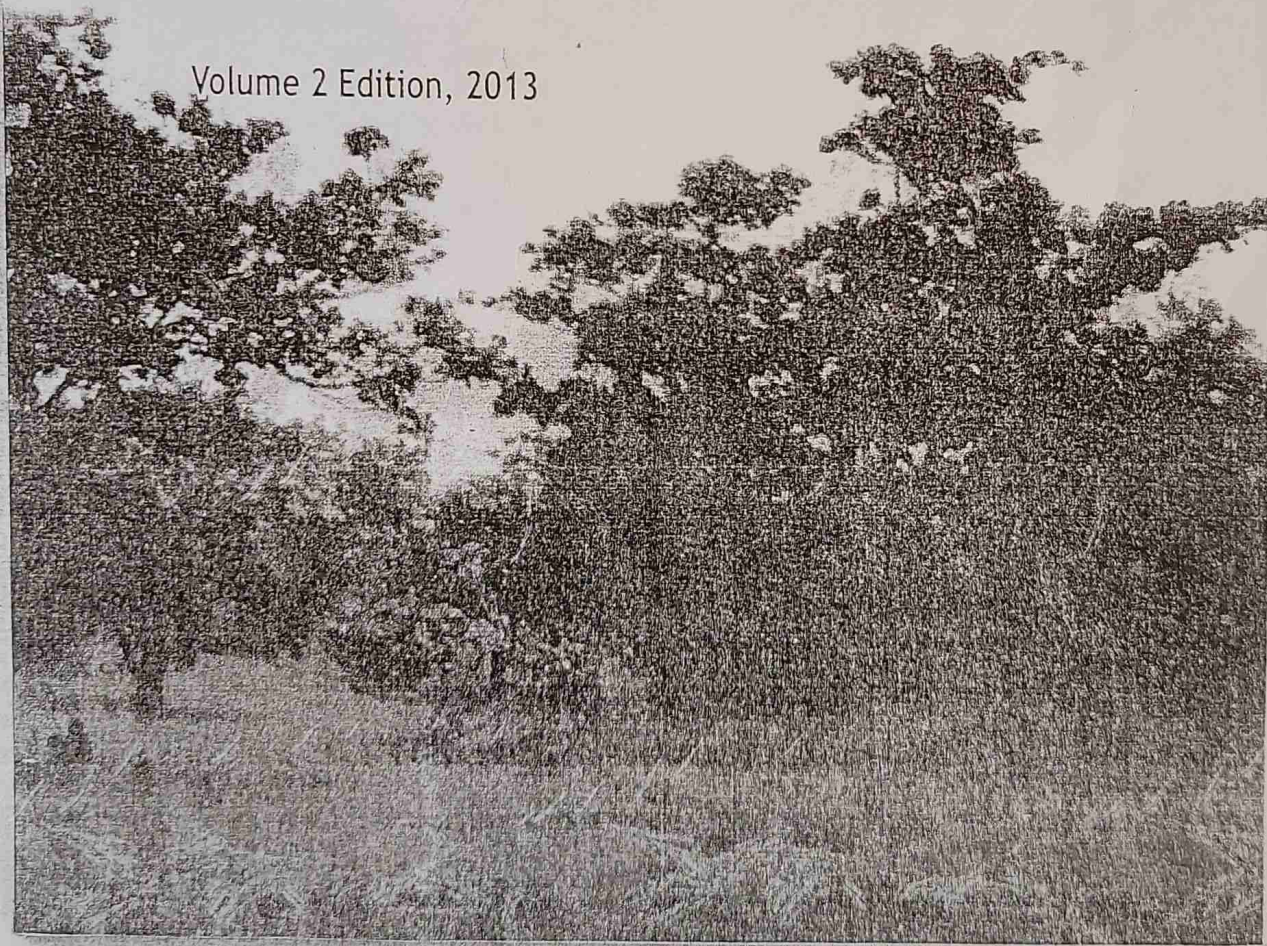


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The Impact of Climate Change on Hydrology and Water Resources in Nigeria

By

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Abstract

Nigeria today remained one of the water stressed countries in the world due to increased in her water demand resulting from population growth, degradation of watersheds induced by land use change and siltation basins. However a recent global change in climate is worsening the already bad situation with regards to water resource in the country, hence this examination of climate changes impacts on the country's hydrology and water resources. Issues such as causes of climate change, climate change effects on water supply and flood generation were examined. The research concludes by suggesting sustainable watershed management as the best possible option towards mitigating water resources problems induced by climate change.

