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The Effect of Climate Change on Water Resource in Nigeria Regions

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ABSTRACT

The study examined the effect of climate change on water resource in Nigeria. The specific objectives were to; Examine the relationship between climate change and water resources and Evaluate the rainfall and temperature variation effects on water resources. The Global Climate Models (GCMs) and Intergovernmental Panel on Climate Change (IPCC) studies were adopted in the study to examine the effect of climate change on water resource in Nigeria. The global climate model was used to mimic the operational process of the atmosphere and the oceans while Intergovernmental Panel on Climate Change (IPCC) design were explored to predict the expected patterns of the climate change. The Regional Climate Model (RCM) was employed and it was apparently found to be the best climate model tools when dynamically downscaling climate features and when forecasting for a specific climate region. The study reveals a clear relationship between climate change and water resource. The climate change has negative effect on water resource and it have serious consequence on human being. And also, their Source of livelihood is seriously affected both during the on raining or dry seasons and the entire environment. The study also revealed that, the climate change is accelerated by human activities.

Keywords: Climate Change, Water Resource, Nigeria.

1. Introduction

Climate Change with all indication has direct effects on water resource in Nigeria.
The climate change on water resource might result, both in positive and negative effects. The effect does not only on water resource also on ecological system, hydrological and biological still affects life and the regional economy. Therefore, the climate change affects regions sustainable development and the world at large. It directly affects the nature and characterize it, mostly on freshwater resources which most Nigerians depends on, even the entire world. In Nigeria, Climate has been changing with substantial evidence. The entire country has witnessed an increase in temperature, flooding, and rising in sea level, heavy rainfall, has given rise to land degradation; drought and desertification, effect on fresh water resources and loss of biodiversity Elisha et al., (2017). The intensities and durations of rainfall has extremely increase in many regions in Nigeria. It is producing a large runoffs and flooding in so many places in the region. In some regions, it has been estimated that, it shall be perpetual increase in the rising of sea level than expected and it shall also lead to exacerbate flooding and submersion of coastal lands. In the Northern region droughts have remain persistent and as the case may be, it is expected to continue (Chukwu, 2015). The trials associated with climate change are not the same across Nigeria Regions. The country has a tropical climate with no less than two precipitation regimes which in the Northern region we have experience low precipitation while in the Southeast and Southwest region we have experience high precipitation. This tendence may lead to aridity, the Northern region may suffer desertification and drought while the Southeast and Southwest region may suffer flooding and erosion (Akande et al., 2017; Nkechi et al., 2016). An analysis carryout by Federal Ministry of Environment in 2014 prove that, the Northern region witness greater degree of vulnerability due to climate change than the Southern regions.

The Problem and Objectives of the Work

The effect of Climate change on water resource is a global problem and almost every nation experience different kind of climate change problem. Our dear country Nigeria, has experienced both temporal and spatial variations in mean atmospheric the air temperature. Since 1901, Nigeria have experienced an increase in temporal air temperature and is about 120 years today. Generally, it has remained as a trend to the nation. The high tendance level of rainfall and temperature within some certain period of time, have so much affected the nation. Most especially on area of water resource.

Objective of the Study

The main objective of this study is to examine the effect of climate change on water resource in Nigeria. The specific objectives are to;
i. examines the relationship between climate change and water resources.
ii. evaluate the high tendance level of rainfall and temperature as a result of the effect of climate change on water resources.

2. Concept of Climate Change and Review of Previous Works

Climate change is well known across the globe as one of the most important environmental problematics the entire world is facing (UNEP, 2013). Because of the environmental problematics that make the climate change the greatest interesting issue across the globe because of its effect on water resource that is so indispensable in the sustenance of man and his environment. Human activities on earth are mostly responsible for climate change. These activities particularly industrialization and transportation in cities have led to increase in concentration of some gases known as Green House Gases (GHGs) in the atmosphere. The Green House Gases which envelope many cities in the world are made up of carbon dioxide (CO2), Chloroflouro carbons (CFCs), Nitrous oxide (N2O), Methane (CH4) and Sulphur hexafluoride Cunningham and Cunningham, (2006). These five Green House Gasses are responsible for an increase in temperature of urban areas more than the surrounding rural areas. This very feature happens all over the globe and produces a major environmental problem known as global warming. Table 1: The percentage of global warming caused by the five greenhouse gases.

