Climate Change, Human Development and Economic Growth in Nigeria

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Abstract

This paper investigated the issue of interrelationships between climatic change, human development and economic growth in Nigeria. Secondary sources of data which were gathered from the publications of Central Bank of Nigeria Statistical Bulletin (CBN), National Bureau of Statistics (NBS) and World Development Indicators (WDI). These data were analysed using quantitative analysis. The paper found that Climate change has imposed a lot of constraints that have incapacitated human development and consequently impacted economic growth adversely in Nigeria. The paper recommended continual intervention of the governments and international development agencies on formulating policies that will minimize the enormous constraints to human capital development and enhance economic growth in Nigeria.

Keywords: climate change, human development, economic growth, Nigeria

1. Introduction

Climate change is one of the human development issues which undermine expanding human potential, developing capabilities and enlarging freedom. It's one of the factors that threatens to erode human freedom, limits choice thereby questioning the principle of human progress. It is one of the greatest challenges confronting the world and impacting negatively on the aspirational goals of majority of developing countries today. Climate change is a change in the composition of the atmosphere that is over and above natural variations, attributed directly or indirectly to human activities. (Odjugo, 2010). It manifests itself with temperature increases, changes in precipitation, sea level rise, and the intensification of natural hazards, such as storms, floods, droughts, and landslides (IPCC, 2007).

Currently across the globe, temperatures are rising; the spatial and temporal variability of rainfall has increased and the number of extreme events is rising rapidly. The changes have resulted in more frequent and intense tropical storms, floods, droughts and extremes in local temperature, etc. Of particular concern is that the increased extremes and variability in climate is leading to more frequent and severe damage of critical infrastructure and assets that underpin community health and wellbeing. Such impacts include loss or damage to housing, roads and other transportation means, water supply, forests products, crop yields, and other natural resources that underpin the social fabric and economy of areas with exposure to climate change challenges (Steffen, 2009).

Climate change compounds Nigeria's human development challenges in fundamental ways. Our country's agriculture is dependent on climatic patterns. The rapid southern expansion of the Sahara Desert has compounded access to water, increase incidences of drought, desertification and exacerbate the degradation of agricultural land and yields. Increased gully erosion in the south east and coastal erosion in the southern region is devastating the lives and livelihoods of over 50 million Nigerians living along the low laying coastal regions and potentially posing threats to Nigeria's oil facilities located within these areas.

As a result, the conditions of human development remain challenging over the years. Out of 182 countries ranked on the United Nations Development Programme Human Development Report, Nigeria's position is 158 (UNDP, 2009). Average life expectancy has declined to 47.7 years over the years. Today, there is 37.4% probability of an average Nigerian not surviving to age of 40. As many as 53% of the population have no access to safe sources of water supply, while the literacy rate is only 72%.

The climatic changes in form of growing shifts in temperature, rainfall, storms, and sea levels have posed enormous stress on resources such as land and water in Nigeria. The poor responses to resource shortages haven impacted human development negatively (Sayne, 2011). This has resulted to displacement of persons, sickness and hunger, fewer jobs, and ultimately poor economic growth. Although, some empirical literature in Nigeria have examined the potential impacts of climate change on economic growth, existing studies has so far not been able to identify a systematic, causal relationship on how climate change will affect human development and consequently economic growth. Therefore, the main objective of this paper is to analyse empirically the relationships between climate change, human development and economic growth in Nigeria. The paper is divided into 5 sections. The next section presents literature review and theoretical framework. Section 3 and 4 present methodology and analysis of the data collected, while section 5 concludes the study.

2. Literature Review and Theoretical Framework

There exist many theoretic and empirical studies on potential ways through which temperature could affect the level of economic activity. Firstly, the damaging impact of climate on ecosystems from erosion, flood and drought, the extinction of endangered species and deaths resulting from extreme weathers cause permanent damages to economic growth. Also, the economic implication of combating the impact of warming would limit the quality and quantity of investment in economic and physical infrastructures, research and development and human capital thereby reducing economic growth (Ali, 2012).

Some of the existing literature showed that climate change affects economic output (GDP). Studies by Deschenes and Greenstone (2007), Barrios, Bertinelli and Strobl (2010) suggested that climate change could impact economic growth. If climate change affected only the level of economic output, for example by reducing agricultural yields when temperature rises (precipitation falls), this would imply that subsequent temperature decreases (precipitation increases) – due for example to stringent abatement of emissions – should return the GDP to its previous level. But this is not the case if climate change affects economic growth. The reasons are the following. First, economic growth will be lower even if GDP returns to its previous level because of forgone consumption and investment due to lower income during the period of higher temperature (lower precipitation). In addition, as long as countries spend some resources to adapt to climate change, they incur opportunity costs in terms of not spending these resources on R&D and capital investment. These have negative effects on economic growth.