Introduction

Excessive release of greenhouse gasses (CO₂, CH₄, CFs, NO₂) into the atmosphere by man trap much of the heat that would otherwise escape from the earth, resulting in global warming. This produces diverse effects on both physical and biological systems. McCarthy *et al.*, (2001) identified some observed changes with linkage to climate change to include shrinkage of glaciers coastal storm surges, high temperature, intense wind and high precipitation.

Effects of climate change according to Adefolalu (2007) is already taking place at the local level in Nigeria, especially in the Sudano-Sahelian ecological zone where cases of drought, desertification, increased temperature and flooding has been widely reported (Babatolu, 1998; Mortimora and Adams, 2001; Odekunle et al 2008). The frequency and intensity of climate change disasters such as flood have badly affected many urban centres in Nigeria (Rasid, 1982; Odemerho, 1988; Emuh, 2007; Tobrise, 2007; Iroye, 2008). According to Sambo et al. (2010), climate change has the potential of affecting all natural and human systems and thus, may be a threat to human development and survival, socially, politically and economically. Conway and

Hulme (1996) observed that climate change disasters in Africa have resulted in widespread acute human suffering and economic damage.

Climate Change Effects on Water Resources

Availability of water is an essential component of welfare and productivity. Healthy people and good environment flourish where water is available in adequate quantity and acceptable quality (Sule, 2003). These facts thus accounts for the reasons why climate change impacts on water resources are high of the research agenda worldwide (IPCC, 2007). Currently in Nigeria, more than 53% of the populace do not have access to adequate supply of safe water (Population Reference Bureau, 2008). The IPCC (2007) observed that there have been growing environmental problems in almost all countries in Asia, Africa and Pacific due to unsustainable use and development of water resources. Climate change could worsen this already bad water supply situation particularly in the Sudano-Sahelian ecological zone where drought and desertification is already being observed, most especially in areas north of latitude 12° North of the equator (Adefolalu, 2007). Climate change induced water stress will have serious impacts on food production. Degrade freshwater ecosystems and generate conflict in areas with competing demands for shrinking water resources. According to Peel et al (2004) high levels of variability in rainfall and river flow in Africa across range of spatial and temporal scales posses great consequences for the management of water resource systems.

AWWA Research Foundation Report (2008), listed four main areas where climate change impact on water resources will be felt and this includes:

- i. Water Quantity: This relates to availability of supply. Direct impact of climate change on water quantity resulting from increasing temperature and precipitation variability include reduced stream flows, earlier and more intense snowmelt and runoff and reduced aquifer recharge. Increase in demand resulting from warmer temperature is also expected with peak demand coinciding with periods of most restricted supply.
- ii. Water Quality: Extreme precipitation events are expected to create treatment challenges which will manifest through sediment and pathogen loads, urban storm water runoff and sewer overflows. In same vain, widespread and persistent algal blooms, changes in

watershed/vegetation and increased water temperature will impact seriously on water quality leading to increases in eutrophication, disinfectant demand and regrowth potential. Ground water resources, especially in coastal areas will also be impacted by rising sea levels and intrusion of saline water.

- iii. **Operation Reliability:** The operation reliability of water infrastructure and projects will be affected by climate change. While flood damage will increase, reservoir management, especially those designed to balance water supply and flood control will be more complicated due to changes in runoff timing and intensity. Coastal facilities will also be threatened by rising sea level and increase erosion due to intrusion of salt water.
- iv. **Financial and Institutional Impacts:** This relates to reduction in revenue from water utilities, the need for development of new rate structures which will reflect the increasing value of water and increasing conflicts with competing water users.

Nigeria, being a developing country can be regarded as a poor nation. The country with limited technical capability, high level of corruption and mismanagement will find it difficult adjusting to worsening water supply problem induced by climate change while attempts to implement adaptation measures will impose, heavy burden on the already bad national economy.

