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## **Review of Studies On Global Warming And Climate Change In Nigeria**

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**Abstract:** - Studies on global warming and climate change in Nigeria have grown by leaps and bounds in the last two decades. This paper reviews fifty three studies done on climate change hazard in Nigeria with a view to characterizing the studies and establishing the existing gaps in literature. The secondary objective of the paper is to establish the broad consensus of the Nigerian scientific community on critical issues relating to the climate change hazard. The paper started with the identification of the broad objectives of the studies done on the climate change hazard in Nigeria. This is followed by the classification of the studies and the discussion of the main significant contributions as well as an appraisal of the methods of investigations in the field where appropriate. The basic consensus reached were also identified and described. Finally, new directions for future research in the field are suggested.

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### **I. INTRODUCTION**

Climate change has been 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 (UNFCCC, 1992; Obioha, 2009). Climate change involves a change in both the mean meteorological values and variability of these values. The anticipated change in mean climatic conditions is expected to be a slow process, occurring over many decades (Obeta, 2009). Climate variability describes seasonal changes, inter-annual variability and the likely frequency of weather-related extreme events. This variability is often an ongoing stress within people's lives. Climate change and climatic variability are frequently discussed in literature and they add to a complex bond of stress to the economy through their impact on key sectors or on the important drivers of growth, including agriculture and natural resources, water, health and infrastructure.

Climate change is real; it respects no political boundary and the risks it poses to nation's socio-economic development are enormous. Hence, this paper has attempted to provide a synthesis of the consensus of the Nigerian scientific community on key issues relating to the climate change hazard in Nigeria in the last few decades. The broad objectives are to reveal how it dominates academic discuss in Nigeria and to determine the consensus generated on the causes, impacts, vulnerability, adaption and its potential dangers to Nigerians and all their activities. In addition, the paper will identified the characteristics of the works done on this hazard in Nigeria and the extent to which the Nigerian scientific community are working or reporting on the environmental hazard.

### **II. BROAD OBJECTIVES OF THE REVIEWED STUDIES**

Some of the objectives of climate change studies from the works reviewed can be summarized as follows:

1. To fill critical knowledge gaps on the mechanisms of climate change
2. To determine the natural and man-induced reasons for global warming and climate change
3. To generate knowledge on the impacts of climate change on human health, environment, infrastructure, biodiversity, waste, agriculture, forestry, tourism, settlements and resources, dependent ecosystems etc in Nigeria
4. To explore the possibilities of integrating climate change considerations into existing curricula, policies and strategies for effective environmental management
5. To generate knowledge needed to understand and better manage climate change risks to water resources, coasts, and fragile ecosystems especially in the semi-arid areas in northern parts of Nigeria.
6. To assist Nigerian governments, policy makers and other stakeholders understand, appreciate and incorporate climate change hazard into policy and operational decisions at all scales and across all vulnerable sectors in Nigeria
7. To generate accurate and robust information on the spatial-temporal dimensions/effects of climate change in Nigeria and to establish trends, implications and the possible opportunities (benefits) of climate change hazard
8. To evaluate the effectiveness of ongoing responses, create awareness, build adaptive capacity and educate interested persons on issues relating to the climate change hazard in Nigeria

9. To identify the social and economic costs of climate change including the cost of not taking adaptation option.
10. To provide all stakeholders with relevant information on vulnerability and adaptation options

### **III. CLASSIFICATION OF THE STUDIES ON CLIMATE CHANGE IN NIGERIA**

Research works on climate change and global warming in Nigeria as noted previously, have grown by leaps and bounds in the last few decades especially since the early 1990s. No attempt has been made to classify or to summarize the significant contributions of these studies.

In this section, we deal with the classification of the studies reviewed. The studies, in our view, can generally be classified under the following categories:

Classification

- 1) Studies on reality, nature and conceptual issues
- 2) Studies on causal factors of climate change. These include studies on the effects of natural phenomena and human activities such as land use and socio-economic variables, such as gas flaring, urbanization and deforestation.
- 3) Studies on impacts of climate change on man, his property and socio-economic activities
- 4) Studies on vulnerability, mitigation, and adjustment to climate change
- 5) Studies on risk assessment, economic costs and management. This include studies based on the application of GIS, simulation, modeling and other related techniques
- 6) Studies on climate change science as a new field of study (unique discipline).
- 7) Studies on the forecasting (predication) and monitoring of climate change hazards in Nigeria

