Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.7, No.3, 2017

Potential Benefits of Climate Change for Crop Production in Ebonyi State, South-Eastern Nigeria

Diagi Bridget[1]* Moses Nwagbara[2]
1.Department of Geography and Environmental Management, University of Port Harcourt, Nigeria
2.Department of Soil Science and Meteorology, Micheal Okpara University of Agriculture Umudike, Nigeria

The research is financed by the Authors

Abstract
The present warming of the earth-atmosphere system resulting from the continuous emission of greenhouse gases is causing changes in the other components of the system. These changes have both favourable and adverse impacts. However, the negative side of this changing climate has been given attention by researcher more than the positive side. Some regions of the world are experiencing a warmer and wetter climate which could improve agricultural production, while some others are going through a drier climate which could result in drought and its attendant consequences. This paper therefore, examines rainfall and temperature trends as indicators of climate change over Ebonyi State in South-eastern Nigeria were majority of the inhabitants are engaged in one form of agriculture or another. Data were collected from the Nigeria Meteorological Agency of Nigeria. Moving average and linear regression were employed to examine the trend in temperature and rainfall totals from 1984 to 2015. Results indicate that there are upward trends in temperature and rainfall totals in the study area. The area is warming by 0.0037℃ per annum and getting wetter at the rate of 8.9318mm per annum. With these results, farmers in Ebonyi State are likely to have more farm areas for crop cultivation as sizes of swamps increase. This is especially so for rice cultivation for which the State is very popular in Nigeria. The study therefore, recommends that due to the increasing trend of rainfall occasioned by rising temperature agriculture in the State can be enhanced to boast food security in the State and Nigeria in general.
Keywords: Climate change, Trend, Agriculture, Swamp, Rice cultivation

1. Introduction

The present warming of the earth-atmosphere system resulting from the continuous emission of greenhouse gases is causing changes in other components of the system. Global warming is mainly caused by the increase of greenhouse gases of the atmosphere (Houghton, 2002). The assumption that increased greenhouse gas concentrations may lead to a rise in global temperatures first emerged in the 1960s (Peterson et al., 2008). Majority of climate scientists now agree that the evidence for anthropogenic global warming is strong (Rosenberg et al., 2010). The emission of carbon dioxide comes from a variety of natural sources; but human-related emissions are responsible for the increase that has occurred in the atmosphere since the industrial revolution. Evidence has shown that the level of carbon dioxide in earth's atmosphere presently is higher than at any time in the last 800,000 years, for example atmospheric CO^2 concentration had reached 390 ppm at the end of 2010, 39% above what it was at the start of the industrial revolution in 1750 (IPCC,2013). Other sources include water vapour, chlorofluorocarbons (CFCs), methane, tropospheric ozone and nitrous oxide. These gases are released into the atmosphere due to human activities such as burning of fossil fuel, gas flaring and deforestation amongst others .These gases are termed greenhouse gases, because they act as the glass of a greenhouse or sunroom which is relatively transparent to solar radiation which is in short wavelength but absorbs and emits terrestrial radiation which is in long wavelength, and thereby increasing the temperature within the glass house or room. Several researchers have analyzed temperature-time series from various climate change perspectives ranging from temporal and spatial scales (Thomas et al., 2013; Sonali & Kumar, 2013; Ogolo & Adeyemi, 2009; Odjugo, 2011; Smadi & Zghoul, 2006). Analysis indicates significant increase of temperature in different parts of the world. (Chima et al., 2011) noted that, increase in temperature could result in dryness in some areas, while in others areas it may increase rainfall. Consequently, it is expected that the Continuous emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems including agricultural activities(IPCC,2013).Climate change affects agriculture in a number of ways, through changes in average temperatures, rainfall, and climate extremes (for example heat waves); changes in pests and diseases; changes in atmospheric carbon dioxide and ground-level ozone concentrations; changes in the nutritional quality of some foods; and changes in sea level (Deschênes, & Greenstone, 2007). However, the changes in climate are not uniform the world over so also are its manifestation, to some regions, a changing climate could have a positive impact while for some others it could be negative. The manifestation of these changes in climate is also seen to be causing serious health challenges as a result of increased exposure to heat such as stress, heat stroke, heat rash, heat syncope, and heat exhaustion. Weather hazards such as droughts, floods, incidence of wild fires, extreme weather events as a consequence of change in climate has resulted in