The extent to which climate change will affect water resources in Nigeria will however be determined among other factors on government policies in areas of water pricing, drainage basin development and urban planning and management. Other factors include rate of population growth, technological advancement, social, economic and legislative conditions.

Climate Change Effects on Flood Generation

Flood is any high stream flow which overtops natural or artificial banks of a stream. Flooding when it occurs affects landuse adjacent to the affected stream, river or channel causing great losses both in form of lives and properties. According to United Nation (2001), floods have the greatest damage potential of all natural disasters worldwide and affect the greatest number of people. In same vein, International Federation of Red Cross and Red Crescent Societies (2001, 2003) reports that weather related disasters from a global perspective have been rising since 1996 and increasing from an

annual average of 200 (1993-1997) to 331 (1998-2002). Climate change influence flooding because hydrological response of any drainage basin is principally defined by the production of runoff against a given rainfall, though soil characteristics and basin geomorphology have their roles (Iroye, 2008).

Due to global warming, many subsystems of the global water cycle are already intensifying resulting in increase of both flood magnitude and frequency. These events have resulted in colossal loss in Nigeria, both in terms of lives and properties (Table 1)

Table 1: Some Flood Problem Across Nigeria

Year of flood	City	Damage Caused
1980	Akure	20 houses collapsed, 3 people killed
1982	Ibadan	3 people killed
1984	Ibadan	5 people died and millions of naira worth of properties destroyed
1984	Port-Harcourt	Thousands of people rendered homeless and properties worth million of naira destroyed
1987	Sokoto	Loss of farm produce worth N14 million and destruction of 85,000 hectares of land
1987	Borno	13 people killed, 68 rendered homeless
1988	Kaduna	4 lives lost and thousands naira worth of properties destroyed
1988	Kano	55 people died, 80,000 homes washed away
1988	Ibadan	Millions of naira worth of properties destroyed
1990	Minna	Thousands of naira worth of properties destroyed
1992	Jos	Thousand rendered homeless
1994	Borno	Over 200 lives lost and properties damaged
1994	Ikot Epen	3 lives lost and thousands of naira worth of properties destroyed
2003	Kaduna	22 villages submerged, several people killed & thousand rendered homeless
2003	Sokoto	House submerged and million naira worth of properties destroyed
2006	Obio-Akpa	20 lives lost and several acres of farmland destroyed
2008	Minna	7 people killed, houses submerged
2009	Benin	8 lives lost and million of naira worth of properties destroyed
2010	Ibadan	Thousands of naira worth of properties destroyed
2011	Ibadan	Thousands of naira worth of properties destroyed

Sources: Faniran, 1991; Sule, 2003; Federal ministry of Water Resources and rural Development, 2008.

In 2012, the country experienced unprecedented flood which affected twenty seven states in the Federation. The flooding killed over three hundred persons, caused extensive damage so social infrastructure and displaced about two million people from their homes.

Climate change according to World Meteorological Organization report (2008) is making weather less predictable, rains more uncertain and heavy storm rainfall more likely due to presence of particle dust in the atmosphere, especially in urbanized areas. This is because, urban area due to high percentage built-up surfaces with little or no vegetation do develop higher temperature than their surrounding areas. The higher temperature thus developed creates a local air circulation and dust particles caught up in such circulation acts as condensation nuclei on which moisture in cloud condenses forming large rain drops. Increase in flood damages in Nigeria can thus be linked to global warming which is leading to more intense storms (Green, 1999; Emuh, 2007).

Adaptive Response to Climate Change Impact on Hydrology and Water Resources

Adaptation is an activity which is undertaken to minimize adverse effects of climate change and maximize its advantages. It is an important approach for protecting human life, ecosystem and economic system from risk posed by climate variability and change, and for exploiting beneficial opportunity provided by changing climate. Development of adaptation strategies is germane as no man can stop climate from changing. This is because, such changes are inherent part of climate system which is brought about either through natural forces or induced by man.

Adaptive response to climate change effects on hydrology can either be structural or non-structural. While structural adaptive responses are usually technological in nature, requiring considerable investment in achieving effectiveness, non-structural adaptive response is basically organizational (Rogers, 1985). Examples of non structural adaptive response to floods include zoning laws, sheltering, sand bagging and flood insurance programme. Other indirect organizational responses include monitoring of weather and river systems.

