E

Methodology: Multistage sampling procedure was employed in random selection of states, local government areas, communities and rural farming households for the study. Firstly, four states were randomly selected from the nine states that make up the Niger Delta. These states are Bayelsa, Cross River, Delta and Ondo states. Secondly, two local government areas were selected from each of these states. Thirdly, two communities from each of the local government areas were selected, making it up to 16 communities. Finally, the rural farming households in the sampled communities formed the sample frame. Fifty rural farming households were randomly selected from each of the sampled communities making it up to 800 households. Data for this study were obtained using personal interview and structured questionnaire survey and out of the 800 respondents 739 was utilized for this study.

Data collection: Annual mean time series data from Nigerian Meteorological Agency (NIMET) that include the following; temperature, and rainfall from January, 1971 to December, 2009 were collected for the study.

Method of data analysis:

Trend analysis: Line graph was used to determine the trend of the climatic variables (temperature, and rainfall) in the Niger Delta Region.

Table 2: Socio-economic characteristics of respondents

Variables	Bayelsa (n = 186) (%)	Cross river (n = 172)	Delta (n = 198)	Ondo (n = 183)	Niger Delta (n = 739)
Age (Years)					
30-39	24(2.2)	24 (2.3)	44 (6.0)	19 (2.6)	111 (15.0)
40-49	76 (10.3)	62 (8.4)	79 (10.7)	61 (8.3)	278 (37.6)
50-59	68 (9.2)	66 (8.9)	64 (8.7)	78 (10.6)	276 (37.4)
60-69	18 (2.4)	19 (2.6)	11 (1.5)	23 (3.1)	771 (9.6)
70-79	0 (0.0)	1 (0.1)	0 (0.0)	2 (0.3)	3 (0.4)
Mean	49 years	49 years	47 years	51 years	49 years
Gender distribution					
Female	83 (11.2)	82 (11.1)	94 (12.7)	72 (9.7)	331 (44.8)
Male	103 (13.9)	90 (12.2)	104 (14.1)	111 (15.0)	408 (55.2)
Marital status					
Single	11 (1.5)	22 (3.0)	14 (1.9)	6 (0.8)	53 (7.2)
Married	120 (16.2)	90 (12.2)	129 (17.5)	118 (16.0)	457 (61.8)
Widow	33 (4.5)	17 (2.3)	29 (3.9)	29 (3.9)	108 (14.6)
Widower	4 (0.5)	2 (0.3)	3 (0.4)	4 (0.5)	13 (1.8)
Divorced	18 (2.4)	41 (5.6)	23 (3.1)	26 (3.5)	108 (14.6)
Educational status					
Informal	55 (7.4)	48 (6.5)	61 (8.2)	29 (3.9)	193 (26.1)
Primary	78 (10.5)	61 (8.3)	76 (10.3)	50 (6.8)	265 (35.9)
Secondary	37 (5.0)	41 (5.6)	42 (5.7)	72 (9.7)	192 (26.0)
Tertiary	16 (2.2)	22 (3.0)	19 (2.6)	32 (4.3)	89 (12.0)
Mode	Primary	Primary	Primary	Secondary	Primary
Household size					
2-4	5 (0.7)	7 (0.9)	8 (1.1)	2 (0.3)	22 (3.0)
5-7	26 (3.5)	45 (6.1)	41 (5.6)	60 (8.1)	172 (23.3)
8-10	71 (9.6)	66 (8.9)	75 910.2)	86 (11.6)	298 (40.3)
11-13	54 (7.3)	38 (5.1)	47 (6.4)	33 (4.5)	172 (23.3)
14-16	30 (3.9)	16 (2.2)	27 (3.7)	2 (0.3)	75 (10.1)
Mean (persons)	10	9	10	9	10
Annual income (N)					
21,000-60,000	89 (12.0)	62 (8.4)	148 (20.0)	12 (1.6)	311 (42.1)
61,000-100,000	95 (12.9)	85 (11.5)	49 (6.6)	65 (8.8)	294 (39.8)
101,000-140,000	2 (0.3)	25 (3.4)	0 (0.1067)	(9.1)95	(12.9)
141,000-180,000	0 (0.0)	0 (0.0)	0 (0.0)	28 (3.8)	28 (3.8)
181,000-220,000	0 (0.0)	0 (0.0)	0 (0.0)	6 (0.8)	6 (0.8)
221,000-260,000	0 (0.0)	0 (0.0)	0 (0.0)	5 (0.7)	5 (0.7)
Mean (N)	61,7907	1,895	50,803	113,068	73,896

Figures in parenthesis ( ) are percentages; Field survey data (2011)

Growth model: Growth model was used to predict the future values of climatic variables (temperature, and rainfall). This model was specified as linear, quadratic and cubic equations.

