

*Full Length Research Paper*

# Implications of climate variability on water resources of Nigeria: A review

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**The current water management practices in Nigeria may not be robust enough to cope with the impacts of climate variability on water supply reliability, flood risk, health, agriculture, energy and aquatic. As such, the impacts of climate variability on water resources utilities were evaluated. This paper, therefore, focused on climate variability effects on water and ecosystems services, particularly under extreme weather conditions such as flooding and drought; taking into account the variability in precipitation and temperature. The study was based on a review of existing assessments during the years 1999 to 2010. The major aim of the study was to explore how climate variability affects water resources in Nigeria by determining the impact of climate variability on water resources sustainability and how these changes are controlled by the impacts of climate variability. The result showed that the cost in future of the emerging climate scenario for Nigeria will be too expensive. As the loss for Nigeria is projected to be between 2 and 11% of Nigeria's GDP by 2020; rising to between 6 and 30% by the year 2050. Some mitigation and adaptation strategies were recommended.**

**Key words:** Water resources, climate variability, extreme events, precipitation, temperature, impacts.

## INTRODUCTION

There are many parts to the climate variability story that come together to produce a picture of potentially significant implications for water utilities in Nigeria. Understanding the vulnerability of Nigerian's water resources to climate variability is vitally important. Water is one of Nigerian's greatest resources. Changes in weather and climate have been known to profoundly influence water resources, a factor that increases the vulnerability of humans to infection. Generally, water resources involve all forms of fresh water needed for life's necessities, ranging from domestic needs to drinking, washing and cleaning to agricultural needs involving food processing and irrigation, industrial production, transportation, recreation and the maintenance of natural ecosystems.

In its contribution, IPCC (2008) voiced its concerns regarding water utilities in a changing climate. Nigeria has a relative abundance of water. However, the water is not evenly distributed across the country, and water availability varies both between years and with the

changing seasons. As a result, most regions of the country have experienced water-related problems, such as shortages (droughts), excess (floods) and associated water quality issues. Water for drinking in Nigeria comes from three major sources, generally: Atmospheric water in form of rain, and ultimately the source of drinking water in most rural areas of the third world countries where water is scarce; surface water classified as rivers, streams, lakes or reservoirs and ponds; and ground water obtained from boreholes sunk into water-bearing rocks or aquifers, or water that gushes out from rocks such as in springs (Enete, 2008).

United Nations Millennium Development Goal 7 (MDD7) calls on countries to "Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation". In this study, safe water is defined as water of sufficiently high quality that it can be consumed or used without risk of immediate or long-term harm. But climate variability and change increasingly threaten the supply of safe water through man-made infrastructure, as well as water-related ecosystem services.

More intense extreme events are already being observed, including heavy rainfall and flooding, and low

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flow and drought conditions. These will test water utilities infrastructure to the limit, risking the failure of water treatment plants, drinking water contamination and even the breakdown of supplies. It will also affect some of the water services, such as adequate water resources, that we take for granted today. As experience has shown that the direct human, environmental and economic consequences of extreme events are potentially very significant. And managing environmental and health threats requires knowledge of the medium-to long-term recovery of ecosystems, and resilient water supplies and sanitation from utilities (European Commission (EC), 2011).

This paper focuses on climate variability effect on safe water and water resources, particularly under extreme weather conditions such as flooding and drought. It covers the Nigerian State and is based on a review of existing assessments and other literature conducted between the periods 1999 to 2010.

### Statement of the problem

The problem of the study was to determine the extent and in what specific ways climate variability affects Nigeria water resources. The research questions raised include:

1. What are the specific changes in water resources of Nigeria that are brought by climate variation?
2. How these changes could affect the sustainability of water resources in Nigeria?
3. What practices are already being used to tackle and cope with the issues in the country?

### Research objectives

The main aim of the study is to explore how climate variation affects the water resources in Nigeria. In lieu with this, the following specific objectives were addressed.

1. Determine the impact of climate variation on water resources of Nigeria;
2. Determine the available mitigation and adaptation strategies open to Nigerians in a changing climate.

### RESEARCH METHODOLOGY

The study adopted descriptive research design. A descriptive research intends to present facts concerning the nature and status of a situation, as it exists at the time of the study and to describe present conditions, events or systems based on the impressions or reactions of the respondents of the research (Osuala, 2001). It is also concerned with relationships and practices that exist, beliefs and processes that are ongoing, effects that are being felt or trends that are developing (Ogbu and Enete, 2006).

In the study, both primary and secondary data were incorporated. The essence is to provide adequate discussion for the general

readers that will help them understand more about the issue of climate variation and the different variables that evolve with it.