With evidences that global climate is changing, Nigerians, have no option than to take adaptive strategies towards ameliorating the incessant effects of drought, desertification, erosion sedimentation and floods. The role of adaptation as an important component of climate change impact and vulnerability assessment has long being recognized. According to United Nation Framework Convention on Climate Change (UFCC, 1998), parties are committed to formulate and implement national or personal programmes containing measures to investigate climate change.

Whichever adaptive strategy that is being embraced should however be sufficiently robust to protect life, shelter and livelihoods. For example, while seemingly minor factors such as low house foundation in regions experiencing heavy rainfall due to climate can induce flood, seemingly minor factors such as raised window level can play an important role in flood abatement. Among numerous options available to reducing climate change effects on hydrology and water resources in Nigeria is drainage basin planning and development.

A drainage basin is a topographically defined area within the total catchment area of a major river system. It represents the soil, water bodies and vegetation within a catchment area. Drainage basin can be regarded as an open system where energy supply for its maintenance and preservation inform of solar radiation is balanced by constant removal of material and energy represented by river discharge and re-radiation. Comprehensive planning and dev of drainage basins in the country can improve the potentials of the basins and help in mitigating climate change impacts on both the quantity and quality of water resources. This aim can be achieved by understanding the combine roles played by catchment controlling variables. Good watershed management aims at retaining more rainfall on the land for man use and improves the river regime by reducing flood peaks and sediment transport. This can be carried out through:

- (i) Afforestation: Afforestation programme influence basin hydrological process through its biological, thermal and physical effect. This is because the thick letter produced by the trees will promote the activities of soil organisms through the increase in soil organic matter, thus opening up soil pores resulting in high infiltration rate, hence low runoff discharge in basins prone to flooding. Not only this, the infiltrated water during the rainy season will aid maintaining ground

water recharge, thus helping to sustain dry season discharge in such a basin. In this way, afforestation programme will not only help in solving flood problem induced by climate change, it will also help in conserving water for dry season usage and solve problems relating to erosion and sedimentation.

- (ii) Flood plain zoning: This is recreation of flood plain landscape, where both ecological processes and flooding will operate with as little interference as possible advocates of this adaptation method believe that flooding induced by climate change can rarely be completely prevented, particularly in urban environment, hence the suggestion for its management. This method of basin management is not only cost effective, but ecologically valuable as it creates a more natural environment that looks better, and benefits wildlife at the same time as it restores the flood plain hydrological function to delay flow and attenuate flood wave.
- (iii) Inter basin water transfer: This measure is highly effective as short time solution for mitigating climate change impacts on water resources. The technique ensures efficient use of water in deficit regions
- (iv) Engineering Construction: This entails the construction of micro dams along main river channels and large reservoirs and flood detention structures on the tributaries

Other adaptation options available to water resources in Nigeria according to Odjugo (2011) include expanded rain water harvesting, water storage and conservation techniques, water use, desalination and irrigation efficiency. He however identified finance human resources and physical barriers as key constraints to these adaptation techniques. Though comprehensive basin management remains the best option to reducing climate change impacts on hydrology and water resources, various approaches can be used in mitigating the potential vulnerability of water systems to climate change. Among such approaches includes: pricing systems, water efficiency initiatives, improvement in agricultural policies and urban planning and management

Conclusion

Climate change is increasingly emerging as a serious threat to sustained economic growth and development in Nigeria. This fact can be buttressed with increasing frequency and degree of extreme hydrometeorological hazards such as flood, erosion, sedimentation drought and desertification in different parts of the country. Other effects of climate change, particularly on hydrology and water resources in Nigeria include decrease in river runoff, rising of sea level, coastal erosion and shrinkage of lakes. The consequence of these effects on the country includes reduction in available freshwater, food insecurity, loss of biodiversity, weakened physical infrastructural base, and development and intensification of conflicts in water stressed areas.

Though, international communities and governments at various levels are making frantic efforts to cut down green house gas emissions fuelling climate change, the already built-up green house gases in the atmosphere can be held responsible for the above aforementioned hazards. However, since activities responsible for causing climate change and its follow effects cannot be stopped for now, then the only option remaining is to develop coping strategies towards mitigating its negative effects, hence the need for developing adaptive response, both by the people and government at various levels.

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