Gas	percentage (%)
carbon dioxide (CO2)	64
Chloro flouro carbons (CFCs)	11
Nitrous oxide (N2O)	0.6
Methane (CH4)	19
Sulphur hexafluoride	0.4
Total	100

Source: Cunningham and Cunningham (2006).

There has been a slight departure from the average temperature of about 1 to 1.50c more than what it used to be within the past secular period of about 150 to 100 year ago all over the alobe (Chukwu and Okwu-delunzu, 2015)

Sawa (2010) reported that, places in the Sudano-Sahelian region of Northern Nigeria are facing global climate change in form of observed increase in number of dry spells during the rainy season from May to September. The increasing dry spells adversely affect the growth of the vegetation. This leads to drought and desertification as the vegetation gets degraded. It might be controlled by minimizing human activities in that region more especially those directly involve in extraction of fuel wood and grazing by animals (Chukwu and Okwu-delunzu, 2015). Another manifestation of climate change in Nigeria is the rate of present occurrences of extreme weather events.

The increased in temperatures is by 1.2o C in the coastal area of Niger Delta region and 2o C in the Northern region of Nigeria (Ojugbo, 2010). For 120 years now, Nigeria have been observing an increase in air temperature of 1.70 C. A mean air temperature of increase of 1.70 C was observed in Nigeria for the last 105 years. It is only Mambilla in Obudu and Plateau Jos that have observed the lowest yearly temperature recorded and it is because of semi temperate climatic condition. The high increase rainfall since 1970 in some coastal area in Nigeria is the supporting evidence of climate change in Nigerian regions. A continuous decline in rainfall has persisted and more consisted in the mainland interiors of the semi-arid regions of Nigeria. The high increase in rainfall since 1970 in those coastal regions in Nigeria is somehow responsible for devastating floods in the coastal area like Port Harcourt, Calabar, Warri and Lagos state as observed by Ojugbo (2010).

In recent time in Maiduguri, Katsina, Sokoto, Kano and Nguru in the Northern region have witness of high temperatures and low rainfall (Chukwu and Okwu-delunzu, 2015). The high temperatures and low rainfall in some semi-arid area like Maiduguri, Katsina, Sokoto, Kano and Nguru of the Northern region have caused an increase in evaporation, desertification and drought in Nigeria. This has caused reduction in water levels and a total dry up of small rivers in some parts of Northern regions of Nigeria.

3. Methodology

The Study Area

The study area is Nigeria. It is located between latitudes 40 – 140 north of the Equator, and longitudes 30 – 150 East of Greenwich Meridian. It is situated on the western coast of Africa. It is between the Bight of Benin to the fringes of Sahara Desert between Cameroon and Benin Republic. The Nigeria has a landed area of 923,768 km2 with a coastline of 853 km. The National Population Census conducted in 2006 in Nigeria show the entire population of 140,431,790 people and its make Nigeria the highest population in Africa. In 2012 an estimate of about 170,123,740 people was produce and it make Nigeria 7th most populated country in the world and the highest black.

There is wide variation in the climate of Nigeria due to physical setting. In the south, it is sub-equatorial climate while in the north, it is tropical continental. The vegetation consists of forests in the south and savannah grassland in the north, middle belt is given and Sudan savama. The drainage consists of two major rivers and other smaller ones and lakes. It is important here to state that the two major rivers and their tributaries in both south and the North are important for agriculture as they supply water for irrigation for the production of a variety of food crops, cash crops and market garden crops.

Methods of the Research

The Global Climate Models (GCMs) and Intergovernmental Panel on Climate Change (IPCC) was adopted in the study to examine the effect of climate change on water resource in Nigeria Regions. The global climate model tries to mimic the operational activities of the atmosphere and the oceans while Intergovernmental Panel on Climate Change (IPCC) is use to predict the expected patterns of the climate change IPCC, (2007).

The model of global climate is a mathematical representation of a computer devices. It is dynamic and also in physical processes of the atmosphere, land surface, ocean and cryosphere and their respective interactions, Gleick (1987). The global climate models simulate the extensive topographies of the current climate sensibly well and it is enabled to replicate the observed large-scale changes in climate over the recent historical. Since we can confidently obtain a confined forecast of the response of climate to current and future human activities. The Global Climate Model divides the earth's surface into a series of horizontal boxes known as grids which are detached by similar lines to latitude and longitude. The size of those boxes is determined by the model's resolution. The vertical layers of the Global Climate Model are characterized in different levels in the atmosphere and depths in the ocean Gleick (1987). Most of the Global Climate Models have horizontal resolution ranging from 250 and 600km, and also from 10 to 20 in vertical layers in the atmosphere while. ocean model has a horizontal resolution of about 125 to 250km and the vertical resolution are ranging from 200 to 400m. IPCC, (2007).