### **IV. STUDIES ON THE REALITY, NATURE, AND CONCEPTUAL ISSUES ON CLIMATE CHANGE**

Many studies have been done on mechanism and perception of climate change in Nigeria. (Oje, 1987; Ayoade, 1995; Bello, 1998). Ayoade, (1995) and Oje, (1987) were probably the first set of scholars to research on the meaning, nature, and problems of climate change and global warming in Nigeria. Ayoade (1995) defined climate change as any long-term significant change in the expected average weather of any place over an appropriate period of time. In other words climate change depicts abnormal variations in the expected climate of a region. Bello (1998) noted that the climate change is brought about by many factors. These factors include the drying processes of the earth, sunlight intensity and more importantly, anthropogenic factors (fossil fuels combustion) and ozone layer depletion. These workers agreed that climate change and its associated consequences threaten Nigerians desire of achieving socio-economic development and being among the twenty most industrialized countries in the world by the year 2020. The general causes of and strategies for mitigating climate change were specifically examined by Ayoade (1995) and Bello (1998). They proposed four approaches for mitigating the climate change menace. These are change of life style, new inventions (e.g. of vehicles using non-fuel energy), formation of appropriate environmental management policies and innovative drives towards sustainable utilization of environmental resources.

Other workers such as Bormet et al (2007) and Ayoade (2004) have also examined the mechanism of climate change. For instance, Ayoade, (2004) stated that climate change is caused by green house gases. The earth's atmosphere, he noted, acts like the glass in a greenhouse allowing much of the sun's solar radiation to travel through unimpeded, but trapping a lot of the reflected heat trying to escape back to space. This process raises the earth's temperature (just as it does in a greenhouse) by bringing about measurable increases in the average temperature of earth's atmosphere, oceans and land mass. Green-house gases (GHG) enhance the greenhouse properties of the earth's atmosphere. They allow solar radiation from the sun to travel through the atmosphere but prevent the reflected heat from escaping back to space. This is what causes the earth's temperature to rise (Bormet et al, 2005). (Onokala and Ali, 2009) added that the earth is currently facing a period of rapid warming brought about by rising levels of heat trapping gases (green house gases) in the atmosphere a process known generally as global warming). The green houses gases involved include carbon dioxide, Methane, Nitrous oxide, ozone, synthetic chemicals and Aerosols. They summarized the basic factors responsible for climate change and global warming as: (1) volcanic eruption (2) massive carbon dioxide emission (3) variations in solar output and (4) variations in the earth's orbital characteristics. Citing several authors these workers noted that volcanic eruptions inject large quantities of dust and greenhouse gaseous with potentials of substantial global warming into the atmosphere. Over millions of years these materials alter global climate characteristics. Carbon dioxide emission resulting from industries and other related human activities as well as the changing composition of the atmosphere were cited by these workers as major forcing mechanisms of climate change in Nigeria.

## **V. STUDIES ON CLIMATE CHANGE SCIENCE AS A NEW FIELD OF STUDY (UNIQUE DISCIPLINE)**

Bayon (2000) and Igwebuikwe et al (2008) wrote on every aspect of climate change science including the concept, causes and the need to build adaptive capacity to the hazard in Nigeria. Bayon (2000) noted that Nigerian climate is actually changing and that some impacts of the change are already observable; and that there is broad scientific consensus that future change will occur. He enumerated the evidences which confirm the changing phenomena of Nigerian climate as: (i) rising higher temperatures (ii) rising sea level (iii) changing pattern of rainfall (iv) emergence of more draughts and desertification in northern Nigeria (v) changes in the migration patterns of birds/land animals in Nigeria (vi) high rate of evaporation (vii) stronger atmospheric circulation (viii) intensification of the global hydrological circle. He emphasized that it is incumbent on research centers in Nigeria to create awareness of the change in climate and on the potential dangers posed to man and animals by climate change. Ayoade (2004) added that climate change is a major environmental hazard; that the earth is warming up; that there are overwhelming scientific consensus that it results from the concentration of green-house-gases in the atmosphere, and that the hazard is human-induced. He was of the view that Nigeria, because of her location, is one of the countries expected to be most affected by the impact of climate change through sea level rise and the occurrence of other extreme hydrological phenomena-unusual heavy rains, wind storms, floods, mud or land slide, draughts as well as famine, heat waves, ocean surge and extreme temperatures.

