

Climate Change and Its Impact in Nigerian Economy

Nebedum Ekene Ebele¹ and Nnaemeka Vincent Emodi^{2*}

¹Department of Climate Change, Hallym University, 1 Hallymdaehak-gil, Chuncheon, Gangwon-do, 200-702, South Korea.

²College of Business, Law and Governance, James Cook University, P.O.Box 6811, Cairns, QLD 4870, Australia.

Authors' contributions

This work was carried out in collaboration between both authors. Author NEE designed the study, wrote the protocol and wrote the first draft of the manuscript. Author NVE managed the literature searches and revised the manuscript. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2016/25162

Editor(s):

(1) Alessandro Pezzoli, Water Supply & Wastewater Engineering, Turin Polytechnic, and Department of Meteorology, Turin University, Italy.

Reviewers:

(1) Neha Bansal, Sardar Vallabh Patel University, Gujarat, India.
(2) Anonymous, Dr Y S Parmar University of Horticulture & Forestry, India.
Complete Peer review History: <http://sciencedomain.org/review-history/14301>

Review Article

Received 20th February 2016
Accepted 8th March 2016
Published 22nd April 2016

ABSTRACT

Climate change has become a great challenge to our generation and its impact is felt in almost every society in the world. Nigeria as a developing country with a population of about 180 million is likely to be adversely impacted by climate change due to its vulnerability and low coping capability. Evidences have shown that climate change impacts on Nigeria arises from various climate change related causes experienced due to the increase in temperature, rainfall, sea level rise, impact on fresh water resources, extreme weather events, flooding, drought in the north and increased health risk. The study reviews some existing literatures, information, policies, and data on climate change in Nigeria and its impact on the various sectors of the economy. The finding for this paper indicates that many sectors of Nigerian economy appear to be directly vulnerable to the impacts of climate change such as agricultural sector, health, energy, etc. This generally affects the growth of economy. The impacts of climate changed highlighted in this study raise the need for more support in research and education awareness on the impact of climate change in Nigeria. This review attempts to create awareness on the impacts of climate change in Nigeria and presents some policy recommendations for adaptation and mitigation measures to tackle the challenges.

*Corresponding author: E-mail: emeka50@snu.ac.kr;

Keywords: Climate change; impact; Nigeria; mitigation and adaptation.

1. INTRODUCTION

Climate change is an undeniable environmental threat of the 21st century which the world is currently experiencing and seeking measures to adapt and mitigate its impact. The United Nations Framework Convention on Climate Change (UNFCCC) defines 'climate change as a change which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere over comparable time periods' [1]. Climate change is already beginning to transform life on earth. Around the globe seasons are shifting, temperatures are increasing and sea levels are rising. Climate change affects the whole world though the poorest people who contribute least to the change are the ones who suffer the most. Scientific research shows that the net climate resulting from the change will largely be driven by atmospheric greenhouse gases [2].

The Germany Advisory Council on climate Change noted that climate change is a threat already having substantial impact on humans and natural ecosystem both in developed and developing countries but at varying degree [3]. For developed countries which are the major contributor to climate change, the impacts they face are less severe due to, high adaptation techniques, and technologies, effective research proven policies, mechanized agricultural system and wealthy economic status [4]. The presence of these factors has enabled the developed countries to adapt and curtail the adverse impacts of climate change. But for the developing countries like Nigeria and many more, the impact is greatly felt due to the poor adaptation capacity, lack of technology etc.

Concern over the negative impact of climate change has strengthened fears that environmental degradation and demographic pressures will displace millions of people in Africa and create serious social upheaval. Most scientists studying the potential impact of climate change have predicted that Africa is likely to experience higher temperatures, rising sea levels, changing rainfall patterns and increased climate variability, all of which could affect much of its population [5]. The core challenge is that climate change threatens to overburden states and regions that are already fragile

and conflict prone. A United Nations report predicts that access to water may be the single biggest cause of conflict and war in Africa in the next 25 years. Such wars are most likely to be in countries where rivers or lakes are shared by more than one country [6]. Between July 2011 and mid-2012, a severe drought affected the entire East Africa region and was said to be "the worst drought in 60 years.

It is important to recognize that the risks are not just of a humanitarian nature; they also include political and security risks that directly affect African governments in particular and the global community in general [7].

Climate change will negatively affect Nigerian economy with various observable impacts ranging from significant reduction in agricultural productivity to increase in illness, morbidity and mortality rate [8]. The energy sector has not also be left out because climate change has impacted the hydropower plants which are source of electricity for the country. Many other sectors like the transportation, tourism and manufacturing sectors have all been affected which in all generally affects the entire Nigerian economy and it's GDP. As per studies conducted by Department for International development (DFID), it concluded that climate change will cost Nigeria between 6 percent and 30 percent of its GDP by 2050 worth between \$100billion and \$460 billion [9].

This study compiles and summarizes the existing knowledge about observed and projected impacts of climate change on various sector of Nigerian economy. This study aims at the following:

- Identifying the perceived impacts of climate change in various sectors of Nigerian economy.
- To contribute to a better understanding of the possible economic and physical effects induced by climate change in various sectors of Nigerian economy.
- To create awareness and preparedness for climate change issues and to also suggest responsive adaptation measures to help offer solution.

The rest of this paper is organized as follows. Section 2 describes the causes of climate change on the global scene. Section 3 further explains the climate change situation in Africa. Section 4 discusses on the impact of climate change in Nigeria, which includes the agriculture, water, health, energy and other sectors of the economy. Section 5 concludes the study with some recommendation on mitigation and adaptation strategies.

2. CAUSES OF CLIMATE CHANGE

Climate change is caused by two basic factors which include natural process (Bio geographical) and human activities which are also known as (Anthropogenic) (see Fig. 1). The earth's climate can be affected by natural factors that are external to the climate system such as changes in volcanic activity, solar output and earth's orbit around the sun, these factors and its effects have relatively short term effects on climate [10].