injuries, damage to facilities and infrastructure and in some cases death (IPCC, 2007). However bad it may seem, climate change also has its positive side which is often over shadowed because of the negative effects. One area that can be affected either negatively or positively is agriculture as a result of changes in temperature and rainfall this is because they are interrelated process. Consequently, changes in temperatures and precipitation which are the major requirement for crop growth will actually benefit agriculture in some region by way of increasing agricultural productivities and better conditions for vegetation as the region get warmer and wetter. In Ebonyi State, agriculture is the main occupation for about 85% of the inhabitants (Ogbodo, 2013). Therefore any effect on it by way of increased rainfall will enhance better growth of vegetation and greater yield of crops and more water for animal and by implication more food as more moisture will be available by the increasing rainfall. But on the other, hand a decrease in rainfall combined with a rise in temperature could result in insufficient soil moisture which will give rise to withering of vegetation. In view of the stated implication this paper therefore examines the benefits of climate change in Ebonyi State, particularly as it does relate to agriculture.

1.1 Study Area

The study area is Ebonyi State (Fig. 1). It is located in South-eastern part of Nigeria which lies approximately within latitudes 5° 40' and 6° 45' North and longitudes 7°30' and 8°30'East. The mean temperature range within the study area is usually between 27° to 30^0Cover the year (Ogbuene, 2010) Temperature is highest from February to April and it is about 31^0c (Ogbodo, 2013). The soil is texturally clay loam, fairly to poorly drain with gravely subsoil in some locations especially the upland adjacent to lowland areas (Ekpe, et al., 2005). Agriculture is a major industry in Ebonyi State, especially swamp rice cultivation. An estimated eighty-five per cent of the population earns their living from one form of agricultural activity (Ogbodo, 2013). The presence of large arable land, rivers and streams has made farming very attractive. Crops grown in the area include; rice, yam, cassava, cocoyam, groundnut, cowpea and vegetables. Livestock farming, especially the extensive system of rearing sheep, goats and native cattle, is also practiced by the people. Fishing activities are predominant in the southern zone of the State.

2.0 Materials and Methods

Mean monthly maximum and minimum temperature and monthly rainfall totals covering 31 years period for the study area were obtained from the Nigerian Meteorological Agency (NIMET), Oshodi, Lagos, The temperature data was transformed to mean monthly temperature and furthermore to annual, as for rainfall data, the monthly rainfall totals was used for the 31 years period. Data analysis was carried out from the temperature/rainfall data obtained and analyzed for trend and fluctuation using moving averages, linear regression. Their expressions are as follows:

2.1. Moving Average

Moving average is a smoothing method that is needed to check out some up and down i.e. in finding trend that might exit in data as trends tend to be obscured by the random errors. The simplest way of smoothing a time series data is to use a moving average. An average value is computed by using only a specified set of values. In this study, a 10-year moving average is used.

The 10- years moving average is written as:

$$\frac{y_1 + y_2 + y_3 + y_4 \ldots . y_{10}}{n} \quad \ldots (1)$$

Where n is 10 years order and y the variable in this case temperature or rainfall

2.2. Linear Regression

The least squares regression is used in the study to model the trends in temperature and rainfall data over the 31 years period. The result helps to determine the overall average rates of change in trends of annual temperature and rainfall totals in the study area.

The equation for least square regression is

$$y = a + bx \quad \ldots (2)$$

Where

$$b = \frac{n\sum xy - (\sum x)(\sum y)}{n\sum x^2 - (\sum x)^2} \quad \ldots (3)$$

And

$$a = \frac{\sum y}{n} - \frac{b\sum x}{n} = \bar{y} - b\bar{x} \quad \ldots (4)$$

a is the intercept; b the regression coefficient or slope;
y the temperature/rainfall values (dependent variable);
x the time in years ;(independent variable)
$\bar{x}$ the mean time; and