## OVERVIEW OF CLIMATE CHANGE IN NIGERIA

Nigeria is one of the countries expected to be most affected by the impacts of climate change, through sea level rise along our 800 km long coast line, intensified desertification, erosion and flooding disasters and general land degradation. One prediction is that Nigeria will lose close to \$9 billion as a result of the catastrophe, while, at least, 80% of the inhabitants of the Niger Delta will be displaced due to the low level of the oil-rich region (Guardian, Monday September 17, 2001, p. 80).

As Nigeria's economy improves, its per capita greenhouse gas emissions may approach those of the developed nations of the world today. One major source of greenhouse gas emission in Nigeria is gas flaring. For example, in 1986, the gas flared during oil production in Nigeria spanned over 300 field locations and yield wasted heat and energy equivalent of about  $60 \times 10$  kwh (Odjugo, 2002). In 2002, Nigeria flared about 76% of its natural gas (Atevure, 2004) and about 60% in 2006 (Inyang, 2007). This shows that Nigeria has one of the worst rates of gas flaring in the world. The combined effects of gas flaring and a large population will further worsen Nigeria's standing as a key emitter of greenhouse gases globally.

The cost of climate change in terms of GDP will equally be high, as the loss for Nigeria is projected to be between 2 and 11% of Nigeria's GDP by 2020, rising to between 6 and 30% by the year 2050 (Guardian, Monday, 18 July, 2011). The study determined that virtually all of the sectors analyzed manifested some evidence of vulnerability to climate change. None were unaffected; none will remain unaffected in future by changes to climatic conditions.

In Nigeria, precipitation extremes such as heavy rain events have become more intense in the past 50 years and are projected to become more frequent and severe (Adefolalu, 2000). Observed data show that droughts and water shortages are longer and more severe in drought-prone regions. Climate change is projected to cause major changes in yearly and seasonal precipitation and water flow, flooding and coastal erosion risks, water quality, and the distribution of species and ecosystems (Adefolalu, 2000; WHO Europe, 2008).

## CLIMATE VARIABILITY IMPACTS ON WATER

### Water resources

Climate variation is a threat to Nigeria's water resources.

The combination of over-abstraction and periods of low rainfall result in low flow rivers, lowered ground water and the drying up of wetlands. This in turn has detrimental impacts on freshwater ecosystems, worsens water quality and permits saltwater to intrude in aquifers. Scarcity of regular water resources will encourage the use of alternative sources to supply drinking water, industrial processes and irrigation. Alternative sources include desalination, rainwater harvesting and reclaimed (or recycled) water.

### Water and health

Several outbreaks of drinking water related diseases have been reported in the country. Generally, the risks of an outbreak are greater where the standard of water and sanitary services is low and a clear North-south divide is apparent in the geographic distribution of the incidence of water borne diseases. It is more prevalent in the northern states than in the southern states (Adefolalu, 1999).

Extreme events such as flooding, drought, windstorms and periods of exceptionally high and low temperature may lead directly to a multitude of adverse effects on human health, such as death, injuries and post-traumatic mental disorders. These events may also lead to an increase in diarrhea diseases, vector-borne diseases, respiratory infections and skin and eye infections.

Floods can potentially increase the transmission of several water-borne and vector-borne diseases (WHO, 2010). The risk of infectious diseases depends on a number of factors, including the impact of the disaster on water and sanitation systems, the availability of shelter and the scale of population displacement, the functionality of the public health infrastructure and access to health care services, and the nature of response after the disaster (Ivers and Ryan, 2006). Also, there is increasing evidence of the impact that climate-related disasters have on mental health. For example, flooded communities experience a higher incidence of depression (Racher et al., 2004).

Reduction in water flows may lead to increased stagnation, which, combined with rising temperature, can create more suitable conditions for disease vectors such as mosquitoes to breed; such advantageous conditions may increase both the spread and infections of more people by mosquitoes. On the other hand, drought conditions or severe floods may restrict the distribution of some vector-borne diseases, for example, lyme disease, which is transmitted by ticks (Semenza and Menne, 2009).

### Drinking water

Severe flood events can damage or inundate water treatment facilities and contaminate the distribution

system, leading to severe water quality problems. Also, flooding events can lead to other infectious diseases, through contamination of drinking water. These include hepatitis, cholera, typhoid and dysentery. For example, heavy rainfall events have been linked to cholera outbreaks in some northern states of Nigeria (Adefolalu, 1999). Increased rainfall and higher temperature may also cause problems with color and odor of water supplies (Water UK, 2008).