The Anthropogenic factor which are human activities that emit large amount of greenhouse gases into the atmosphere that depletes the ozone layer or activities that reduce the amount of carbon absorbed from the atmosphere. Human activities such as burning of fossil fuels, gas flaring, urbanization, agriculture and changes in land use like deforestation release greenhouse gases (GHG's into the atmosphere which increases the already existing concentration of these gases. The human factors have been proven to be responsible for the ongoing unequivocal climate change or global warming [11].

According to the South African Confederation of Agriculture Union, the main GHG's are Carbon dioxide, methane and nitrous oxide which account for 80%, 14% and 6% of the total GHG emission respectively [12]. GHG's are good absorbers of heat radiation coming from earth's surface acting like a blanket over the atmosphere, keeping it warmer than it would be.

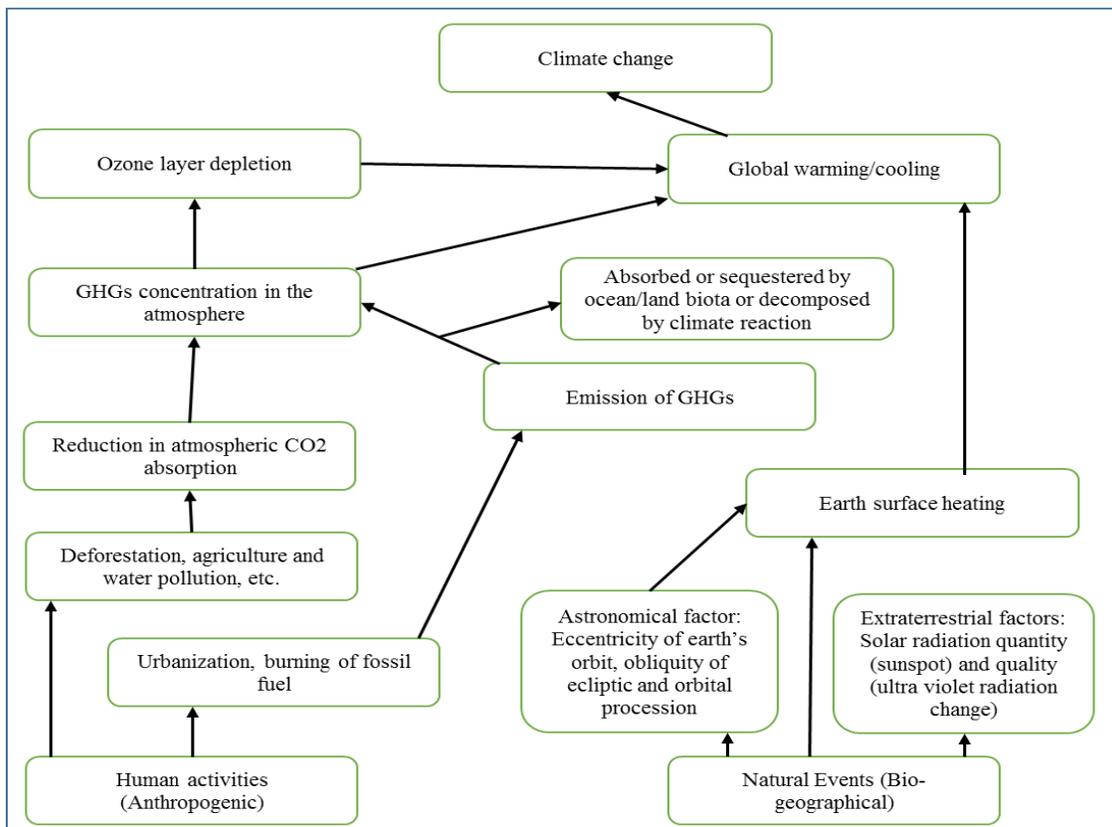


Fig. 1. Causal factors of climate change

Source Ref: [13]

It has been suggested that if the current trends of anthropogenic GHG emissions continue through 2030, earth is likely to experience an average rise in temperature ranging from 1.5°C to 4.5°C [14]. It is well established that the activities of developed nations are mostly accountable for climate change, but developing nations are those suffering more due to inability to cope as a result of poverty and low technological development [15].

3. CLIMATE CHANGE IN AFRICA

Climate change is already happening and small changes in average conditions such as sea levels, or temperature can result in large changes in frequency of extreme events which are highly detrimental to our society. A 0.2 m rise in sea level will inundate 3,400 km of Nigerian coast-land and 1.0 m rise in sea level will cover 18,400 km and submerge the Delta's entire oil and gas infrastructure [16]. Nigeria is already

experiencing adverse climate conditions with negative impacts on the welfare of the people. It is estimated that between 75 million and 250 million people in Africa may be exposed to increased stress like scarcity of water, environmental stress and food security stress, due to climate change by 2022 [11]. The area suitable for agriculture, the length of farming seasons and yield potentials are expected to decrease due to climate change.

Climate change has been confirmed following release of the 4th IPCC Assessment report. Africa will be worst hit by the effects of climate change where Nigeria is part of and as a result of this, Nigeria is vulnerable to the effects of climate change. Available evidences show that climate change will be global, likewise its impacts, but the biting effects will be felt more by the developing countries, especially those in Africa (Fig. 2 and Fig. 3) due to their low level of coping capabilities [17,18].