### ***Studies on causation factors:***

Several workers have discussed the causes of climate change in Nigeria. Adefolu (2007) for instance, discussed the causes of climate change in great details. The hazard, according to him result from a process known as climate forcing; ie a process that can alter the global energy balance as a result of some natural phenomena and anthropogenic factors. He was of the view that the global climate change hazard has a strong impact on Nigeria, particularly in the areas of agriculture, landuse, water resources, health, energy, coastal resources and other sectors of its economy. He concluded by recommending the adoption of some approaches to mitigate the effects of climate change. Specifically, he recommended staff training and re-training, energy audits and bench marking, energy efficiency measures involving the use of high energy efficient equipment and improved operating procedures and maintenance measures to mitigate GHG emissions. He highlighted the possible barriers to mitigating GHG emission in Nigeria, such as financial constraints, lack of capacity/technical skills, limited availability of information etc. Other studies on the climate change in Nigeria were undertaken by Efe, (2007) and Onuoha (2008a). Climate change according to these workers results from natural processes (biogeographical) and human activities (anthropogenic). The natural processes are the astronomical and the extraterrestrial factors. The astronomical factors include the changes in the eccentricity of the earth's orbit; changes in the obliquity of the plane of ecliptic and changes in orbital procession while the extraterrestrial factors are solar radiation quantity and quality. Anthropogenic climate change forcing, mechanisms on the other hand, involves human activities that either emit large amount of greenhouse gases into the atmosphere that depletes the ozone layer or activities that reduce the amount of carbons absorbed from the atmosphere. The human factors that emit large amount of greenhouse gases in Nigeria, according to these workers, include manufacturing activities, burning of fossil fuels, gas flaring, urbanization and agriculture; while human activities that reduce the amount of carbon silks are deforestation, alterations in landuse, water pollution and agricultural practices.

## **VI. STUDIES ON CLIMATE CHANGE IMPACTS IN NIGERIA**

Many workers (Ubachukwu, 2005; Njoku, 2006; Umah, 2009) have studied the effects of climate change on various sectors of the Nigerian economy. These scholars noted that the effects of global warming and climate change in Nigeria are currently of concern to governments, institutions, environmentalists and firms. They noted that the effects climate change in the country generally manifests as shifting weather variations or patterns involving unprecedented and overall changes in weather patterns, excessively heavy precipitation, unusual high temperature, propelling significant changes in different parts of the country, rising sea levels disappearance of the coastal strips and noticeable increases in the frequency of some extreme weather events in the country. They concluded by recommending that governments have a big role in disseminating information on the potential/ actual impacts of climate change as well as on forecast impacts on agriculture, water resources and diseases.

Efe (2009) also studied the threat of climate change to food security and livelihoods in selected states in Nigeria, while Ubachukwu (2005) examined the effects of climate change on food productivity in the Niger delta. They discovered that climate change impacts significantly on all aspects of crop yields, food security availability of seeds and access, and utilization of foods. They noted that there were decreases in crop yields due to decreases in temperatures in his study areas and that most of the farmers had low level of awareness on the

danger of climate change hazard. Efe (2007) highlighted the implications of climate change-induced variability's on food security and livelihoods and recommended that management issues raised in his paper be translated into decision and policy making by stakeholders in order to ensure food security in northern Nigeria. Njoku (2006) and Umah (2009) discovered a downward trend in rainy days per annum at Sokoto and Kano stations with Kaduna having only a slight reduction in its rain day per annum. This observed climate change-induced variability was found to have a negative effect on annual crop yields. Njoku (2006) also discovered that a decrease in food crops availability occurred as rainfall and temperatures decreased in his study areas. He recommended the need to develop effective long-term agricultural policies that are situated within a given set of environmental determinants

Obioha (2005), Baka et al (2007), Okoli (2008) and Oluwatuyi (2009) studied the environmental consequences of climate change hazard in Nigeria. Obioha (2005) discovered that many of the environmental consequences of climate change resulted from physical changes insurance, transportation, flood defense migration, forest, water, security and the spread of diseases. He noted that changes in the timing of seasonal patterns in ecosystems, and direct economic impact are some of the regional effects of global warming. Baka et al (2007) referred to the IPCC 2007 reported and observed that the effects of climate change will be mixed across regions. For Nigeria climate change according to this scholar will lead to extreme weather events, (flooding) and famine, desertification, spread of diseases and water scarcity in some parts of Nigeria.

Okoli (2008) also agreed that most of the environmental consequences of climate change would manifest as physical changes: sea level rises, higher local temperature and changes in rainfall pattern. Oluwatuyi and Jegede (2009) further stressed that sea levels are expected to rise dramatically by the end of the 21<sup>st</sup> century and that coastal cities such as Lagos, Port Harcourt and even Calabar may be adversely affected. They added that Nigeria may loss a significant size of her coastal strips. These scholars however observed that climate change will have positive effects (increased agricultural yields) in some parts of Nigeria. This is because it enhances the role of carbon dioxide in photosynthesis, especially in preventing photorespiration, which is responsible for significant destruction of several crops in Nigeria. Odjugo (2000), Obioha (2005) and Nnaji (2009) also studied the effects of climate change in the socio-economic development in Nigeria and discovered that climate change and existing climatic variability will have harsh effects on the low-income and marginalized poor people in Nigeria and will, in addition, make the process of eradicating poverty more difficult because of the negative effects of climate change on: (i) economic growth (ii) poor people's livelihoods and assets (upon which they depend) and (iii) the level of risks to which the people are exposed.

