

## Water Resources Management Options for Climate Change Adaptation toward Sustainable Development in Nigeria

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**ABSTRACT:** *The present causes and impacts of climate change on the socio-economic development of Nigeria are examined. Apart from the natural causes of climate change, many anthropogenic factors which included clean clearing, bush burning, combustion of fuels, gas flaring, etc. that are capable of releasing greenhouse gases (GHG) were highlighted. Extreme events such as floods and droughts attributable to climate change were found to have caused serious water resources problem culminating in economic loss in the country. Nevertheless, a thorough appraisal towards adaptation to climate change showed little commitment, improperly coordinated policies and poorly funded institutions which are highly inefficient coupled with general poor enforcement of relevant environmental laws. Poor knowledge of the critical importance of water resources management to climate change adaptation in the country has also been identified as a major cause of poor adaptive measures by many stakeholders. Hence, it was recommended that appropriate laws that seek to protect all water bodies should be enacted and enforced to prevent water pollution. Also, investment in the construction of adequate water storage facilities, improved capacity and information services by all relevant government agencies, conservation tillage practice and mainstreaming of adaptation to climate change through water resources management are critical to achieving sustainable development in Nigeria.*

**Keywords:** GHG, Floods, Droughts, Water Storage, Conservation Tillage

### I. INTRODUCTION

No doubt, many Nigerians are still skeptical on whether the word 'climate change' is relevant to the economy of the country. This is because, many believe that since Nigeria and indeed Africa is less industrialized, there is minimal release of greenhouse gases (GHG) to the atmosphere which can invariably deplete the ozone layer and thus lead to global warming and climate change. However, climate change has become the reality of the moment; a consensus exists amongst scientists that global climate is changing and that if the current trends of global warming continues, rising temperature, sea level rises, and more frequent extreme weather conditions (floods, droughts, storms, heat-waves, etc.), would be witnessed in many parts of the world [1]. IPCC in [2], Fourth Assessment Report (AR4) gave the most acceptable definition of climate change as a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period typically decades or longer. The present regional changes in the frequency and intensity of extreme weather events according to [3] are as a result of the climate change impact on global water resources. Higher temperatures

and changes in extreme weather conditions can affect availability and distribution of rainfall, snowmelt, river flows and groundwater, and further deteriorate water quality.

One of the most vulnerable regions in the world to climate change is Africa [2, 4], perhaps due to its natural legacy of extreme high rainfall variability [5]. The impacts of climate change is expected to be more felt in Nigeria through sea level rise along her 800 km long coast time, worsening desertification, erosion and flooding disasters and general land degradation [6, 7]. High vulnerability of the country to climate change might have arisen from over dependence on rain-fed agriculture, compounded by factors such as widespread poverty, unemployment and weak capacity. Thus, many studies have revealed that the prevailing ecological problems being faced by the country are as a result of climate change [8, 9]. Of course, recent flood events in Lagos, Oyo, Akwa-Ibom and Plateau states, to mention but a few have testified to the various scientific predictions that more negative impacts of climate change would be experienced by developing countries through water [4, 10]. In addition, many researchers have also predicted more setbacks for the country in the nearest future as a result of its seeming lack of the financial capacity and technological know-how to combat the projected negative impacts of climate change [7, 11]. If the situation is allowed to continue, the quest of the country to achieve all-round development in line with the Millennium Development Goals and Vision 20:20:20 will be greatly hindered. Hence, climate change adaptation through water resources management for sustainable development becomes an important goal that must be achieved, since water itself is part of the problem and part of the solution [10].