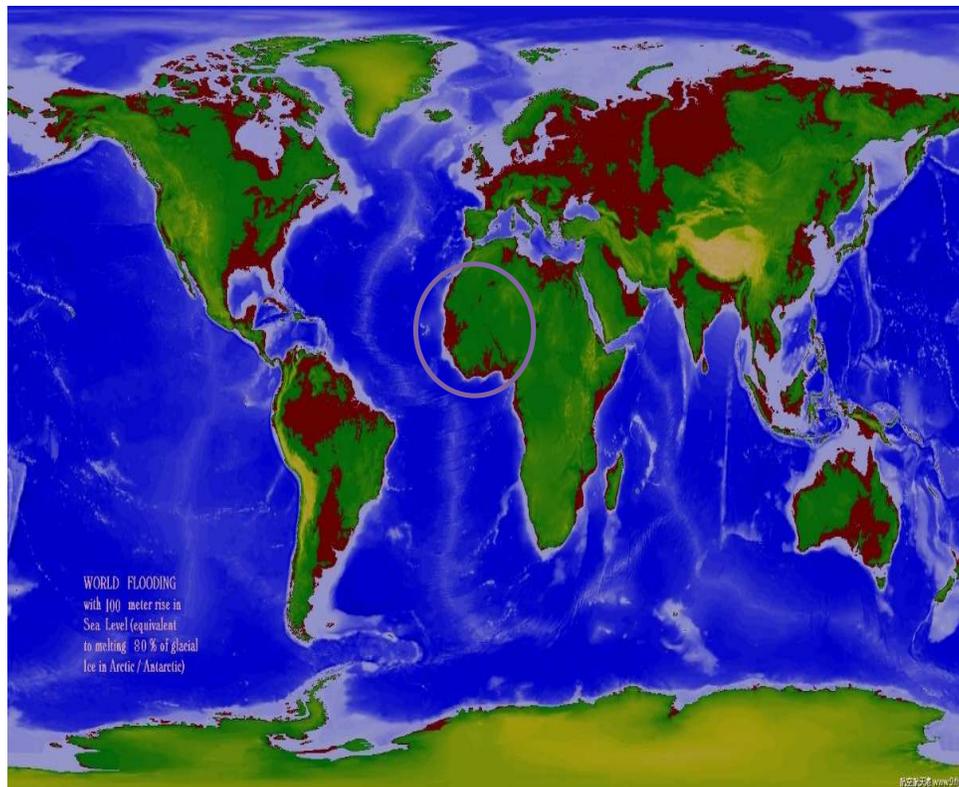


Fig. 2. Affected regions at sea level rise (100 meters)¹
Source: Ref. [19]

¹ A map showing the extent of flooding and vulnerability at 100 meters sea level rise and in the circled area is where Nigeria is located.

Researches have shown that Nigeria is already plagued with ecological problems which have been linked to the ongoing climate change [20,21]. Recent evidence indicates that the world has already warmed by 0.8°C since the pre-industrial era and under a Business as usual (BAU) scenario (Fig. 3), global mean temperature could reach around 2°C by 2060 [22]. Climate change and global warming if left unchecked will cause adverse effects on livelihoods in Nigeria, such as crop production, livestock production, fisheries, forestry and pest harvest activities because the rainfall regimes and patterns will be altered, floods which devastate farmland will occur.

Increase in temperature and humidity would cause increase in pest and disease, also natural disasters like floods, sea level rise and storm surges is anticipated which may cause great havoc to lives and properties. Indeed, in a few conflict-prone spots such as the Niger delta and the arid northeast, this sequence is probably playing out on a limited scale already.

4. IMPACTS OF CLIMATE CHANGE IN NIGERIA

Climate change is having serious and unpredictable impacts on the world. The impacts of climate change are being felt by both developed and developing countries. Many sectors of Nigeria's economy appear to be directly vulnerable to the impacts of climate change. These impacts are currently being experienced on agricultural production, health, biodiversity, social, economic, manufacturing and energy sector, etc.

4.1 Impacts on Agriculture in Nigeria

The concern with climate change is heightened given the linkage of the agricultural sector to poverty. It is anticipated that adverse impacts on the agricultural sector will exacerbate the incidence of rural poverty. Climate change has the potential to affect African agriculture in a range of ways leading to an overall reduction of productivity which could result to a loss in GDP of between 2 % to 7 % in 2100 in the Sahara and

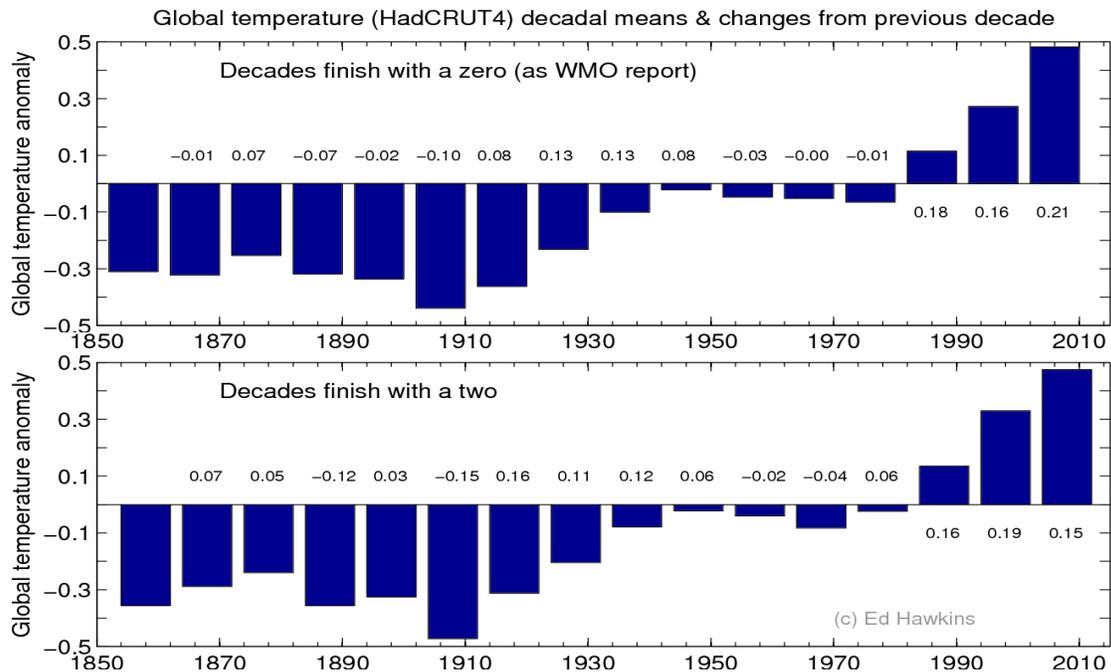


Fig. 3. Global temperature from 1850-2010²
Source: Ref. [23]