$\bar{y}$ the mean temperature/rainfall value

3.0 Result and Discussion

After applying the 10-years moving averages to filter out erratic fluctuations in temperature and rainfall data, annual temperature and rainfall trend lines were fitted with few peaks and depressions remaining (Figures 2 and 3). Thereafter, the linear regression was applied to highlight the general tendency, intercepts, and slopes before the regression lines were generated. The result generated from the linear regression is shown in table one and as graphs in figures 2 and 3. Results revealed that temperature and rainfall possess an upward trend as the area is warming by 0.0037^{o}C per annum and getting wetter by 8.937mm annually. Though the annual rate of increase in mean temperature (0.0037^{o}C) appears insignificant but has implication for other elements of weather and climate for instance rainfall. This is because the increase in mean annual temperatures will make the area even hotter which is already relatively hot. This would bring about increase in evapotranspiration if wet surfaces exist which will by extension cause an increase in the number of water molecules in the atmosphere. A further extension of this is increased condensation, cloud formation and precipitation (rainfall being the most common in the tropics). As climate is caused to change, other components of the earth atmosphere system might respond to influences exerted on them by these changes, for example swamp farms will increase in size due to increasing rainfall thereby creating more land to farm on thus boasting agricultural productivity. The increased rainfall of Ebonyi State occasioned by changing climate through increasing temperature and rainfall totals should be taken advantage of especially by farmers as it will enhances agriculture directly for crop production especially rice cultivation for which the state is well known in Nigeria...and directly and indirectly for animal production in order to prevent food insecurity in the State.

4.0 Conclusion

This study examined trend in temperature and rainfall in Ebonyi State between 1984 and 2015, as indicators of climate change with the view of highlighting the benefits that could be derived from it in the area of agriculture. The temporal pattern suggests a fluctuating and positive increase in trend of both temperature and rainfall. This study agrees with the studies of Amadi, et al., 2014 and Abiodun, et al., 2011 on the rising trend in temperature over Southeast Nigeria. Furthermore, it was found that rainfall shows an upward trend which corroborates with the observed torrential rains being experienced in recent times in the State. From the results and discussion, Ebonyi State is one area that is experiencing the positive side of climate change as a result of increasing annual rainfall totals. Though increase in rainfall could bring about incidence of flooding, destruction of facilities, pressures on dam walls, and so on in some areas, it is however beneficial for the study area where agriculture is the mainstay of the people. This increase in rainfall total could enhance the swampy areas by way of increase thereby creating more cropped land to farm on. Especially as the move by government to encourage agriculture at all levels to ensure food security gain ground this could be an opportunity to invest more in agriculture to boast food production. Also proactive measures should be taken with the increasing annual rainfall totals to avoid it becoming a source of disaster for the study area and Nigeria as a whole.

Figure 1: The study Area: Ebonyi State, South- eastern Nigeria.

Table 1: Trends in mean temperature and rainfall totals for Ebonyi State

Climate variables	period	Regression line equation
Mean annual temperature(°c)	1984-2015	Y= 19.947+0.0037x
Annual rainfall totals(mm)	1984-2015	Y= 16037-8.9318x