They concluded by observing that the impact of climate change and climate variability on short-term economic growth will be enormous but that the impacts would be felt mostly by the down trodden in Nigeria. Obioha (2005) added that economic sectors that depend heavily on climate and weather-sensitive sector for their growth will be affected mostly. He identified agriculture and water resources as such critical sectors. This, he noted, may disrupt government revenues and inhibit government's ability to finance important services. Nnaji (2009) extended these discussions by observing that it will adversely affect the poor by reducing their ability to diversify livelihoods and their ability to afford sustainable and unrestricted coping strategies.

## **VII. IMPACT STUDIES ON WATER AND OTHER RESOURCES**

Kalang, (2007), Obeta (2009), Mbajiorgu and Ogbu, (2010) studied the impact of climate change on water resources in Nigeria. Their studies revealed that climate change has the potential to either alleviate or aggravate water availability in different part of the country. On balance, however, the impacts are likely to be adverse, especially in the semi-arid northern parts, based on the area's past climate and hydrology and because of the limited water infrastructure and use. Kalang (2007) did a preliminary study of the magnitude, effects and distribution of intense rainfall resulting from climate change in Nigeria. Estimates were made of the magnitude-frequency relationships of selected meteorological data (daily rainfall amounts, daily mean temperatures etc) recorded at network stations across the country. The results revealed that projected changes in rainfall and sea level rise and on the incidence of extreme weather events which bring risks to the security of the nation's water resources, agricultural systems and settlements, as well as to the health of our people-risks which could be severe in several parts of Nigeria. Temperature in areas of 2-3oC were also predicted, and these will have irreversible effects on the nation's fragile ecosystems such as coral reefs and low-lying freshwater wetlands of the Niger Delta.

## **VIII. STUDIES ON VULNERABILITY TO CLIMATE CHANGE HAZARD IN NIGERIA**

Vulnerability studies on climate change in Nigeria include the works of Baka et al (2007), Nwafor (2007) Onuoha (2008) and Ajaero and Madu (2009). Baka et al (2007) noted that vulnerability is an indication of people's exposure to external risks, shocks and stresses and their ability to cope with and recover from, the resulting impacts. They noted that vulnerability may differ seasonally or at different times within people's lives.

It also differs across groups, within communities or individuals within a household owing to their livelihood activities or social standing. In Nigeria, they identified the most vulnerable groups as the extreme poor, aged, sick people displaced by conflicts and urban dwellers.

Nwafor (2007) added that a common theme in the climate change vulnerability literature is the idea that countries, regions, economic sectors and social groups differ in their degree of vulnerability to climate change. This is partly due to the fact that changes in temperature and precipitation will occur unevenly and that climate change impacts, resources and wealth are distributed unevenly across the globe. Onuoha (2008) extended these observations by adding that unless appropriate, mitigation measures are adopted to reduce vulnerability in Nigerian and other developing countries of sub Saharan Africa, climate change portends grave danger to our people as well as our biotic and abiotic environments. He expressed concern that all developmental advances witnessed in sub. Saharan Africa may be destroyed or reversed over a short period of time unless we reverse or regulate the climate change phenomenon.

## **IX. ADAPTATION AND MITIGATION STUDIES**

Adaptation, technically, is the appropriate way to deal with the unavoidable impacts of climate change. It is a mechanism to manage risks, adjust economic activity to reduce vulnerability and to improve business certainty. The concern for adaptation and mitigation of climate change phenomenon has revived fulsome attention in literature in Nigeria. Oladip (2008) for instance advocated the entrenching of energy efficiency practices by industries in Nigeria. This according to him will offer very important opportunities for mitigating GHG emissions for energy use. He recommended three basic approaches, viz:

- i) Limited use of fossil fuels for energy, either directly by industry for heat and power generation or indirectly in the generation of electricity and steam.
- ii) Non-energy uses of fossil fuels in chemical processing and metal smelting, and adoption of other innovative strategies
- iii) Retraining, awareness creation and changes in people's behavior and attitude in order to reduce GHG emission by industries in Nigeria. The Energy efficiency measures, suggested as No.1 above, will involve several processes such as, a shift to low carbon fuels, application of waste fuels, increased use of additives in cement manufacturing and removal of  $\text{Co}^2$  from fuel gases in chink or kilms
- iv) Increased use of already proven nuclear energy, a  $\text{Co}_2$  emission-free source
- v) Continued development of new types of energy systems such as fuel cells for use in automobiles
- vi) Carbon sequestration
- vii) Aforestation-plants absorb and use  $\text{Co}_2$  in the process of photosynthesis
- viii) Injecting  $\text{Co}_2$  into ocean depths form  $\text{Co}_2$  hydrates.