² Fig. 3 Showing HadCRUT4 which is a global temperature data set. It showed the decadal rate of global temperature within 2010, decadal temperature at +0.21°C making it the warmest decade since modern measurement began in 1850.

2 to 4% in Western Africa as shown in Fig. 4 [22]. Over 80% of Nigeria's population depends on rain-fed agriculture and fishing as their primary occupation leading to a high risk of food production system being adversely affected by the variability in timing and amount of rainfall.

Crops occupy nearly 94% of the agricultural sector in Nigeria and some areas are already experiencing a loss in length of growing days by 20% [24]. Growth rates of maize, guinea corn, millet and rice are reduced by rises in temperature. Warming trends also make the storage of root crops and vegetables more difficult for those without access to refrigerators. Agriculture in will be adversely impacted by increasing variations in terms of timing and amount of rainfall. Water deficits may also depress crops and livestock production and hence, food supply necessitating imports [8].

As noted by Ref [25], climate change has caused a shift in crop cultivated in northern Nigeria. The preferred crops the farmers cultivated were guinea corn followed by groundnut and maize, but due to increasing temperature and decreasing rainfall amount and direction occasioned by climate change, the farmers as a means of adaptation in 2007 shifted to the production of millet followed by maize and beans.

Another major problem of agriculture in Nigeria due climate change is the reduction of arable lands. While the sea incursion is reducing the arable lands of the coastal plains, the desert encroachment with its associated sand dunes is depriving farmers of their agricultural farmlands and grazing lands. As per studies conducted by Ministry of environment in Yobe state, it concluded that sand dunes and desert encroachment has covered from 25,000 hectares to more than 30,000 hectares ,with its attendant negative impact on food and livestock production [26].

During the worst of the drought in the 1970's and 1980s, close to one million livestock were lost, affecting meat and dairy supply throughout the country [13]. High temperatures have hindered livestock (sheep, goat, cattle, poultry and piggery) production through retarded cycles, reduced meat and milk outputs, as well as their grazing lands. Livestock mortalities (stock losses) increased in poultry, piggery and rodentary production systems to the level of at least 15% per annum. Animal production is affected due to increase in disease and pest (Including PPR, food rot, mange etc.) under the influence of climate change impacts that cut investment profits in livestock production system by more than 20% per annum [27].

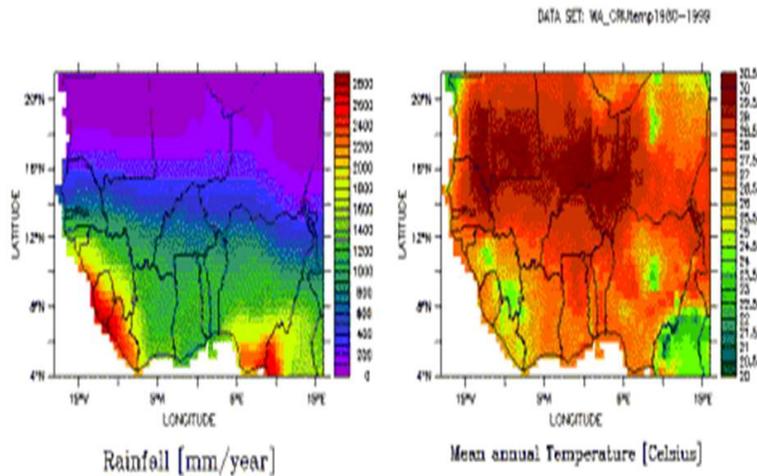


Fig. 4. Percentage change in annual rainfall and temperature 1980-1999³
 Source: Ref. [21]

³ Fig. 4 is a CRU Temperature data set showing temporal distribution of temperature and rainfall from 1980-1999. The set shows an annual rainfall of 2800mm/year and a mean annual temperature of 30.5°C. This temporal distribution is anticipated to contribute to climate change impacts ranging from flooding, sea level rise, heat wave, reduction in length of farming seasons and yield potentials.

Available evidence has shown that the coastal regions will be hit as climate change upsets ocean currents and fisheries [28]. Major changes on fish spawning patterns have already been observed. In the coastal zone, the loss of mangroves as sea level rises will have serious repercussions for fishing as mangroves acts as a sanctuary for young fish to mature [29]. As per study conducted on climate change in Nigeria by Nigerian Environmental Study /Action Team (NEST), it concluded that since 2001 till date, the fishing activities in the various Eco zones of the Nigerian coastal regions has drastically reduced due to the present rise in sea level and heavy rainfall and this has caused a great decline in the fish production business in these areas [30].

Also other effects are flooding of fish ponds especially those sited in wetlands and farmlands nationwide. Increases in the severity of storms will threaten fishing vessels and crew thereby affecting the fish farmers on board. The viability of inland fisheries is threatened by increased salinity and shrinking rivers and lakes [31]. Also, Gwary in his work indicates that what is left of Lake Chad river which provided a lifeline to nearly 30 million people in four countries (Nigeria, Cameroon, Chad and Niger) is not more than 36% of which mostly was attributed to climate change (Lower rainfall and drought) [32].