Regional Climate Model

A Regional Climate Model (RCM) is seeming to be the best climate model tools when dynamically downscaling climate features and when you are forecasting for a specific region. Raneesh (2014) hint that, regional climate model is the best for dynamical downscaling of climate features for making predictions for a particular region. The result from the Regional Climate Models can serve as an input to hydrologic models if you want to investigate the effect of forecasting the climate change on hydrologic processes. Hydrologic models are mainly used as decision making tools in catchment scale Lenhart, Eckhardt, Fohrer and Frede (2002). Those models usually provide cost-effective by means of evaluating the best alternative management plan within a watershed Raneesh (2014). Quantitative estimate of the effect of climate change on hydrology is usually helpful in recognizing potential water resource challenge and making better planning decisions. Thus, region-specific assessment of the prediction shows the effects of climate change on water resources and how it has emerged as an energetic zone of research Brekke, Norman, Kathy, Quinn and Dracup (2004).

Changes in Temperature and Precipitation

The Changes in temperature and its precipitation forms resulting to climate change are highly predictable to affect the spatial and temporal distribution of water resources. Linsley, Kohler, Paulhus, and Wallace (1982) opine that, the act of acknowledging the determination of the response of a catchment to climate change is the most serious challenge facing water resource managers. The effect of climate change on stream water flow in dry and humid basins. The estimates of freshwater resources in the pole climate change period are articulated in terms of mean yearly river discharges Legesse, Vallet-Coulomb and Gasse (2003), Messager, Galle, Brasseur, Cappelaere and Peugeot at al. (2006). In recent time, IPCC reported that, a long-term study has revealed that, the adverse effects of increasing temperature on physical and biological systems has spread in so many parts of the world today IPCC, (2007). The Global Climate Model projections of rainfall and temperature changes are frequently allied with huge uncertainties Zierl and Bugmann (2005) opine that, the Global Climate Models projected very strong effect of global warming in mountain regions to compared with lowlands regions, due to a decreasing lapse rate Bradley, Vuille, Diaz and Vergara (2006).

The valuation of vulnerability is carried out by assessing the impacts of climate change, by which, it may land on the scenarios of upcoming climate.

Dynamical Downscaling

Dynamical downscaling normally adopts high resolution Regional Climate Models (RCMs) to represent regional sub-domains that is always used to lower resolution coupled in Atmosphere Ocean Global Climate Model (AOGCM) that data as boundary conditions IPCC (20007). Dynamical downscaling has the capacity to capture mesoscale nonlinear effects and produced an intelligible information between multiple climate variables. The kind of models used for dynamical downscaling are somehow formulated using physical principles. The dynamical downscaling can credibly

reproduce a wide broad range of climate around the globe, whereby trying enhance some confidence within their capacity to realistically downscale upcoming climates IPCC (20007). These models are applied to Sea Surface Temperatures (SSTs) at some certain periods of interest. It may also produce some boundary circumstances along the atmospheric boundaries which is between winds and temperatures. Wang, Kang and Lee (2004) hinted that, dynamical downscaling is capable of improving climate simulation at regional scales more especially in some certain regions where land surface are more characteristics and control by regional distribution of climate variables. It has obviously improved our understanding of different climate processes. A huge number of variables at high temporal and spatial scale is available from dynamical downscaling simulations and has adopted physically based models into the system. Nevertheless, the models adopted was for dynamical downscaling and they are computationally demanding. It is only a few numbers of the scenario that possibly runs. It is only the numbers of hydrological study that using dynamical downscaling method and it has recent years increased significantly. Viviroli, Archer, Buytaert, Fowler and Greenwood et al. (2010) reported that, the only alternative we have in this study is to use dynamical downscaling methods and it is represented in Figure 4 below.