The equations are as follows:

$Ch^f = a(1+i)^t + e$ (Linear) … ix

$Ch_f = a(1+i)^t + b(1+i)^{2t} + e$ (Quadratic)…x

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

where,

CH_f = Climatic variables (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 that fits the data best was selected.

RESULTS AND DISCUSSION

Socio-economic characteristics of respondents: The mean age of respondents (households) in the Niger Delta region of Nigeria is 49 years. Farming activities are the major occupations in the area while male headed households are dominant in the area (Table 2). Most rural farming households were married confirming that they were responsible, matured and conscious on the level of climate change trend in the Region. Primary school level of educational attainment is dominant in the area while the household size has a mean size of 10 persons per household. The mean annual income of the rural farming households in the Niger Delta region was N73, 896 ($480) revealing a low annual income level.

Trend analysis of temperature in the Niger delta region, Nigeria: Statistical temperature data from 1971-2009 recorded an increasing trend across the randomly selected states in the Niger Delta region. The mean maximum temperature (31.49ºC) was recorded in Delta State while the mean minimum temperature (30.67ºC) was

Table 3: Analysis of climatic variables (temperature) record from 1971-2009 (Niger delta region)

Temperature	Bayelsa	Cross River	Delta	Ondo	Niger delta
Mean (ºC)	31.27	30.66	31.49	31.37	31.18
Standard deviation (ºC)	0.41	0.39	0.53	0.42	0.44
Max. temperature (ºC)	31.93	31.42	32.6	032.24	32.05
Min temperature (ºC)	30.23	29.61	30.09	30.41	30.08
Trend of coefficient (ºC/year)	0.48	0.36	0.57	0.03	0.36
Coefficient of variation (CV) (%)	1.32	1.27	1.68	1.34	1.40

NIMET and Author computed result (2011)

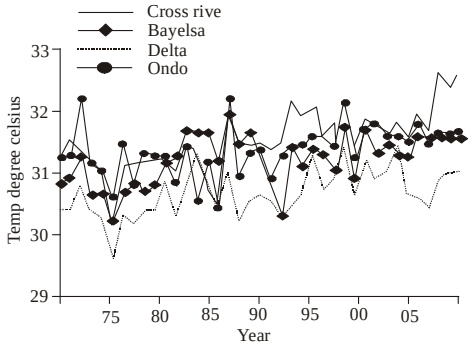

Fig. 1: Trend of temperature data for Niger delta region (1971-2009)

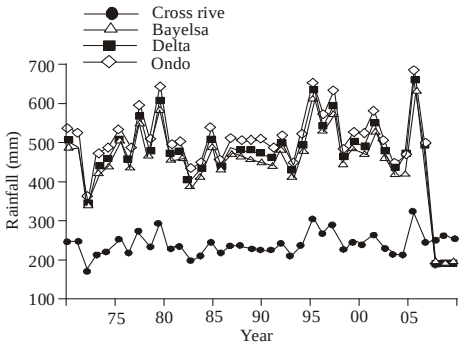

Fig. 2: Trend of rainfall data for Niger delta region (1971-2009)

recorded in Cross River. The Trend in coefficients shows a significant increase in temperature in Delta, Bayelsa and Cross River while in Ondo State there was no significant increase in temperature. The maximum and minimum temperature values of 32.05 and 30.08ºC were recorded respectively in the Region (Table 3). The graph of temperature over time as presented in Fig. 1 shows an increasing trend. The increase in trend of temperature confirms the report by Intergovernmental Panel on Climate Change (IPCC, 2007) that an increase in atmospheric concentrations of greenhouse gases equivalent to a doubling of carbon dioxide (CO_2) will force a rise in global surface temperature. Also as observed by FAO (2008) Climate change will lead to gradual changes in mean temperatures and rainfall. The mean temperature of 30.67 to 31.49ºC recorded in Cross River and Delta State respectively was confirmed by the report of Adejuwon (2004) that "in the far South, mean maximum temperature is between 30.0 and 32.0ºC while in the North it is between 36.0 and 38.0ºC.