Efe (2008) added additional numbers of mitigation measures and management practices which included energy efficiency measures ie using high energy efficient equipment and operating procedures and maintenance measures to mitigate GHG emissions. Rakiya (2008) also added a number of other strategies for stemming the impact of climate change in Nigeria. The suggested measures were:

- 1) Introduction of carbon tax to reduce the utilization of oil, gas and coal
- 2) Use of alternative energy resources-wind, solar etc.
- 3) Ban of gas flaring in the Niger Delta because gas flaring has contributed substantially to global warming and has increased the acid rain in oil producing communities in Nigeria

He concluded by observing that overcoming the challenges posed by climate change to economic growth and sustainable development in Nigeria require creative thinking, holistic ideas, innovative solutions and the participation of all stakeholders-governments, NGOS, private sectors, civil society organizations etc. The possible barriers to mitigating GHG emissions in Nigeria, according to this scholar, include lack of relevant information on energy efficiency measures, financial constraints, inadequate technical skills and lack of political will.

## **X. COMMENTS AND OBSERVATIONS**

Eight observations and comments will be made in this sector on the studies reviewed the first is on the quantum and regularity of investigations in climate change by scientists in Nigeria. The nation's research landscape continues to witness, with near-constant frequency, new works on various spheres of the climate change hazard, particularly on its impacts, vulnerability, levels of enforcement of mitigation measures, growing damage potentials and risks posed to man or his environment etc. This shows clearly that climate change hazard has emerged as one of the frontier environmental issues attracting attention/comments from academics and other stakeholders in Nigeria. This high level of interest among the Nigeria scientific community on this hazard is not surprising, given the crucial influence of climate change on the pace and patterns of the nation's socio-economic

development. Based on this, one can assert that the Nigerian scientific coming community is living up to its responsibility trying to push forward the frontiers of national development.

Our second observation is that studies on climate change hazard in Nigeria have been undertaken by scholars from diverse backgrounds. (See table 1) Infact, the fifty three studies reviewed (authored by sixty seven scholars) showed clearly that workers and methods span through a range of disciplines, including climatology, physics, geography, biophysical sciences, surveying, engineering, agricultural sciences, social sciences, economics, chemistry, management and planning

**Table 1: Studies Reviewed and Background of the Authors**

S/No	Faculties of learning	Sub-disciplines or Department	No. of studies
1	Environmental sciences	Geography, Surveying and geo-informatics, Estate Management, Urban and Regional Planning, Environmental Technology, Hydrology and Water Resources.	18
2	Agricultural Sciences	Soil Science, Crop science, Aquaculture and Fisheries Management, Animal Science Agricultural Economics	10
3	Engineering Sciences	Civil Engineering, Water Resources and Environmental Engineering, Agricultural and Bioresources engineering	11
4	Natural Sciences	Geology, Chemistry and Physics-meterology	5
5	Planetary Sciences	Geology and Geodynamics	2
6	Social Sciences	Economics, Sociology	3
7	Geo Sciences	Geophysics	3
8	Education	Environmental Education, Science Education	8
9	Government Agencies	National Water Resources Institute, Nigerian Meteorological Agency, National Hydrological Services Agency, Federal ministry of the Environment	4
10	Others	NASDA, Archeology and Tourism, NGOs	5
	Total		67

This supports the view of several scholars such as Ayoade, (1974) and Oyebande et al (2006) that climatic science is an interdisciplinary field of study. Also noticeable in the works reviewed is the high level of collaboration. This shows that Nigerian scholars are eager and willing to work together and to build new knowledge about the potential effects of the changing climate system.

Thirdly, the works reviewed suggest that research efforts in climate change hazard in Nigeria are largely adhoc, fragmented and limited in scope. Many of the reviewed works were not published on the internet and are rather sketchy-failing to synthesize and communicate existing and emerging knowledge for adaptation, vulnerability, policy formation etc. Few of the works actually provided development drivers (governments, private sector, NGOS, industries etc.) with clear and reliable information to assess risks and develop area-specific adaptation strategies. This shows that there is urgent need in Nigeria to conduct strategically focused research on specific areas of need and to link existing researches to organizations and to conduct multidisciplinary and cross-sectoral investigations.

Fourthly, most of the researches reviewed were probably done for the sake of journal publications; for the need of the researcher and not for what other sector of the economy (agriculture, industry, power, commerce etc) wants. Information on financial assistance, acknowledgement commissionship (of research) linkages and the interest of governments/ other users of the information generated from the researches were generally lacking. This in our view contrasts dramatically with what is obtained in other countries where strong linkages between researches and end-users of research outcomes exist.

Finally, many the researches reviewed were short-term researches (lasting for less than one year). This probably due to the fact that they were not funded otherwise a normal problem-solving research on the climate change hazard on any sector of the economy should span (ignore) over at least 12 calendar months and such researches need to be properly funded.