4. Results and Discussion of Research Findings

Effects Climate of Change on flooding in Nigeria

In the year 2011 and 2012, Nigeria experienced heavy flood in many parts of the country due to heavy rainfall more especially in the southern regions, western region and Middle Belt. On 28th, August 2011, there was heavy down pour in more than five decades wreaked havoc across the city of Ibadan Suleiman (2014). There was might rainfall on 28 august, 2011 and it hit all-time height of about 187.50 mm and also accompanied by heavy winds gust reaching up to 65 km/hr. The rain was heavier than the previous rains that felled on September 1987, it was the highest rainfall recorded which is about 178.30 mm (IITA, 2011). The month of July/September 2012, Nigeria witness the heaviest flooding in decades worsted than ever and many states was affected across the regions. And get across to the major rivers, Benue and Niger were burst even their banks, it was due to hours of incessant rains. More than one hundred- and forty-(140) persons loss their lives, thousands were displaced across the regions, businesses and schools were closed and thousands of hectares of farmlands all submerged in those mostly affected regions Suleiman (2014).

In Rivers State, Kogi, Benue, Edo and Niger States thousands of people lost their properties and most of them were displaced and temporally resettled in internally displaced camps for about four months. Daily Herald (2012), reported that when President Goodluck Ebere Jonathan visited the most affected States, he describes the floods as national disaster. IFRC (2013) reported that seasonal heavy rainfalls specifically occurred from the months of July to September starting from the year 2010 to 2013. This resulted to disastrous floods which collapsed earth dams and released more water from large dam. It caused massive flooding globe and many lives and properties were destroyed in Nigeria (Suleiman 2014, Chukwu and Okwu-delunzu, 2015).

Plate 1: A flooded community in Isoko South Local Government Area, Delta State. UNICEF Nigeria

Source: Niger Delta Support Programme (NDSP) 2020.

Plate 2: Flood in Benin City.

Source: Etiosa Uyigue and Matthew Agho (2007)

The Ocean and Rising Sea Level

Evidences of climate change in Nigeria confirms the Rising sea level and ocean surge which is as a result of global warming. Awosika and Folorunsho (2005) stated that, one of the most fastest eroding islands that serve as a beach that losses about 30 meters to the ocean yearly is Victoria Island. Ugborodo /Escavors loses about 24 metres annually and by the end of the 21st Century Lekki and Victoria Island were presumed to lose about 584 and 602 square kilometres. The Niger Delta region will experience the worst ever with about 15,000 square kilometres under the sea. In recent time, in august 2012, Lagos State has suffered so much from ocean surges and the degradation of beaches such as Lekki, Alpha and Kurama with loss of lives and properties destroyed. The Atlantic Ocean water surged into people residences; many people were totally displaced from home in Lekki. The Lekki Beach remained under heavy water for some days and the water dry, it wiped off everything.

In Niger Delta region, at this present time, the weather condition has totally changed from primary activities because of crude oil extraction by companies that operate there. Ubani and Onyejekwe, (2013) opine that, the only singular and the most common source of global warming is gas flaring and it directly contribute to the emission of nitrogen (II) oxide, carbon monoxide, and methane which is the cause of environmental pollution, also ecological disturbances. The Gas flaring contaminates the atmosphere and produces emissions that cause thermal pollution as the immediate impact of gas flaring is experienced in high and rising temperature in the communities close to the flare sites and beyond, acidification of rain water and deposit of black powder cover (Alaba et al., 2013). For instance, figure 1 shows Lagos State coastal area rising sea level.