4.2 Climate Change Impact on Water Resources, Wetlands and Fresh Water Ecology

Climate change will affect the nature and characteristics of freshwater resources on which Nigeria depends on for its freshwater. Changes in weather and climate have been known to profoundly influence water resources, a factor that increases the vulnerability of human to infection. The impacts will vary between eco-zones exacerbating problems of too much water (flood) to little water (droughts) and reduced water quality, salt water intrusion, sea level rise, drying, poor water quality in surface and ground water system [33].

The UN Food and Agriculture Organization rates Nigeria's water use and conservation practices "poor" by international and African standards, and only 8 percent of homes nationwide have treated pipe-borne water [6]. Many countries in Africa live under water stress, defined as those using more than 20 percent of their renewable water resources [3]. About 25% of the contemporary African population experience

water stress, while 69% live under conditions of relative water abundance [34]. But abundance does not necessarily mean availability. As per study conducted on climate change in Nigeria by Nigerian Environmental Study /Action Team (NEST), it observed that various parts of the southern part of Nigeria showed many adverse effect of climate change on the people of the coastal regions [30]. In Akwa Ibom state, which is one of the major coastal cities in Nigeria, Ikot Ibom Itam community, experienced heavy rainfalls which led to the disappearance of about four local streams, flooding of many homes and heavy erosion damages [31].

It has been estimated that a rise in sea level by up to 59cm by 2100 will see several of Nigerian coastal states being submerged in water. Such events will no doubt, disrupt the life and activities of the inhabitants as well wreak great havoc on the ecological balance [35].

UNEP alerts that globally, wetlands have been reduced by 56% and will reduce more by 2100 [36]. It is estimated that one third of all endangered species are dependent on wetlands [37]. Nigeria is richly endowed with abundant wetlands ecosystem the majority of which are found in the Niger, Benue and Chad basin. Wetlands represent 2.6% of the country's area of about 923,768 Km.

In Nigeria, inundation is the primary threat for at least 96% of the land at risk [38]. With a 1-m rise in sea level, up to 600 km² of land would be at risk. This area includes parts of Lagos and other smaller towns along the coast. The periodic overflow of the Atlantic Ocean across the Bar beach bank is an indication of a phenomenon that may accelerate as climate change intensifies and the sea level rise even further. The Niger delta is one of the most important wetlands in Nigeria, the largest in Africa and third largest in the world.

The southern ecological zone of Nigeria largely known for high rainfall is currently confronted by irregularity in the rainfall pattern, while Guinea savannah is experiencing gradually increasing temperature. The Northern zone takes the threat of desert encroachment at a very fast rate of 30 hectares per year, occasioned by fast reduction in the amount of surface water, flora and fauna resources on land [39,40]. There is evidence that climate variability and change has affected Nigeria's water and wetland resources. Several large river and lake system have suffered

marked reduction in flow rate and in the length of their networks in response to reduced rainfall and higher evaporation e.g. Sokoto river system in North West Nigeria in 1965-1995, experienced a great reduction in flow which had direct consequences on the replenishment of most of West Africa's dams as it has resulted in water shortage for hydropower generation, agriculture and urban water supply [41]. Since the mid-sixties (40) years rainfall has decreased by about 15 to 20 % in average over west Africa and run off have decreased by about 30 to 50% or more over most rivers [42].

4.3 Impact of Climate Change on Health Sector in Nigeria

Climate change could negatively impact human health in developing country like Nigeria. Climate change affects human health directly or indirectly in many ways. Changes in temperature, precipitation, rising sea levels, increasing frequencies have great implications on human health in the area of injury, illness, morbidity and mortality. Rising sea level is anticipated as a result of climate change Hence flooding may result which is likely to increase the vulnerability of the poor to malaria, typhoid, cholera and pneumonia. Also temperature and rainfall dynamics may increase the distribution of disease vectors such as dengue, malaria and incidence of diarrheal disease [43].

The Guardian Newspaper of 30th march 2010 reported that within one week in the early of 2009 over 209 people were killed by meningitis in Nigeria and Niger republic [44]. According to [45] climate change will increase threats to human health thereby affecting their productivity. Already a study by the World health Organization shows that climate change is the cause of 150,000 deaths every year [2]. Heavy rainfall events can also carry terrestrial micro-biological agents into drinking water sources which eventually lead to outbreak of Cryptosporidiosis, giardiasis, amoebiasis, typhoid and other infections [46,47].

Recent evidence showed that typhoid is mostly triggered in high temperature and increased humidity over the years is a proof of climate change. A large part of Nigeria's economy is dependent on natural resources that are vulnerable to climate impacts. When resources are affected, the health of Nigerians can also be affected.

4.4 Impact of Climate Change on Energy Generation and Supply in Nigeria

Energy services are necessary inputs for every nation's development and growth. And also the fuel driving the engine of growth and sustainability development is a nation's access to reliable and adequate energy [48]. No economy can sufficiently thrive without adequate access to clean reliable and adequate energy. The supply of energy entails the generation, transmission and distribution of energy, notably electricity.

Nigeria has an abundant supply of energy sources as it's endowed with thermal, hydro, solar, oil resources and yet still described as an energy poor country [49]. Nigeria as a country is highly vulnerable to the impact of climate change because its economy is mainly dependent on income generated from the production, processing, export and/or consumption of fossil fuels and associated energy-intensive products [50].

The US Department of energy asserts that changing climate trends which are expected to continue can restrict supply of secure, sustainable and affordable energy which is critical to the nation's economic growth. Energy services and resources in Nigeria will be increasingly be affected by climate change in trends, increasing variability, greater extremes and large inter-annual variations in climate parameters in some regions. [51]. Climate change is also expected to negatively impact the already limited electrical power supply through impacts on hydroelectric and thermal generation coupled with service interruptions is also expected to result from damage to transmission lines and substation equipment impacted by sea level rise, flash floods and other extreme weather events [52].