Dell, Jones, and Olken (2012) provided evidence on the effect of climate change on economic growth from a panel of 136 countries over the period 1950-2003. They discovered three primary results from their study. First, higher temperatures substantially reduce economic growth in poor countries. For instance, a 1^0C rise in temperature in a given year reduces economic growth by 1.3 percentage points on average. Second, higher temperatures appear to reduce growth rates, not just the level of output. Third, higher temperatures have wide ranging effects, reducing agricultural output, industrial output, and political stability. Also Ali (2012), using a Co-integration analysis on Ethiopia found a negative effect on growth. He specifically observed that change in rainfall magnitude and variability has a long term drag-effect on growth.

Frankhauser and Tol (2005) examined the link between climate change and economic growth using a simple climate-economy simulation model. They argued that the capital accumulation effect is important, especially if technological change is endogenous, and may be larger than the direct impact of climate change. The savings effect is less pronounced. The dynamic effects are more important, relative to the direct effects. They concluded that in the long run, for high direct impacts, climate change may indeed reverse economic growth and per capita income may fall. For global warming of 3° C, the direct damages to the economy are estimated to at least 15 percent of GDP. When the effect of capital accumulation and people's propensity to save are factored into the damages, the impact would be higher.

Evidence from Ayinde, Ogunlade and Adewumi (2011), using econometric analysis on Nigeria (1980-2005), revealed that temperature change generated negative effect while rainfall change exerted positive effect on agricultural productivity. The Fourth Assessment Report of the IPCC provides some illumination results about the impact of climate change on African development. For instance, projected reductions in yields in some countries could be as much as 50% by 2020, and crop net revenues could fall by as much as 90% by 2100, with small-farm holders being the most affected. It will also aggravate the water stress currently faced by some countries - about 25% of Africa's population (about 200 million people) currently experience high water stress. The population at risk of increased water stress in Africa is projected to be between 350-600 million by 2050 while between 25 and 40 percent of mammals ecies in national parks in sub-Saharan Africa will become endangered (Boko, et al, 2007). There exists very little evidence on how Climate change impact on human development. For example Science Daily (2010) revealed that over the past four decades, the spread of malaria to highland areas of East Africa, Indonesia, Afghanistan, and elsewhere has been linked to climate change. This was a rare phenomenon in the cooler highland areas about 50 years ago. Tanser, Sharp and Le Sueur (2003) also projected that due to changing temperature pattern in Africa; there would be 5–7 per cent potential increase (mainly altitudinal) in malaria distribution with surprisingly little increase in the latitudinal extents of the disease by 2100.

Moreover, Boko et al (2007) also provided some insights into the climate change implications on public health in Africa. As argued by Gallup, Sachs and Mellinger (1999), that vector-borne diseases, particularly malaria, can have such a large effect on labour productivity which could make many countries in Sub- Saharan Africa to be trapped in a vicious cycle of disease–low productivity–poverty–deficient health care. This has implications on the future welfare of the society.

Evidence from Rabassa et al (2012) reveals that weather shocks exacerbate child morbidity and mortality in Nigeria rural areas and is of considerable magnitude. Rainfall shocks have a statistically significant and robust impact on child health in the short run for both weight-for height and height-for-age, and the incidence of diarrhea. The fact that diarrhea is the leading cause of child malnutrition, and the second leading cause of death for young children in the country underscores the severity of the impact on human development and long term welfare implications of weather changes. The intensity is highest in hottest regions. However, children seem to catch up with their cohort rapidly after experiencing a shock.

In summary, the studies explored so far have shown that climate change have influence on economic growth and on the levels of living generally. However, the subsequent sections examined the linkage between climate change, human development and economic growth.

2.1 Theoretical Framework

This section presented the theoretical framework of analyzing the linkages between Climate change, human development and economic growth. Without the full understanding of the intervening factors, it may be difficult to grasp the true nature of the relationship between these variables in Nigeria. One of the most widely used economic models of climate change are integrated assessment models linking climate and economic simulations (Stern, 2007). The important assumptions underlying the economic models of climate change are rational actors, perfect competition and optimizing behavior (Chandran and Sandya, 2012). Stern (2007) uncovered the fact that the differences among the major climate change models are driven almost solely by assumptions about the rate of discounting the benefits of climate change mitigation (avoiding the costs of future climate damage to economic activity) and costs of mitigation efforts. In the case of climate change, it is important to examine the uncertainty in terms of the potential risks, the prospects for future economic growth and proper social discount rate (Weitzman, 2007). However, there is a growing consensus among economists that the standard economic model is of limited use in dealing with either mitigation or adaptation policy responses to climate change. Adapting to climate change is increasingly challenging and will become more and more difficult as global temperatures rise. The task will be made easier because of new directions in economic theory and policy recommendations recognizing the heterogeneity of regional economies and of human communities.