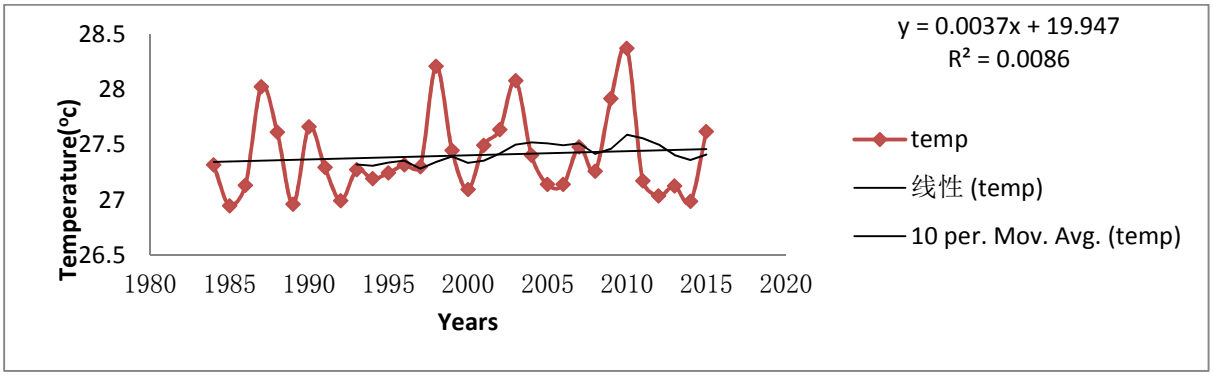

Figure.2: Trends of mean annual temperature for Ebonyi State

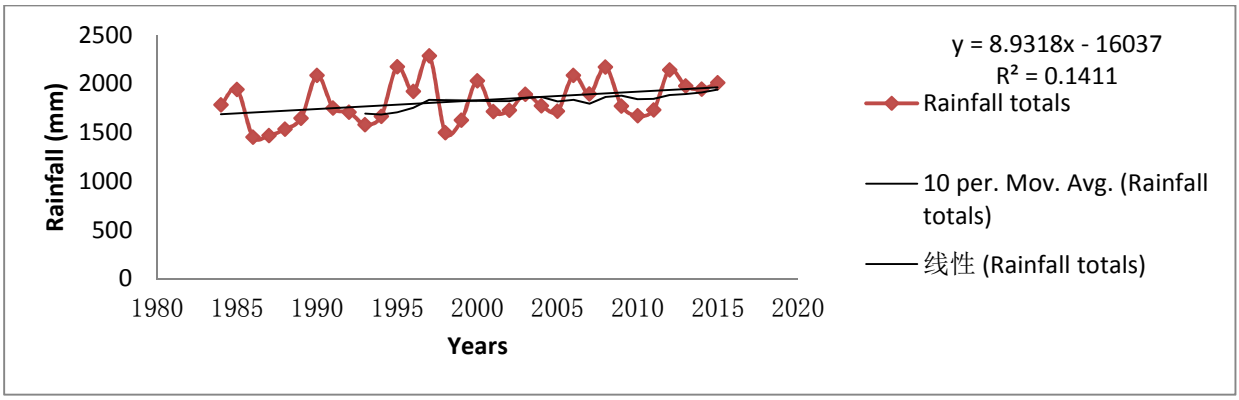

Figure.3: Trends of Annual Rainfall Totals for Ebonyi State

Reference

Abiodun, B.J. et al. (2011). *Climate change scenarios for Nigeria: understanding the biophysical impacts*: A Report by the climate systems Analysis Group, Cape Town, for building Nigerian's response to climate change project.

Amadi, S.O. et al. (2014).Trends and variations of monthly mean minimum and maximum temperature data over Nigeria for the period 1950-2012. *International Journal of pure and applied Physics*, 2 (4), 1-27.

Chima, G.N. et al. (2011). Sensitivity of vegetation to decadal variations in temperature and rainfall over Northern Nigeria. *Journal of Soil Science and Environmental Management*, 2(8), 228-236

Deschênes, O. & Greenstone, M. (2007). The Economic Impacts of Climate Change: Evidence from Agricultural Output and Random Fluctuations in Weather. *American Economic Review* 97(2), 354–385.

Ekpe, I.I. et al. (2005). "Physico-chemical properties of four ultisor under different vegetation cover in South-eastern Nigeria." *Journal of Science of Agriculture, Food Technology and Environment*, 5, 74-78.

Houghton. J.T. (2002). *The physics of Atmospheres*. (3rd ed.) Cambridge University press.

IPCC (2007). Climate Change 2007: impacts, adaptation and vulnerability: contribution of Working Group II to the fourth assessment report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK 229

IPCC (2013). *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Odjugo, P.A.O. (2011). Climate change and global warming: The Nigerian perspective. *Journal of Sustainable and Environmental Protection*, 1(1), 6-17.

Ogbodo, E.N. (2013). Assessment and management strategies for the receding watersheds of Ebonyi State, Southeast Nigeria. *Journal of environment and earth Science*, 13 (3).

Ogbuene, E.B., (2010). Impact of meteorological parameters on rice yield: An approach for environmental resource sustainability in Ebonyi rice farmland. *Journal of environmental issues and agriculture in developing countries,* 2 (2 & 3).

Ogolo, E.O. & Adeyemi, B. (2009). Variations and trends of some meteorological parameters at Ibadan, Nigeria. *The Pacific Journal of Science and Technology*, 10(2), 981– 987.

Peterson T. et al. (2008). The myth of the 1970s global cooling scientific consensus. *Bull Am Meteorol Soc,* 89, 1325–1337.

Rosenberg, S. (2010). Climate change: a profile of U.S. climate scientists perspectives. *Climate Change,* 101(3–4), 663–668.

Smadi, M.M. & Zghoul, A. (2006). A sudden change in rainfall characteristics in Amman, Jordan during the mid-1950`s AM. *J. Env. Sci.*, 2(3), 84-91.

Sonali, P. & Kumar, N.D. (2013). Review of trend detection methods and their application to detect temperature changes in India. *Journal of Hydrology*, 476(7), 212–227.

Thomas, T. et al. (2013). Spatio-temporal variation of temperature characteristics over narmada basin – is the consistent warming trend a possible climate change signal. 20th International Congress. Modelling and Simulation, Adelaide, Australia. 2416-2422.

Available from: www.mssanz.org.au/modsim2013.