### Bathing water

Climate variation is likely to cause a decline in the microbiological quality of bathing waters and a subsequent increase in their impact on human health. Climate change will lead to more intense rainfall and increased chances of flooding. This increases runoff, risk of eutrophication and algae growth rates and decrease mixing of waters. Higher ambient temperatures are also likely to increase use of bathing waters with consequent higher potential for exposure to bacterial pollution or toxic algae. Direct skin contact with toxin producing cyanobacteria can cause allergic reactions, skin and eye irritation (UNESCO/IHP, 2005).

Climate variability can also create more favorable conditions for a number of pathogens, increasing their survival and therefore the risk of several infections. Rainfall-induced runoff has been identified as one of causes of faecal contamination in slum areas in Nigeria. Higher temperature may lead to increased thermal stability and stratification in lakes. The lack of movement in surface waters leads to the development of blooms, and can lead to severe oxygen depletion and increased decomposition in deeper waters. This anoxia will provide ideal circumstances for some groups of pathogens (Roijackers and Lurling, 2007).

### Aquatic ecosystems

Extreme rainfall events can result in storm water discharges from combined sewer and surface water overflows, fluvial erosion leading to mobilization of stored chemicals, and run-off of agricultural fertilizers and pesticides, animal wastes and manure. The predicted increased frequency and intensity of storms due climate variation will exacerbate these impacts.

Heavy rainfall can also lead to weakening or failure of earth dams; for example, the failure of some dams and bridges in Sokoto and Kebbi States in 2010. Low flows and subsequent intense rainfall events may also lead to fish kills, while increased temperatures can also put cold water fish at risk. Some aquatic organisms may alter their spatial distribution, moving to find the most suitable water quality and temperature, while other species may become extinct. Some fishes may be affected by

changes in water level, temperature, oxygen levels and increased levels of harmful algae (Cheney and Deway, 2005).

Severe drought can degrade or destroy wetland ecosystems through changes in water availability, higher temperature and increased evaporation rates, causing deterioration in wildlife habitats (WMO/UNEP/ IUCN, 2009). Changing temperature may also cause many plants and animals to migrate pole wards, and species which cannot move easily may be lost.

### Water and sanitation infrastructure

Flood events may put a large number of water and waste water treatment works and pumping stations at risk of flooding in many places on the network. This may lead to the failure of operation and the loss of public water supplies, and can also have significant impacts on drinking water quality.

Assets on the coast (such as pipe networks, water and wastewater treatment works and pumping stations) will also be at increased risk of coastal flooding and storm damage, and may be lost altogether through coastal erosion and sea level rise.

### Mitigation and adaptation strategies

To reduce the impact of climate variations on the water resources of Nigeria, the following recommendations were made:

1. Implementation, enforcement, compliance and review of existing urban and natural policies;
2. The domestication and implementation of disaster contingency plans and other environmental policies;
3. The need for the construction of central drainage systems consisting of interconnected flood reservoirs fitted with valves at various levels and discharge pumps;
4. Canalization of the swamps to ease transportation alongside the channelization of rivers to confine river discharge to their channels;
5. There is the need for the surveying and mapping of flood prone areas so as to reduce vulnerability and the risk of hazards in coastal communities;
6. The need for integrated water resources management approach in planning, development and management of water resources in the country;
7. Nigeria's climate change plan of action should take into account sea level rise of over 1 m and storm surges of 2 metres;
8. More permanent solutions should be found for the active eroding parts of the coastline e.g. building wave breakers further out at sea and maintaining them;
9. Focusing on knowledge and capacity development by improving weather forecasting, water resources

monitoring, improving disaster preparedness, investing in appropriate technology development and strengthening capacity for planning and coordination;

10. Making adaptation and climate risk management a core developmental component with a particular focus on sustainable water resources;

11. Improving water use efficiency, planning for alternative water sources (such as treated wastewater or desalinated seawater), and making changes to water allocation.

### Conclusion

Understanding the vulnerability of Nigerian's water resources to climate variability is very important. Water is one of Nigerians greatest resources, but changes in climatic variables, such as temperature and precipitation, will greatly influence the hydrological cycle, and changes in these variables will affect runoff and evaporation patterns, as well as the amount of water stored in lakes, rivers, wetlands, soil moisture and groundwater. These will test water utilities infrastructure to the limit, risking the failure of water treatment plants, drinking water contamination and even the breakdown of supplies. The study, therefore, determined that virtually all of the sectors analyzed manifested some evidence of vulnerability to climate change. None were unaffected and none will remain unaffected in future by changes to climatic conditions.

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