Trend analysis of rainfall in the Niger delta region, Nigeria: The rainfall data from 1971-2009 recorded a decreasing and increasing trend across the randomly selected states in the Niger Delta region, Nigeria. The maximum and minimum rainfall volume of 321.84 and 153.38 mm respectively recorded over the period (1971-2009) in the Niger Delta region (Table 4). The maximum rainfall volume of 240.60 mm was recorded in Cross River State while the minimum rainfall volume recorded over the period (1971-2009) is 176.11 mm in Ondo State. This reveals that the volume of rainfall in Cross River State was higher than that in Ondo State during the period under study. The graph of rainfall over time as presented in Fig. 2. The trend coefficient of rainfall in the entire studied area was not significant in Bayelsa, Cross River and Ondo State while in Delta State it was significant with a negative trend coefficient. This shows that there was a decreasing trend of rainfall in Delta state. The entire Niger Delta region witnessed low coefficient of variation of 13.11%. This decrease of rainfall and increase in temperature is as a result of climate change.

Predicted future values of climatic variables in the Niger delta region: Projected future values of climatic variables (temperature and rainfall) in the Niger Delta region, Nigeria shows an increasing trend in temperature and rainfall values. Cross River State will witness a higher rainfall volume than other States randomly selected for the study. The Cross River value of rainfall projected has a minimum value of 259.07 mm and maximum value of 290.08 mm in the year 2015 and 2050, respectively, as compared to Ondo State with the projected minimum value of rainfall 194.93 mm and maximum value 229.92 mm in the year 2015 and 2050, respectively (Table 5). The future value of temperature projection was higher in Delta State that has 32.25ºC minimum and 33.34ºC maximum in the year 2015 and 2050, respectively as compared to Cross River State with a projected value of temperature of 31.12ºC minimum and 31.71ºC maximum in the year 2015 and 2050, respectively. The entire studied area will witness a maximum and minimum rainfall of 248.78 and 223.81 mm in the year 2050 and 2015, respectively. Also the entire Niger Delta Region

Table 4: Analysis of rainfall data from 1971-2009 (Niger delta region)

Rainfall	Bayelsa	Cross river	Delta	Ondo	Niger delta
Mean (mm)	190.53	240.60	231.41	176.11	209.66
Standard deviation (mm)	20.49	30.39	27.31	30.38	27.14
Max. rainfall (mm)	239.05	321.84	283.05	222.37	266.58
Min rainfall (mm)	151.37	170.79	189.02	102.35	153.38
Trend of coefficient (mm /year)	0.01	0.08	-0.32	0.26	0.01
Coefficient of variation (CV) (%)	10.75	12.63	11.80	17.25	13.11

NIMET and Author computed result (2011)

Table 5: Predicted future values of climate variable (temperature and rainfall)

Temperature(°C)	2015	2020	2025	2030	2035	2040	2045	2050
Beyelsa	31.71	31.81	31.91	32.01	32.11	32.21	32.31	32.41
Cross River	31.12	31.21	31.30	31.40	31.49	31.58	31.68	81.77
Delta	32.25	32.40	32.56	32.71	32.87	33.03	33.18	33.34
Ondo	31.75	31.83	31.91	31.99	32.07	32.15	32.23	32.31
Niger delta region	31.71	31.81	31.92	3 2.03	32.13	32.24	32.35	32.46
Rainfall (mm)								
Beyelsa	197.88	199.76	201.66	203.58	205.52	207.48	209.45	211.44
Cross river	259.07	263.29	267.57	271.93	276.36	280.86	285.43	290.08
Delta	243.38	246.19	249.02	257.89	254.79	257.72	260.69	263.69
Ondo	194.93	199.59	204.35	209.22	214.22	219.33	224.56	229.92
Niger delta region	223.81	227.21	230.65	235.65	237.72	241.35	245.03	248.78

Author computed projected values (2011)

will witness a minimum and maximum temperature value of 31.71 and 32.46ºC in the year 2015 and 2050, respectively (Table 5). But generally there will be an increase in both rainfall and temperature in the studied area (Niger Delta region, Nigeria) in accordance with IPCC (2007) Projection report that rainfall in the very humid regions of Southern Nigeria in expected to increase. This may be accompanied by increase in cloudiness and rainfall intensity, particularly during severe storm. IPCC (2007) also confirmed that precipitation decrease in the humid regions of West Africa, including Southern Nigeria, since the beginning of the century is about 10-25% or about 2-5% per decade. If this trend persists, rainfall in the humid region of Southern Nigeria may be about 50 to 80% of the 1900 values by 2100 with increase in ocean temperature. Evidence from Sub-Saharan Africa indicates that rainfall variability, projected to increase substantially, also reduces GDP and increase poverty (Brown *et al*., 2009). The increase in projected future values of temperature was in accordance to the findings of Stern (2006) that if emissions continue at today's rate, the global average temperature is likely to rise by 2-3ºC over the next 50 years, with implications for rainfall and the frequency and intensity of extreme weather events.