Building Nigeria's Response to Climate Change (BNRCC) report asserted that hydropower generation is the energy source most likely to be affected by climate Change as it is sensitive to the amount of, timing and geographical pattern of precipitation as well as temperature. The report also stated that a reduced flow in river and higher temperature reduces the capability of thermal electric generation as higher temperature also reduces transmission capacity. Also excessive drought will lead to higher evapotranspiration that adversely affects water volume thereby reducing hydroelectricity capacity [31]. The BNRCC report is aimed at building informed responses to

climate change in Nigeria by enhancing capacity from community, state and national levels and to implement effective adaptation strategies, policies and actions.

The ability of the Kanji Dam hydropower project to perform as designed has been greatly hampered by the drought which has ravaged most of the West African countries bordering on Sahara for the past three years. The effect of this drought on the power plants has led to a drastic reduction in the expected power supply from Kanji Dam [43].

4.5 Impact of Climate Change to Other Various Sectors

Many other sectors are anticipated to be influenced by climate change that may lead to sea level rise, drought, floods etc. and transport sector, tourism, energy and utility will be among most the worst hit as they are directly affected. Tourism especially the beach based tourism will be negatively affected, the beaches and lagoons will be taken over by water due to sea level rise as in the case of Lagos bar beach and Lekki Island [9].

Nigeria's transport systems will not escape the effects of global warming and climate change. For example, higher sea level rise may require costly changes to other ports and coastal roads and railways as the current means of communications along the coast may be covered by the intruding sea water or washed away by erosion. Changes in lake and river levels would also affect inland navigation [50].

Manufacturing sector will suffer losses from reduced potentials to reduce output requiring agricultural produce as inputs. Sea level rise may lead to flooding which can destroy transportation and other infrastructure as well plants and industrial layouts that can hamper productivity and efficiency in the sector. Oil production wells in the coastal regions will be submerged by sea level rise of 1-3 meters which will cut down the oil production and other commercial activities, which would cost Nigeria \$43 billion in GDP over thirty years [50]. Extreme weather events around the coastal region will threaten rise in the Niger delta [51].

Climate change impact has caused the Nigerian Government a huge sum of expenditure. The Federal Government has disbursed Naira3bn from the Ecological fund in the last two years.

The fund was established to ensure adequate provision of pools of funds to address ecological problems such as flood, soil erosion, desertification and general environmental hazards. A breakdown of the figures indicated that N2.3bn was disbursed for erosion, flood and pollution control and Naira765m was disbursed for the provision of incinerators for six teaching hospitals and three Federal Medical Centers [53]. Also a huge amount of funds is been spent by the government in the treatment and resettlement of victims of increasing environmental disaster linked with climate change.

Today 80% of all the government revenue and 97% of Nigerian foreign exchange come from Niger delta oil. Some hydrological modeling estimates that a 3 feet sea level rise could put nearly all the Delta's onshore oil fields under water [16]. The DFID study concluded that without a strong adaptive and mitigation response climate change would cost the country between 6 % and 30 % of its GDP by 2050, worth between \$100billion and \$460 billion [9].

5. CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Conclusion

Evidences from negative impacts of climate change observed from increase in temperature, rainfall, sea level rise, desertification, flooding and drought, proves that climate change is indeed a reality.

Particular threats are posed to Nigeria's competitiveness in agriculture from changes to rainfall patterns in the north resulting in increased desertification and flooding.

Economic activities in so many states would be affected such as Lagos, Nigeria's commercial hub, which has recently been identified among the 21 cities most likely to be affected by rising sea levels.

The findings of this study indicate that various sectors of Nigeria's economy would be vulnerable to impacts of climate change. It is therefore very paramount that the nation should take proactive measures in her response to this issue. The government and the people of Nigeria should take up the challenge and seek cooperation and collaboration with international agencies in other to create opportunities for

technology and skill transfer to foster better adaptation and mitigation measures. This study henceforth recommends the need for further research on this issue of climate change in other sectors.

It also recommends that productive collaboration between the government, stakeholders and communities is encouraged so that necessary adaptation and mitigation measures can be fully implemented at all levels.

5.2 Policy Recommendations

Nigeria is highly vulnerable to the impacts of climate change and must, therefore as a matter of urgency take steps to reduce its vulnerability, build its resilience and build its adaptive capacity. so henceforth In order to deal with the adverse impact of change on the Nigerian economy and society, certain adaptation and mitigation strategies have to be employed so as to take appropriate actions to prevent or minimize the damages they can cause to the developing economy of Nigeria and livelihood of the people. The following policy recommendations are proposed as follows;