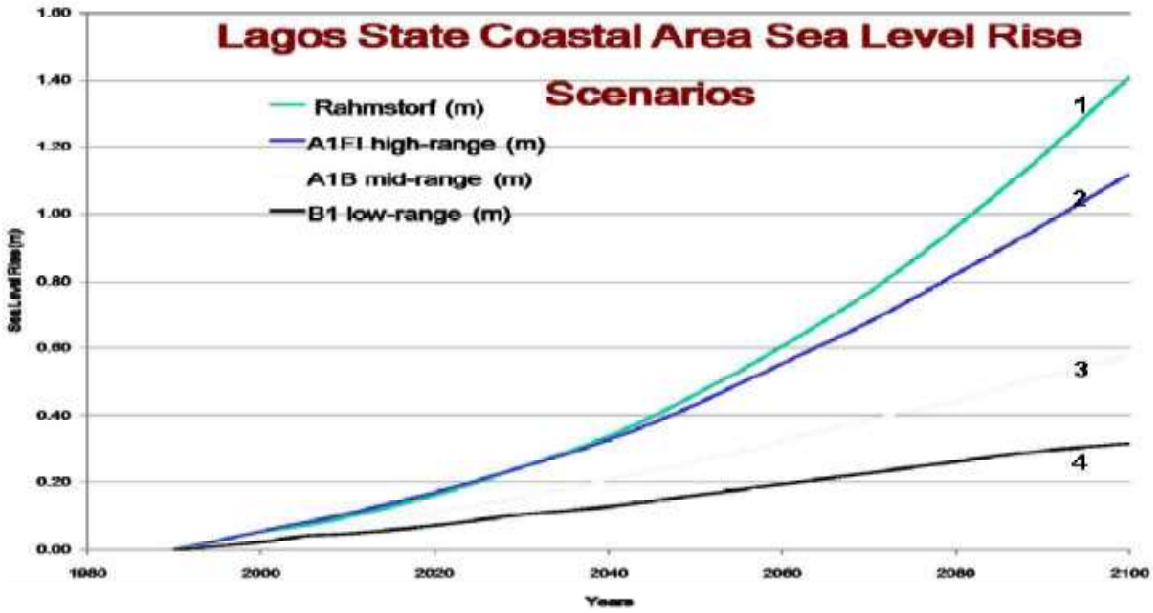


Figure 1: Lagos State sea level rise vulnerability assessment

Source: Abdullahi and Adeogun (2014).

Increase in Temperature

Increase in temperature especially in the semi-arid region has resulted in the less farm work as farmers and other farm workers get tired easily due to dehydration and constant sweating. This was supported by Bello, (2012) who indicate that sudden increase in air temperature in Nigeria was observed as from the early 1970s until 2005 which is linked to the effect of climate change and its associated global warming which was previously reported by several studies. The mean air temperature from 1901-1970 was 26.30 C and increases to 27.80 C from 1971-2005 Bello, (2012). Also, farmers continue to complain that agricultural produce has been very poor these days as they are facing declining crop yields due to weather fluctuations and other environmental threats. As long as the temperatures increase, more water is needed for the people, animals and plant in order to preserve their health (more especially the plant) and to thrive. Many vital economic activities such as energy production to power plants, growing food crops and raising livestock all of those needs water. The quantity of water available for these activities may be reduced as Earth warms and if competition for water resources increases. USGCRP (2014).