The economics of well-being is a standard model of climate change and economic development. In this model per capita GDP is an indicator of social welfare. Frey and stutzer pointed out that utility is equivalent to income and that more income makes a person happier. These measures showed that the relationship between per capita income growth and wellbeing is not generally positive in real-world contexts, at least above some minimal income level (Frey and Stutzer 2002).

They have shown that economic growth may reduce welfare even within a standard optimization model. Sen and Haq (1990) have developed a more complete measure of human well-being, called the 'Human Development Index' (HDI). It measures the average achievements in three basic dimensions of human development, health, education and income. After the formation of HDI, a number of related indices were developed in the purview of the human development.

3. Research Methodology

This study employed an analytical framework in the form of extended Cobb-Douglas production function, in which a generalized Cobb-Douglas production and extending the Neo-classical growth model to include CO2 emission (Climate change) along with capital stock (i.e human development) as the input of the production function and the gross domestic product as the output.

3.1The Empirical Model

The empirical model is represented by the real GDP per capita growth rate and is assumed to be affected by the rate of CO2 emission (C), as well as human development index (HDI). This paper adapted Mobolaji, Hassan, Sofoluwe, and Adebiyi (2011). Thus, a simple growth model where the economic growth is influenced by CO2 emission (C), as well as human development index (HDI) is specified.

$rRGDP_t = f (CO2_t, HDI_t, POV)$…………………………………………(i)

The model becomes:

$rGDP_t = \beta_0 + \beta_1 CO2_t + \beta_2 HDI_t + \beta_3 POV_t + \varepsilon_t$………………………….(ii)

Where

$rGDP_t$ = dependent variable measured by the growth rate of the real GDP per capita
α = intercept
β_1, β_2 = parameter to be estimated
CO2 = carbon dioxide (CO2) emission
HDI= human development index
POV= poverty index

Taking the natural logarithm of both side of the model produces a linear equation of the form:

$LogrGDP_t = \beta_0 + \beta_1 LogCO2_t + \beta_2 LogHDI_t + \beta_3 LogPOV_t + \varepsilon_t$………………………….(iii)

ε = Error term which shows that other external factors that might affect the magnitude of the GDP that are not stated in the model

The model is expressed in log form for the purpose of linearizing it. It is also necessary to remove variation in the data and also to minimize bias in the data collected. (Gujarati: basic econometrics).

t = 25 (number of years)

From the above specification, a theoretical a priori expectation is that CO2 emission has negative impact on growth; hence, we expect β1 to be negative and significant indicating that higher CO2 emission retard growth.

3.2 Sources of Data

In order to examine the relationship between climate change, human development and economic growth in Nigeria, secondary sources of data such as data on Carbon dioxide (CO2) emission, GDP per capita, human development index (HDI) and poverty index (POV) used for this study were drawn from the publications of Central Bank of Nigeria Statistical Bulletin(CBN), National Bureau of Statistics(NBS) and World Development Indicators(WDI). The data spanned through 1985 and 2010 were analyzed using Ordinary Least Square (OLS) regression technique.

4. Analysis and Results

The aim of this section is to analyse the data collected for the purpose of determining the relationships between climate change, human development and economic growth in Nigeria. To this effect, the times series properties of the data employed in the study were examined. Thereafter, the analysis of the impact of climate change, human development and economic growth was conducted.

Table1: Augmented Dickey Fuller (ADF) Test for Unit Root

Variables	Level	1st Diff.	2nd Diff	Critical Values			Order of Integration
				1%	5%	10%	
Log(RGDP)	4.308260	-1.4922	-3.352957	-3.7343	-2.9907	-2.6348	I(0)
Log(CO2)	-1.829700	-3.363559	-5.591484	-3.9635	-3.0818	-2.6829	I(2)
Log(HDI)	-2.606079	-13.08527	-15.22046	-3.7343	-2.9907	-2.6348	(1)
Log(POV)	-1.613582	-3.725017	-6.038885	-3.7343	-2.9907	-2.6348	(2)

The characteristics of the data was examined to determine whether the data is stationary (i.e whether it has unit roots) and the order of integration. In this regard, the Augmented Dickey-Fuller (ADF) was used. The result of the stationarity test with intercept term is presented in Table 1. It is clear from the table that all the variables have different order of integration as shown in the table. Note that the ADF-test statistic of each is greater in absolute value than the 95 percent critical value. Thus, these variables showed that there is the possibility of the long-run relationships between climate change, the Nigeria's real GDP and human development.