CONCLUSION AND RECOMMENDATIONS

The study findings revealed the Niger Delta region; Nigeria had 49 years of mean age of respondents (households) engaging in farming activities and dominated by male headed households. Most rural farming households were married confirming that they were responsible, matured and conscious on the level of food production and climate change factors that affect food security in the Region. Primary school level of education dominated the Region while the household size was with a mean size of 10 persons showing a large household size. The mean annual income of the rural farming households in the Niger Delta region was N73, 896 ($480) revealing a low annual income level due to effect of climate events in the Region. The trend analysis shows an increasing trend in mean temperature values and a decreasing trend in the mean rainfall values in the Delta state, but increasing trend in Bayelsa, Cross River and Ondo state. The statistical projected future values of mean temperature and rainfall shows an increasing trend in the values. Meteorological station units should be established in the rural farming areas especially in the Niger Delta region where accessibility is extremely difficult. This will make available meteorological data (information) to the reach of the poor rural farming households for the attainment of food security status.

REFERENCES

Akoroda, M., 2000. Remediation Response in the Niger Delta. Paper Presented at a Seminar to market the anniversary of Jesse Fire Disaster, Nigeria Institute of International Affairs, Lagos.

Adejuwon, S.A., 2004. Impacts of Climate Variability and Climate Change on Crop yield in Nigeria. Lead paper Presented at the Stakeholders workshop on Assessment of Impacts and Adaptation to climate change, conference center, Obafemi Awolowo University, Ile-Ife 20-21 September.

Anee, J., 2004. Oil of poverty in the Niger Delta. A Publication of the Africa. Network for Environment and Economic Justice. Retrieved from: www.fao.org/docrep/003/x8346E/x8346e02.htm#pl-10.

Awosika, L.F., 1995. Impacts of Global Climate Change and Sea Level Rise on Coastal Resources and Energy Development in Nigeria. In: Umolu, J.C., (Ed.), Global Climate Change: Impact on Energy Development. DAMTECH Nigeria Ltd., Nigeria.

Brown, C.R., Mecks, Y. Ghile and K. Hunu, 2009. An Empirical analysis of the effects of climate Variable on national level economic growth. Background paper for the WDR 2010. Civil Liberties Organization (CLO), 1996.

Confalonieri, U., B. Menne, R. Akhtar, K.J. Ebi, M. Hauengue, R.S. Kovats, B. Revich and A. Woodward, 2007. Human Health. In: Parry, M.I., O.F. Canzian, J.P. Palutikef, P.J. Vander Lindem and C.E. Jjanson, (Eds.), Climate Change: Impacts, Adaptation and Vulnerability. Contribution of Working Group 11 the fourth Assessment Report of the Inter-Government Panel on Climate change, UK Cambridge University Press, Cambridge.

FAO, 2007. National Programmes for Food Security: FAO's vision of a World without hunger. Rome.

FAO, 2008. Expert meeting on Global perspectives on fuel and food security: Technical Report, 18-20 February, Rome.

IPCC, 2007. Summary for Policymakers in: Climate Change: Impacts and Adaptation and Vulnerability. Contribution of Working group 11 to the forth Assessment Report of the Intergovernmental Panel on Climate Change: M.L.

Iyayi, F., 2004. An integrated approach to development in the Niger Delta. A paper prepared for the Center for Democracy and Development (CDD).

Jike, T.V., 2004. Environmental Degradation, Social Disequilibrum and the Dilemma of Sustainable Development in the Niger Delta of Nigeria. J. Black Stud., 34(5): 686-701.

National Population Census (NPC), 2006. Federal Republic of Nigeria, Federal Ministry of Women and Social Development.

Okecha, S.A., 2000. Pollution and Conservation of Nigeria Environment Owerri Nigeria. T Afrique Int Association, pp: 29-30.

United Nations Framework Convention on climate change (UNFCCC), 1992.