- Adopting improved agricultural systems for both crops and livestock For example, diversify livestock and improve range management; increase access to drought resistant crops and livestock feeds; adopt better soil management practices; and provide early warning/meteorological forecasts and related information.
- Increasing use of climate forecasting to reduce production risk.
- The Federal Government and its agencies should review natural agricultural policies and related programmes so as to encourage and support development initiatives which can introduce newly advanced and proven strategies which will help agricultural production.
- The agricultural and Research institution should commence research into crops that are resistant to drought and heat.
- The River basin Authority should commence design and construction of new water projects for drought management and irrigation farming.
- The Federal Ministry of Environment should check erosion problem by construction of dykes and storm surge barriers against sea level, also development on wetlands, flood plains and area close to sea level, especially by the poor who are most vulnerable to disasters should be stopped.
- Quality health information and robust enlightenment campaigns will help people adapt before any disaster. Campaigns on preventive and defensive medical practices should be taken to the grass roots in local areas and with their local dialects.
- Undertaking research to better understand impacts of climate change on human in respect to Nigeria health sector and status.
- Reinforcing programmes to advocate and promote the relevance of environmental sanitation and waste management facilities so as to reduce exposure and vulnerability of the society and also improving climate – sensitive disease surveillance and control.
- Developing and building actions plans for urban and rural area development for proper settlement so as to reduce vulnerability of the environment.
- Commissioning an extensive study for an up- to- date Greenhouse gas (GHG) inventory, projection and mitigation strategies.
- Relocation of settlers in areas vulnerable to sea level rise and flooding, protection of existing natural barriers, building of sea walls and dune reinforcement.
- Encouraging the use of low cost solar energy cookers instead of wood burning devices which cause deforestation.
- Terrestrial and marine ecosystems that act as carbon sink reservoir to greenhouse gases should be protected and sustained by reducing bushing burning and encourage afforestation, also enforcing laws and penalties on bush burning which destroys fresh grasses for animal grazing.
- Oil spillage and gas flaring in the coastal regions should be checked to help enhance carbon sink and depletion of the ozone layers.
- The use of renewable energy sources such as fuel cells that convert hydrogen fuel directly into electricity without first burning it to produce heat as well as small photovoltaic cells should be encouraged.
- Realignment/ relocation, designing of standards and planning for roads, rail and other infrastructure to cope with warming and drainage effects.
- Also more importantly there is a need to integrate national and international strategies for instance including national

- plans for food security and forest stewardship into adaptation actions, so that international goals under UNFCCC and MDG's are not only met, but mutually strengthened.
- Encouraging greater efforts and expansion of market will improve environmental effectiveness. Efforts can include diverse elements such as emission targets; sectoral, local, sub-national actions; research development and development programmes; adopting common policies; implementing development-oriented actions; or expanding financing instruments.
 - Soliciting for International cooperation to support implementation of adaptation actions, including through vulnerability assessments, prioritization of action, financial needs assessments.
 - Sectoral adaptation plans should be revised and updated at least every 5 years. However, where a sectoral mitigation plan is required under the proposed National Low Carbon Development Bill, both mitigation and adaptation plans should be reviewed in tandem.
 - Adhering to and implementing existing adaptation mechanisms and resources under the Kyoto adaptation protocol designed to mitigate climate change's effects on Africa.
5. Debay T. The impact of climate change in Africa. Institute for Security Studies. Paper 220; 2010.
Available:www.issafrica.org
 6. UN Food and Agriculture Organization. Nigeria water profile. New York: United Nations. Nigerian National Bureau of Statistics. Social statistics Abuja; 2009.
 7. Aaron S. Climate change adaptation and conflict in Nigeria. United states Institute of Peace. Special Report; 2011.
Available:www.usip.org
 8. Usman YD, Dije BI. Potential challenges of climate change to the Nigeria economy. IOSR Journal of Environmental Science, Toxicology and Food Technology. 2013; 6(2):07-12.
Available:www.iosrjournals.org
 9. Department for International Development (DFID). Impact of climate change in Nigeria's economy. Final Report; 2009.
 10. Facts on Climate Change. By Canada's action on climate change.
Available:<http://climatechange.gc.ca/default.asp?lang=En&n=65CD73F4-1>
 11. Intergovernmental Panel on Climate Change (IPCC). Climate change impact, adaptation and vulnerability: Contribution of working group II to the Forth Assessment Reports of the IPCC. Cambridge University Press, Cambridge; 2007b.
 12. South African Confederation of Agriculture Unions, SACAU. Climate change: Key Issues for famers in Southern Africa, opportunities and possible responses. Discussion. 2009;3.
 13. Odjugo PAO. Quantifying the cost of climate change impact in Nigeria: Emphasis on wind and rainstorm. Journal of Human Ecology; 2008.
 14. Porter G, Brown JW. Global environmental politics: Dilemmas in world politics; 1991.
 15. Odjugo PAO. General overview of climate change and spatial planning concerns in Nigeria: Remedial measures for more effective response. J. Hum. Ecol. 2010; 29(1):47-55.
 16. Onofeghara "Nigerian wetlands". L. Awosika, Impacts of global climate change and sea level rise on coastal resources and energy development in Nigeria (DAMTECH NIGERIA LTD, 1995).
 17. Nwafor JC. Global climate change: The driver of multiple causes of flood intensity in Sub-Saharan Africa. Paper presented at the International Sustainability Conference

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. UNFCCC. United Nations Framework Convention on Climate Change; 1992.
2. Nkmedirim LC. Climates in transition: Commission on climatology. Washington DC, Minateman Press; 2003.
3. World Bank. World Development Report; Sustainable development in a dynamic world. Transforming Institutions, Growth and Quality of Life. World Bank Washington DC; 2003.
4. Mcguian C, Reynolds R, Wiedmer D. Poverty and climate change: Assessing impacts in developing countries and the initiatives of the international community, London School of Economics Consultancy Project for The Overseas Development Institute; 2002.