## **XI. SUGGESTED NEW DIRECTION FOR RESEARCHES ON CLIMATE CHANGE HAZARD IN NIGERIA**

In this review, we have examined the scope of the work done by the Nigerian scientific community in the area of climate change. As the paper shows, a range of issues dealing the causes, effects, vulnerability, adaptation, perception and adjustment have been repeatedly researched on. The issues of risks and/or damage assessment have not received adequate attention despite the fact that the negative impacts of the climate change phenomenon were generally discussed by most of the researches. Also studies on prediction and forecasting are

scarce and between. This may not be unconnected with data limitations-there are very few functional hydro-meteorological and gauge stations keep up to-date-records in Nigeria. Against this background the paper suggests that research efforts should be directed to the following.

- 1) Addressing critical knowledge gaps on the effects of climate change hazard key sectors in Nigeria and establishing suitable methods for identifying and assessing potential adaptation strategies.
- 2) Developing climate changes action plans for vulnerable areas/sectors in Nigeria and providing guidelines for the implementation of such plans.
- 3) Developing improved regional climate projections and projections of extreme weather events in various parts of Nigeria.
- 4) Conducting interoperated studies on predictions/forecasting of climate change as well as impacts on priority sectors and vulnerable regions such as the Niger delta and coastal cities like Lagos and Port-Harcourt
- 5) Developing better regional climate models that shows relationship between climate variability and physiological and ecosystem processes.
- 6) Undertaking integrated assessment/ of the impacts and analysis that define/identify and describe viable response options by governments and disaster managers and other stakeholders in Nigeria for future changes in climate
- 7) Identifying and assessing social and economic costs of climate change on various sectors of the Nigerian economy including the cost of not taking adaptation action.
- 8) Improving regional climate modeling and downscaling techniques.

## **XII. CONCLUSION**

Climate change, as shown by the studies reviewed, is a topical issue that engages the attention of many researchers in Nigeria. This is probably due to numerous climatic extremes (floods, droughts, heat and cold waves etc) experienced in various parts of the country. These extreme hydrological events affect Nigerians and their activities. Concerned about these effects, therefore, the Nigerian scientific community, are forced to seek ways of finding lasting solutions to the challenges of climate change through frequent studies. A lot of information about how climate is changing and the broad physical impacts which these change have on various sectors of the Nigerian economy have been generated.

However, adequate and relevant information about the projections of climate change, particularly of extreme weather events, social and economic trends that affect climate change vulnerability, and the social and economic impacts of climate change in specific areas/sectors in Nigeria are generally lacking. To overcome this, we suggest that governments and other stakeholders should assist in building the capacity of Nigerian scientists in climate change science so that they can generate adequate information, synthesize knowledge, undertake long-term researches coordinate and commission research activities and provide adequate information for decision makers in a form that will be relevant to their sectoral or regional needs.

## **REFERENCES**

- [1] Abu, B. (2007): Sea level rise and the Niger delta of Nigeria. *Journal of Wetland*, 3(1): 44-52.
- [2] Adefolalu, D. O. A (2007): "Climate change and economic sustainability in Nigeria", Paper presented at an International Conference on climate change, Nnamdi Azikiwe University, Awka 12-14 June 2007.
- [3] Adejuwon S.A. (2004): Impacts of climate variability and climate change on crop yield in Nigeria. Stakeholders' workshop on assessment of impacts and adaptation to climate change.
- [4] Adejuwon, S.A. (2004): "The impacts of climate variability and climate change on crop yield in Nigeria". Paper presented at stakeholders' workshop on assessment of impacts and adaptation to climate change Obafemi Awolowo University, Ile-Ife, Nigeria.
- [5] Adelalu, T.G (2012): Climate variability and river Benue discharge in Jimeta, Yola Area, Nigeria" Paper delivered at the Annual National conference of the Nigerian Association of Hydrological Sciences (NAHS) at Abeokuta, Ogun State Benin Sept 12-10, 2012.
- [6] Agunwanba J.C. (1994): Impact of climate change on water availability and implication, *Global climate change, impact on every development*, 75-79.
- [7] Ajaero, C.K (2009): "Climate Change: Concepts and Issues" Paper Presented at a Conference on Climate Change and the Nigerian Environment Organized by the Department of Geography University of Nigeria, Nsukka. Between June 29<sup>th</sup> and July 2<sup>nd</sup>
- [8] Ayoade, J.O. (1995): Climate and human welfare: Inaugural lecture delivered at the University of Ibadan, Thursday, June 15, 1995, Ibadan University Press.
- [9] Ayoade, J.O. (2003): *Climate Change: A synopsis of its nature, causes, effects and management* Ibadan, Vantage Publishers.