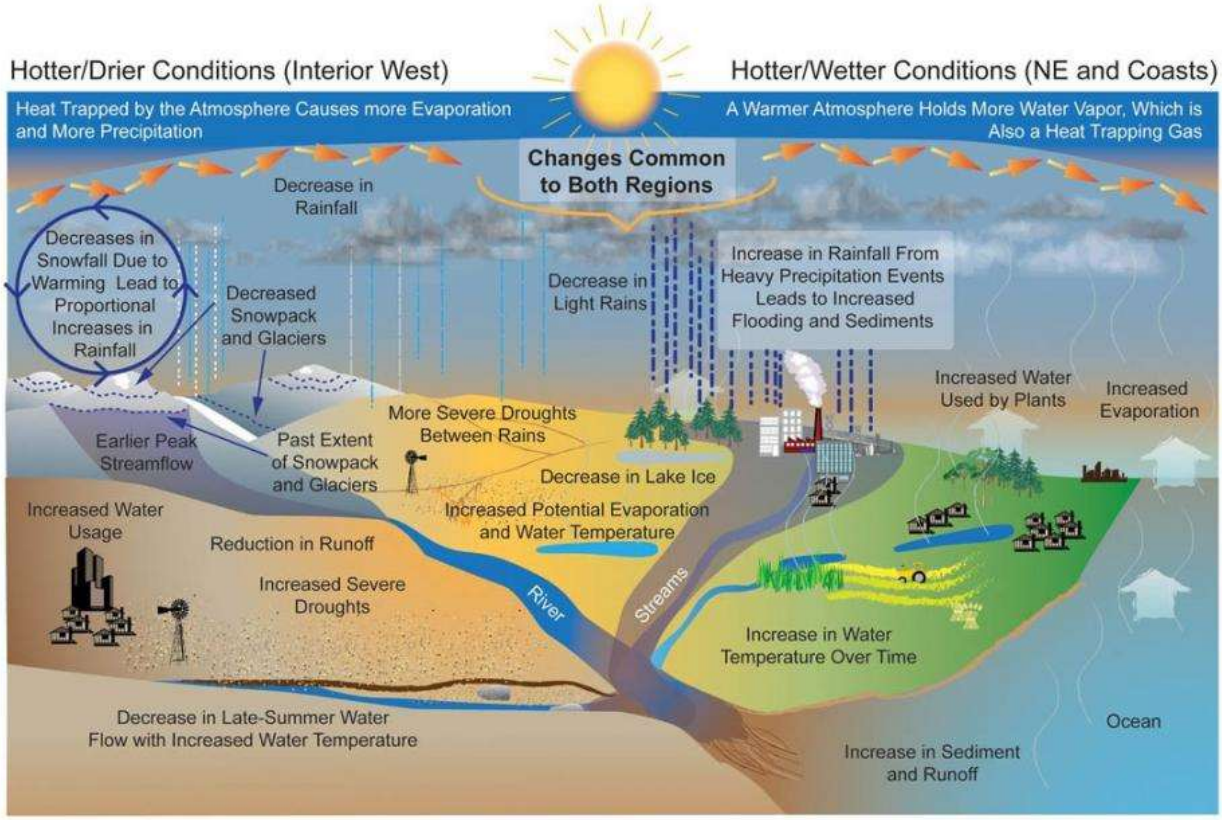


Figure 2

Source: U.S. Global Change Research Program, (2014).

The Relationship between Climate Change and Water Resources

All the water resources and the global hydrologic cycle is a very important link of climate change. The effect of climate change on water resources is because of the water and water quality and quantity changes that caused by climate factors (particularly rainfall and temperature changes). This is as a result of the changes of the various water cycle links. Climate change will change the world of the present situation of the hydrologic cycle, and cause the redistribution of water resources in time and space. It also will have a direct effect on the evaporation, runoff, the soil moisture and relative humidity. The redistribution and changes of water resources in space will cause the human society and the ecosystems to change significantly. At the same time, the changes in water resources system will affect the local climate, and will exacerbate climate change in a certain extent. This relationship as shown in Figure 3 is a Cycle Diagram of Climate Change Effects.