- on Climate change and Economic Sustainability held at Nnamdi Azikwe University, Enugu, Nigeria. 2007;67-72.
18. Jagtap S. Managing vulnerability to extreme weather and climate events: Implications for agriculture and food security in Africa. Proceedings of International Conference on Climate and Economic Sustainability held at Nnamdi Azikwe University, Enugu, Nigeria. 2007; 45-52.
 19. Starts With A Bang. Science Blogs. Available:www.scienceblogs.com/startswithhabang/2010/03/19/one-thing-we-can-all-agree-on (Retrieved on 27th June, 2015)
 20. Adefolalu DOA. Climate change and economic sustainability in Nigeria. Paper presented at the international conference on climate change, Ngami Azikiwe University, Awka. 12-14, June; 2007.
 21. Ikhile CI. Impacts of climate variability and change on the hydrology and water resources of the Benin-Owena River Basin. Ph.D. thesis submitted to the department of Geography and Regional Planning, University of Benin, Benin City, Nigeria. 2007;234-236.
 22. PACJA (Pan African Climate Justice Alliance). The Economic Cost of Climate Change in Africa; 2009.
 23. The Global Climate 2001-2010, A Decade of Climate Extremes. The World Meteorological Organization. Available:http://www.wmo.int/pages/media/centre/press_releases/pr_976_en.html (Retrieved on 26th June, 2015)
 24. Mendelsohn R, Nordhaus W, Shaw D. The Impact of global warming on agriculture: A Ricardian analysis. American Economic Review. 1994;84:753-771.
 25. Scoones I, et al. Introduction: New Directions for African agriculture. IDS Bulletin. Institute of Development Studies. 2005;36(2):1-12.
 26. Yobe State Ministry of Environment (2001) as quoted in Niase A, Afouda A, Amani A, Reducing West Africa's vulnerability to climate change impacts on water resources, wetlands and desertification. IUCN Regional office for West Africa; 2004.
 27. Nkomo JC, Nyong AO, Kulindwa K. The impacts of climate change in Africa. Final Draft Submitted to The Stern Review on the Economics of Climate Change; 2006.
 28. Idowu AA, Ayoola SO, Ikenweibe NB. Implication of climate change in Nigeria. Iranica Journal of Energy and Environment. 2011;2(2):145-152.
 29. Okali D. Climate change and Nigeria: A guide for policy makers. Nigerian Environmental Study/ Action Team (NEST); 2004.
 30. NEST. Facts on Climate Change in Nigeria #5: Repercussions for Coastal Zones and Marines Ecosystems; 2008c.
 31. Building Nigeria's Response to Climate Change (BNRCC) Report. National Adaptation Strategy and Plan of Action on Climate Change for Nigeria. Prepared for the Federal Ministry of Environment Special Climate Change Unit; 2011.
 32. Gwary OM. Climate change, food Security and Nigerian agriculture. A Paper submitted to Federal Ministry of Environment Abuja and UNDP Abuja; 2007.
 33. Chidi HO, Ominigbo OE. Climate change and costal wetlands: Nigeria perspective. International Journal of Environmental Issues. 2010;7(2):216-223.
 34. VÖrÖsmarty CJ, Dougda EM, Green AA, Rarenga C. Geospatial indicators of energy water stress: An application to Africa. Ambio. 2005;34(3):230-236.
 35. Onyeka EM, Adaobi VM. Climate change: A challenge of environmental education in the 21st century. Multidisciplinary Journal of Research Development. 2008;10(5):40-46.
 36. United Nations Environmental Programme (UNEP). The Status of the Nigerian Coastal Zone; 2007. Available:www.unep.org/abdjconvention/docs (On August 2nd 2011)
 37. Asibor G. Wetlands: Values, uses and challenges. A paper presented to the Nigerian Environmental society at the Petroleum training institute, Effurum; 2009. Available:www.nestinteractive.org/climatechangedocs/policymakersoct25.pdf (21st November 2004)
 38. Awosika LF, French GT, Nicholls RT, Ibe CE. 'The impacts of sea level rise on the coastline of Nigeria.' In O'Callahan J, (ed.) Global climate change and the rising challenge of the sea. Proceedings of the IPCC Workshop at Margarita Island, Venezuela, 9-13 March; 1992.
 39. FME. Federal Ministry of Environment Abuja; 2004. Available:www.nigeria.com.ngcichn.org/ccinfo.php

40. Obioha E. Climate change, population drift and violent conflict over land resources in North Eastern Nigeria. *J. Hum. Ecol.* 2008;23(4):311-324.
41. Nwankwoala HO. Case studies on coastal wetlands and water resources in Nigeria. *European Journal of Sustainable Development.* 2012;1(2):113-126. ISSN: 2239-5938
42. Oyebande L, Amani A, Mahe G, Niang-Diop. IUCN-BRAVO working paper on Climate change water and wetland in West Africa; Building Linkages for Their Integrated management; 2002.
43. Haines N, Korats RSD, Campbell-Lendrumb C, Corralan C. Climate change and human health: Impacts, vulnerability and public health. *Journal of the Royal Institute of Public health.* 2006;120:585.
44. The Guardian Newspaper. Heat, Dusty weather Raise Health Concerns. *Climate change Effects in Nigeria* 30th March; 2010.
45. Pittock AB. Climate change: Turning up the heat. *London Earth Scan.* 2005;1(23).
46. Lisle JT. Cryptosporidium contamination of water in the US and UK: A Mini- review. *Aqua.* 1995;44:103-117.
47. Rose JBS. Climate and water borne outbreaks in the US. A preliminary descriptive analysis. *Journal of the American Water Association.* 2000;92:1194-1199.
48. Oyedepo SA. On energy for sustainable development in Nigeria. *Renewable and Sustainable Energy Reviews.* 2012;16: 2583-2598.
49. Ubi PS, Effiom L. The dynamic analysis of electricity supply and economic development: Lessons from Nigeria. *Journal of Sustainable Society.* 2013;2(1):1-11.
50. Ministry of Environment of Federal Republic of Nigeria (MOEFRN). Nigeria's first communication under the United NATIONS Framework Convention on Climate Change. Abuja. National Oceanic and Atmospheric Administration, Silver Spring, MD, USA. 2003;690.
51. US Department of Energy US Energy sector vulnerability to climate change and extreme weather. DOE/PI-003; 2013.
52. Abiodun AA. Waters of Lake Kaniji – Hydrological predictions and performance. *Hydrological Science Bulletin.* 1973;18(3): 321-327.
53. Emeka E. Nigerian Ecological Fund issues, respective, wordpress.com; 2010. Available:<http://climatechange.gc.ca/default.asp?lang=En&n=65CD73F4-1>

© 2016 Ebele and Emodi; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

*The peer review history for this paper can be accessed here:
<http://sciencedomain.org/review-history/14301>*