- [10] Barmet, T.P, Adam, J.A. and Letternmer, D.P. (2005): "Potential Impact of Global Warming on Water Resources in snow dominated regions" Findings of the IPCCX, Regional Assessment of Vulnerability for North America
- [11] Bayon, C.E. (2009): "Climate Change, Population Drift and Violet Conflict Over Land Resources in Eastern Nigeria" *Journal of Human Ecology* 24(4). 311-124
- [12] Bello N.J., (1998): A study of evidence of change based on rainfall seasonality and the reliability of rainfall regime in Nigeria. *Proceedings of Sustained Africa*, 4: 30-32.
- [13] Efe, S.I (2008b): Climate of Delta state in F.O. Odemerho, et al (eds) *Delta in Maps* Occasional Publication of the Department of Geography and regional Planning, Delsu, Abraka, 24-30.
- [14] Efe, S.I. (2008b): Climate change: A Challenge to my Generation. Being a paper presented at a conference organized by the Nigerian international secondary schools model united nation (Nissmun) Club of infant Jesus Academy, held on July 5<sup>th</sup>, 2008, at infant Jesus academy, Asaba, 2-13.
- [15] Evans, O.A. and Adejuwon, S.A. (1994): Regional climate change, implication on energy production in the tropical environment, *Global climate change, impact on every development*, 1-14.
- [16] Igwebuike, M.N. (2009): "Causes of Climate Change" Paper Presented at a Conference on Climate Change and the Nigerian Environment Organized by the Department of Geography University of Nigeria, Nsukka. Between June 29<sup>th</sup> and July 2<sup>nd</sup>
- [17] Igwebuike, M.N. (2009): "Climate Change, Agriculture and Food Security" Paper Presented at a Conference on Climate Change and the Nigerian Environment Organized by the Department of Geography University of Nigeria, Nsukka. Between June 29<sup>th</sup> and July 2<sup>nd</sup>
- [18] Katanga, B. (2007): Climate change and global environment: The fate of developing nations. *Journal of Environment and Development*. 2(1): 78-88.
- [19] Madu, I.A. (2009): "The Effects of Rainfall Variability on Crop Productivity in Northern Nigeria" Paper Presented at a Conference on Climate Change and the Nigerian Environment Organized by the Department of Geography University of Nigeria, Nsukka. Between June 29<sup>th</sup> and July 2<sup>nd</sup>
- [20] Msumba, A. 2006): Global climate change and sustainable human development. *Journal of Arid Environment*, 5(1): 18-24
- [21] Nigerian Environmental Study/Action Team, 2004: Climate Change and Nigeria: A guide for policy maker, Canada-Nigeria climate change capacity development project.
- [22] Nimet (2010): Climate and water information for safety and sustainable Development, Drought and flood monitor bulletin, Abuja, Nigeria, 1-2
- [23] Njoku, J.D. (2006): "Analysis of the effect of Global warming on Forests of Southeastern Nigeria using remotely-sensed data Unpublished PhD Dissertation, Department of Geography and Environmental Management, Imo State University, Owerri, pp 270.
- [24] Njoku, J.D. (2009): "Climate Forcings of Forest Cover: Identification and verification of Pathways for the Transformation of Food Systems in Southeastern Nigeria" Paper Presented at a Conference on Climate Change and the Nigerian Environment Organized by the Department of Geography University of Nigeria, Nsukka. Between June 29<sup>th</sup> and July 2<sup>nd</sup>
- [25] Nnaji, A.O (1998): Climate forcing, Precipitation Variability and Rainfall Forecasting Models for Northern Nigeria. *Proceedings of the 94<sup>th</sup> Annual Conference of Association of American Geographers*. Boston Massachusetts. March 26<sup>th</sup>-29<sup>th</sup>.
- [26] Nnaji, A.O. (1999): Climate Variation in the Sub-Saharan Region of West Africa: A Study of Rainfall Variability in Northern Nigeria," Unpublished PhD Dissertation, Department of Geography, University of Florida, Gainesville. Pp 182.
- [27] Nnaji, Chubueze E. (2009): "Climate Change and Socio-Economic Development in Nigeria" Paper Presented at a Conference on Climate Change and the Nigerian Environment Organized by the Department of Geography University of Nigeria, Nsukka. Between June 29<sup>th</sup> and July 2<sup>nd</sup>
- [28] Nwafor, J.C. (2007): "Global climate change: The driver of multiple causes of food insecurity in sub Saharan Africa". Paper presented at the international conference on climate change and economic sustainability. Nnamdi Azikiwe University, Awka, 12-14 June 2007.
- [29] Obeta, M.C. (2009): "Climate Variation and Incidence of Selected Waterborne Disease in Nigeria: A Time-Series Analysis" Paper Presented at a Conference on Climate Change and the Nigerian Environment Organized by the Department of Geography University of Nigeria, Nsukka. Between June 29<sup>th</sup> and July 2<sup>nd</sup>
- [30] Obih, I.B. (2002): "Climate Change: Causes, Analysis and Management", Paper presented at a climate change workshop, Abuja, 2002.
- [31] Obioha, E. (2005): Climate change, population Drift and violent conflict over land Resources in north eastern Nigeria. *Journal of Human Ecology*, 23(4): 311-324.