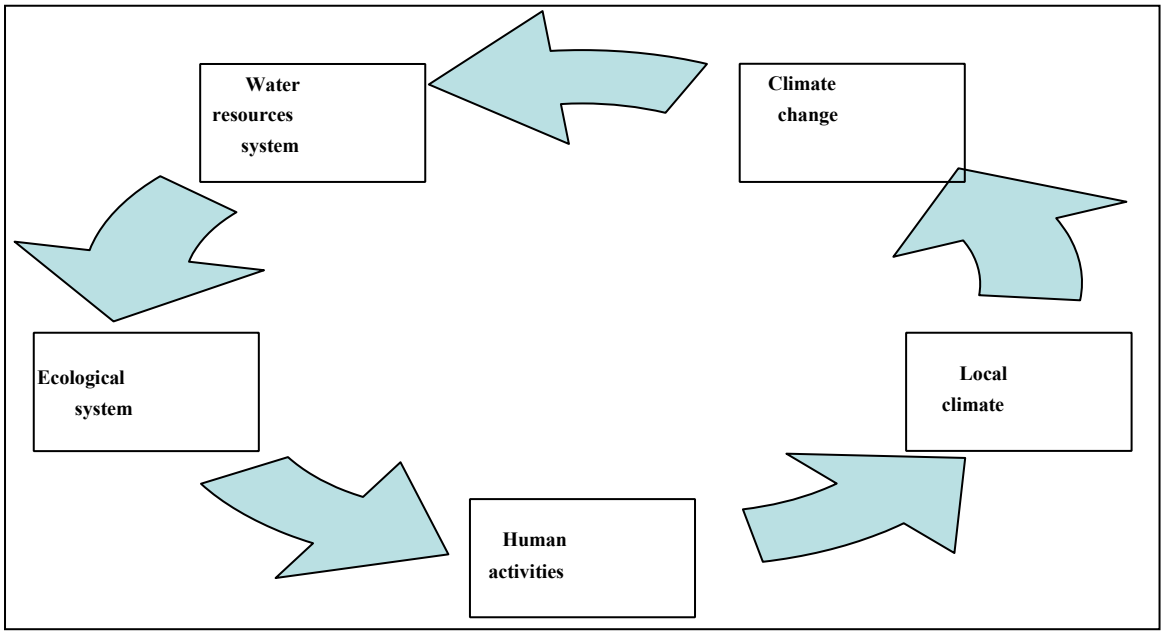
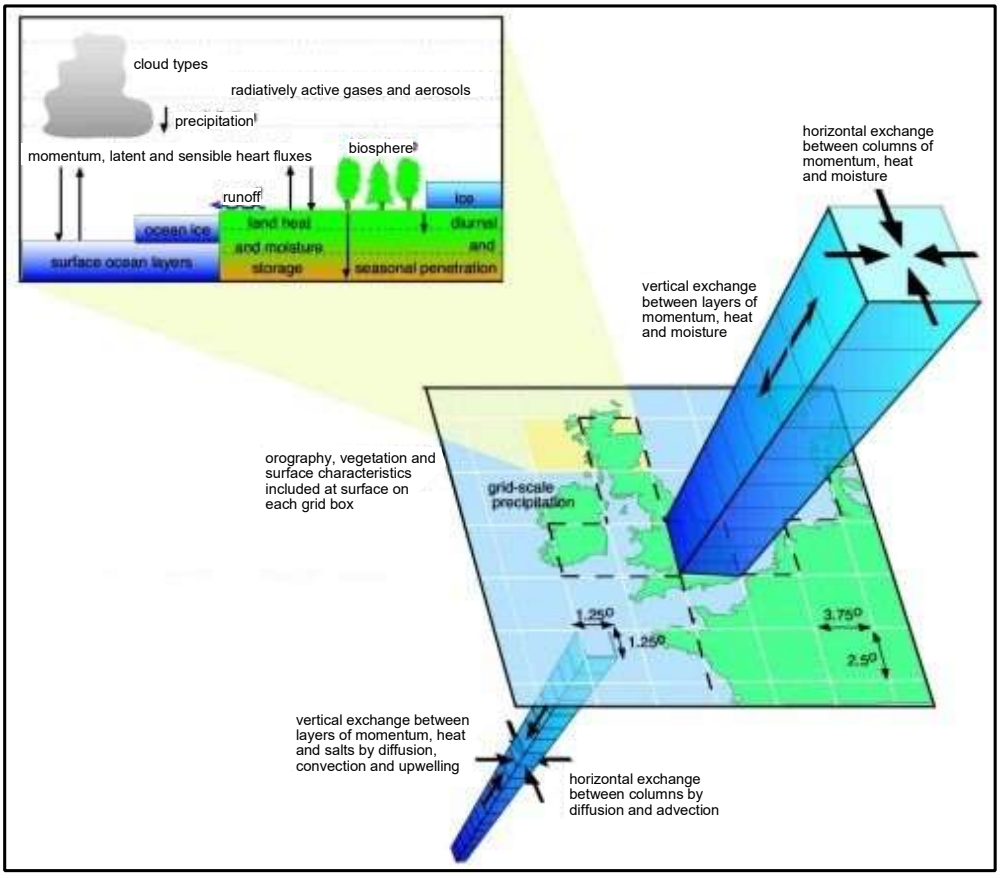