Table 2: Test for Co-integration using Johansen Method

Variables	Eigen Value	Likelihood Ratio	5% Critical value	1% Critical Value	Hypothesized No of CE(s)
Log(rgdp)	0.979962	97.24750	47.21	54.46	None**
Log (co2)	0.827925	34.68532	29.68	35.65	At most 1*
Log (hdi)	0.303324	6.528095	15.41	20.04	At most 2
Log (pov)	0.045503	0.745139	3.76	6.65	At most 2

Given that all the variables are non-stationary, the study attempted to find out whether these variables are co-integrated. In doing this we adopted the Johansen procedure. The result of the test is presented in table 2.The result of the co-integration test indicated in table 2 indicated that there are at least more than one Co-integrating among the variables included in the model. This evidence of Co-integration among the variables ruled out spurious correlation and implied that at least one direction of influence could be established among the variables. There is therefore an indication of the possibility of long run relationships among the variables.

Table 3: Regression Results using OLS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.026724	3.615594	1.113710	0.2801
LOG(CO2)	0.065337	0.517770	0.126189	0.9010
LOG(HDI)	-2.321355	0.480703	-4.829078	0.0001
LOG(POV)	1.645259	0.870167	1.890740	0.0749

R-squared	0.938570	Mean dependent var	12.34898
Adjusted R-squared	0.928332	S.D. dependent var	2.480161
S.E. of regression	0.663962	Akaike info criterion	2.181782
Sum squared resid	7.935219	Schwarz criterion	2.380153
Log likelihood	-19.99960	F-statistic	91.67229
Durbin-Watson stat	0.358379	Prob(F-statistic)	0.000000

From the regression result in table 3, the value of the constant term (intercept) is 4.026724. This signifies that if the explanatory variable is held constant, the real GDP is 4.026724. In the context of the computed elasticity (i.e coefficient of the explanatory variables), the result suggested that, a unit change in CO2 emission will cause a 0.65337 unit rise in real Gross Domestic Product (GDP). Also, unit change in the human development index will cause a 0.057906 unit change in real Gross Domestic Product (GDP). This means that anything that will hamper human development must be discouraged.

The coefficient of determination (R^2) is 0.938570 for the model, thus indicating that there is a very strong positive linear relationship between the dependent variables (GDP) and explanatory variables (CO_2 emmision, human development index and poverty index) and that the explanatory variable accounted for 93.85% of the variations in the real GDP in Nigeria from 1985 to 2010, While the remaining 6.15% variation in the real GDP is explained by other exogenous variables that are not excluded in the models (error term).

This implies that the coefficients are high as 94%. Therefore the models are good fit as only less than 6% of systematic variation is left unaccounted for by the model.

Also, a brief look at the adjusted R-squared value of 94.8% indicates that after removing the effect of insignificant repressor' (explanatory variable), about 6.15% variation in the real GDP is still accounted for by the independence variables. Therefore, the model is a good fit.

The Durbin-Watson statistic is a test statistic used detect the presence of autocorrelation (a relationship between values separated from each other by a given time lag) from a regression analysis that is, it test the independence of error in the least square regression. As a rule of thumb, if D-W is less than 2.0, there is an indication that the successive error terms are on average, close in value to one another and positively correlation, it therefore means there is presence of auto correlation and if greater than 2.0, there is no autocorrelation. The Durbin- Watson statistics for the models is 0.358379 which shows that there is presence of auto correlation because it is less than 2.

The standard error test and the mean of the dependent variable test is carried out to ascertain the correctness, statistical significance and the reliability of the parameters estimated. The standard error of estimate or C is computed to be 3.615594, which is small compared to the mean of the dependent variable (real GDP) which is 12.34898. This is a statistical significance between CO_2, HDI, POV and real GDP.

Finally, the linear regression model for Nigeria has a reasonable fit and therefore it can be concluded that relational expression exist between real GDP, CO2 emission, human development and poverty index..

5. Conclusion and Policy Recommendation

This paper has provided an empirical explanation for the contribution of climate change and human development index on economic growth in Nigeria from 1985-2010. In line with existing literature, this study finds that the human development has a positive and statistically significant relationship with economic growth in Nigeria. Adverse effect of Climate change on human development could hamper growth as indicated in the study. The paper therefore recommends that policy and effective regulation that will curb carbon emission pollution should be put in place. It is essential to examine how the creation carbon credits will be treated in a way full impact of climate change on the lives of populace will be dealt with. Finally, intervention of the governments at all levels i.e. federal, state and local formulating policies that will minimize the enormous constraints to human capital development and enhance economic growth in Nigeria is imperative.

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