- [32] Obioha, E. (2008): Climate change, population Drift and violent conflict over land Resources in north eastern Nigeria. Journal of Human Ecology, A paper presented at Human Security and Climate Change Conference. At Asker, Oslo, June 21-23.
- [33] Odjugo P.A.O. (2000): Global warming and human health: current and projected effects. Environmental Analar No. 5:428-449
- [34] Odjugo P.A.O. (2001): Global warming and food production: A Global and regional analysis. Africa Journal of Environmental Studies, 2(2): 85-91.
- [35] Odjugo P.A.O. (2005): An analysis of rainfall pattern in Nigeria. Global Journal of Environmental Sciences, 4(2): 139-146.
- [36] Odjugo P.A.O. (2007): Evidences of climate change. Paper presented at the international conference on climate change, Nnamdi Azikiwe University, Awka, 12-14 June 2007.
- [37] Odjugo P.A.O. (2008): The Impact of Climate Change on Water Resources: Global and regional Analysis, Journal of Environment, Yola (in press).
- [38] Odjugo P.A.O.; Ikhuoria, A.I. (2003): The impact of climate change and anthropogenic factors on desertification in the semi-arid region of Nigeria. Global Journal of Environmental Science, 2(2): 118-126.
- [39] Okali, D. and Eleri, E.O. (2004): Climate Change and Nigeria: A guide for Policy Makers. The Publication of the Nigerian Environmental Study Action Team (NEST).
- [40] Okali, D.U. (2008): Climate change and sustainable development: challenges to Nigeria, in: Contemporary issues in sustainable development: Lessons for, and challenges to Nigeria. (eds, Popoola, Adeforamiri and Olajide), Ibadan Postgraduate School Publication.
- [41] Oladipo E. (2008) Climate Change and Sustainable livelihoods: Greening Options of Nigeria; In Report of the first national Environment; sustainable Greening the environment for sustainable economic development (20<sup>th</sup>-21<sup>st</sup> Oct.)
- [42] Olaniran, O.J. (1991): Evidence of climate change in Nigeria based on annual rainfall series of rainfall of different daily amounts, 1919-1985. J. Climate change, 19: 319-341.
- [43] Oluwatuyi, O and Jegede A (2009): “Environmental Consequences of Global Warming: An Overview” Paper Presented at a Conference on Climate Change and the Nigerian Environment Organized by the Department of Geography University of Nigeria, Nsukka. Between June 29<sup>th</sup> and July 2<sup>nd</sup>
- [44] Oluwatuyi, O. (2009): “Are Experiencing Drier Conditions in the Sahel Zone of Nigeria”. Journal of Applied Sciences 3(12) 1746-1751
- [45] Onuoha C.M. (2008a) “Sustainable Development and Poverty Reduction in Nigeria” In conference proceedings at the 3<sup>rd</sup> Green Economics Annual International college, Mansfield College, Oxford University, Uk (July 17-18).
- [46] Onuoha C.M. (2008b) Understanding climate change in Africa economies. *The Green Economist-International Journal of the Green Economics, institute, UK*; Vol. 3 Issue2, autumn ([www.greeneconomics.org.uk](http://www.greeneconomics.org.uk))
- [47] Onyebande, (1975): Water Resources Problems in Africa, Problems and perspectives. International African institute, London pp 40-45
- [48] Onyebande, L. Amani, A., Mahe, G. and Niang-Diop, I. (2002): Climate change water and wetlands in West African: Building linkages for their Integrated Management. An IUCN-BRAO Working Paper pp 1-69
- [49] Rakiya. A.M. (2008): Nigeria: Stemming the Impact of Climate Change. Daily Trust Distributed by all Africa Global; Media: <http://allAfrica.com>
- [50] Ubachukwu, N.N. (2005): Climate and Agriculture in Northwestern Nigeria, Unpublished B.Sc. Project, University of Nigeria, Nsukka.
- [51] Umar, A.T. (2008): “Global warming and the Millennium Development Goals (MDGS) in Nigeria: A way forward” Paper delivered at the 5<sup>th</sup> Annual conference of the Association of Nigerian Geographers (ANG) at the University of Calabar, 25<sup>th</sup>-28<sup>th</sup> August. 47-55
- [52] UNFCCC, (2008): “Background to the Kyoto Protocol” retrieved from <http://unfccc.int/essential/background/items/2877.php> on 29.12.08
- [53] Climate change impact on people’s livelihood aspects including their health, access to water and natural resources and homes and infrastructure.