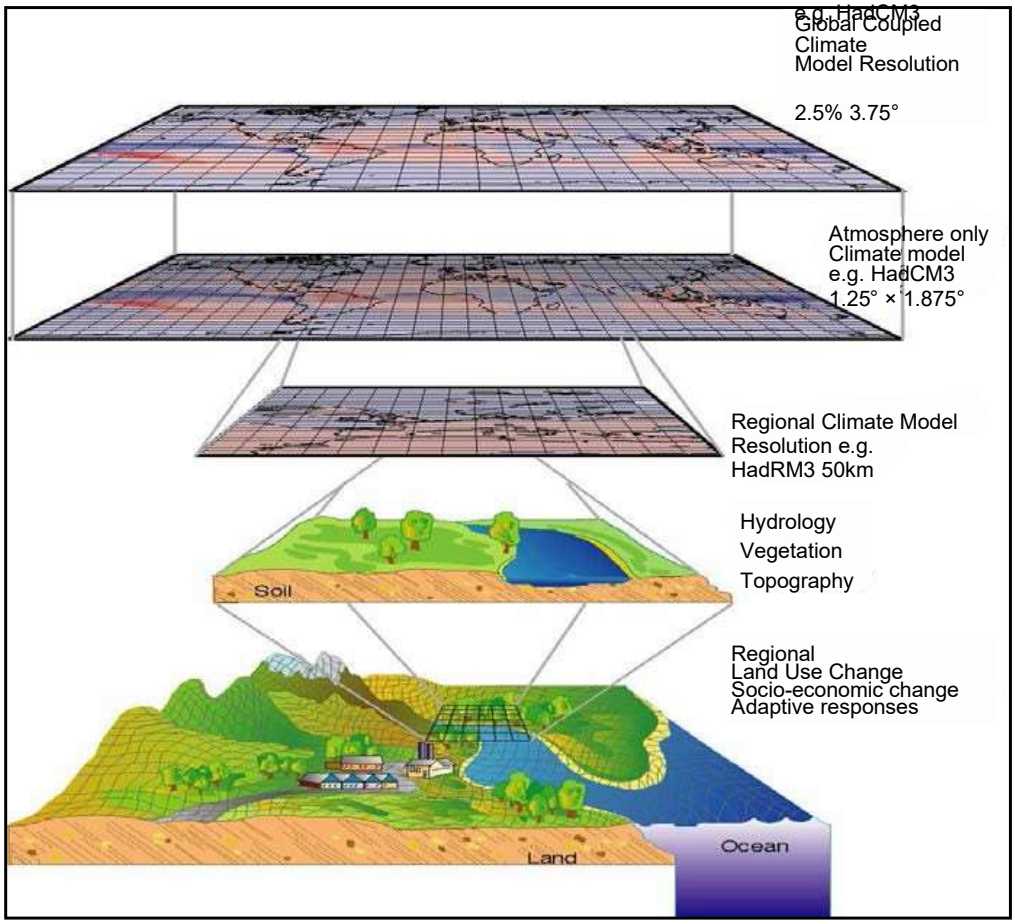
Figure 3
Source: Yang Nan,Men Bao-hui ,Lin Chun-kun (2011).



Representation of a typical GCM.

Figure 4:
Source Intergovernmental Panel on Climate Change IPCC (2007).

Nevertheless, it has been commonly predicted that they are some uncertainties in these climate change scenarios and it should be considered and considered while assessing the impacts and vulnerability. Furthermore, the coarse resolution of the Global Climate Models usually prohibits their direct use at regional scales. Majority of the river's basins magnitude are in the same order or even smaller than the grid dimensions adopted in simulations with the Global Climate Models Raneesh (2014).



Dynamical downscaling of GCM data (coarse scale) to RCM data (fine scale).

Figure 5:
Source: Intergovernmental Panel on Climate Change IPCC (2007).

Results and Discussions

Worldwide assessment of water resources shows a subjected to increase stress prediction in the situation of forecasting climate change and population growth scenarios in other parts of the world Arnell, Liu, Compagnucci, da Cunha and Hanaki et al. (2001). Increase in temperatures and decrease in precipitation would lead to reduction of supply of water while demand of water increases. This rooted to deterioration in the quality of water in freshwater bodies, using severe strain on the previously delicate balance between supply and demand in numerous nations Milly, Dunne and Vecchia (2005). The predicted changes in climate under different climate change scenarios are projected using Global Climate Model (GCM). It is so simulations and it has been used to assess the effect of climate change on water resources in different regions. Many scholars have revealed that the effect of climate change on water resources might vary from region to region depending on the regional geographical appearances and climate Arnell, Liu, Compagnucci, da Cunha and Hanaki et al. (2001).

5. Conclusion

From the research work, we can observe that, climate change is so authenticity and it has an authentic effect which has felt all over the world. Its direct effect is on water resource. These effects are basically negative and have serious consequence on humanity, their source of livelihood is seriously affected whether on raining or dry seasons and the entire environment. It is because of this, that climate change is the most valuable environmental issue facing the globe and the main cause is from human activities. Nigeria is one of the most vulnerable nations in Africa facing climate change challenge due to her wide-ranging climatic regions, coastal location where more people are living and working in those climate change prone areas. Based on the result and discussions in this study, it can be observed that, climate change has truly brought negative effects on water resource in our dear country Nigeria and the entire world. However, mindful efforts must be put in place towards mitigating the negative effect of climate change on water resource in Nigeria.

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