Nearly all aspects of the Nigerian economy, in particular health, food production and security; domestic water supply and sanitation; energy and industry; and environmental sustainability, can be greatly influenced by water resources management. Consequently, management of water resources should be properly embraced to enhance poverty reduction targets and sustainable development in all economic, social and environmental dimensions. Moreover, adaptation which refers to all the responses to climate change that may be used to reduce vulnerability [12] has been generally recommended for the developing nations of the world. However, there is close link between adaptation to climate change and water, both of which play important role in sustainable development. Furthermore, since many economic activities in Nigeria thrive on water resources, the recognition of the critical role of water resources management in adaptation and respond accordingly therefore provides opportunities for development. This is because adaptation measures that deal with climate variability which rely on the existing land and water management practices have the potential to create resilience to climate change and to improve water security and thus

directly contribute to development. Despite the proven effectiveness of these measures, they have not been adequately embraced by stakeholders, hence the need for proper re-orientation and education. Thus, this paper is aimed at examining the present causes and impacts of climate change in Nigeria, assess the various adaptation measures through water resources management and make recommendations with a view to achieving sustainable development in the country.

## II. CAUSES OF CLIMATE CHANGE IN NIGERIA

Climate may change naturally, but the recent changes in climate in many parts of the world are as a result of anthropogenic factors. Fasona and Omojola in [13] stated that many adverse climatic and environmental impacts that occur today have been attributed to man's careless modifications to climate on local and to a limited extent, regional scale in some activities of the distant past. Most disasters (including flood, droughts, desertification, land degradation, subsidence, etc.) are not random events without underlying causes; they are sudden manifestations of gradual degradation processes [14]. Recent rise in population growth in Nigeria has increased the level of consumption of resources, technological advancement/changes technological advancement/changes as well as changes in organization of human societies. This has further led to changes in land use and land cover (urbanization, agriculture and forestry), biodiversity loss, changes in the composition of the atmosphere and climate change. Expansion of town and cities has brought about the need to clear many hitherto forested areas, thus reducing forest trees and the ability of the environment to absorb greenhouse gases (GHG) such as carbon dioxide. On the other way round, agricultural practices in Nigeria is synonymous with slash and burn method, especially amongst the peasants. The practice releases the dreaded GHG to the atmosphere and as well leads to desertification in less forested sudano-sahelian zone of the country.

Besides, increased concentration of GHG in the atmosphere through the industrial activities of many developed and industrialized nations has caused global warming that is being experienced across the world. Prominent amongst the GHG are carbon dioxide, (CO<sub>2</sub>), methane (CH<sub>4</sub>), Chlorofluorocarbons (CFC) and Nitrous oxides (NO<sub>x</sub>). This is one of the reasons why the stance of China, a leading emitter of greenhouse gases in the world, was said to be crucial in efforts to create a successor to the current Kyoto Protocol which expires in 2012 [15]. At present, as earlier mentioned, Nigeria also contributes to the GHG emission in her own small ways. Apart from bush burning, combustion of organic fuels such as coal, oil, gas, etc. are also sources of GHG. It could be recalled that there has been increased usage of these fuels in recent time in the country owing to increased number of vehicles, use of generators and rapid industrialization. In fact, it has been revealed by many researchers that anthropogenic factors such as urbanization, deforestation, population explosion, industrialization and the emission of GHG contribute to the depletion of the ozone layer and its associated global warming and climate change [16-18].

The pursuance of food security which calls for increased agricultural activities in the country has also

necessitated increased use of nitrogen fertilizers and other agrochemicals that are capable of contributing to GHG emission. Clean clearing that is also common amongst many farmers in Nigeria for agricultural production, turns forested area to croplands thereby reducing the rate of carbon sequestration (trapping and absorption of carbon (IV) oxide gas). Thus, agriculture has therefore been described as the greatest culprit of climate change causing significant effects through the production and release of GHG and reduction of carbon sequestration [19]. Furthermore, livestock management, polythene (nylon) manufacturing, burning of organic matter and animal dungs, all produce methane gas. In addition, many hydrocarbons which constitute about 14% GHG are produced for use in both domestic and the industrial sector, while gas flaring a common practice in the country has also been recognized as a major source of GHG emission in Nigeria [6], producing about 2.5 billion cubic standard feet, which is about 80% of produced associated gas in about 150 flaring sites in the Niger Delta [20]. This practice has further worsened the country rank in the world as a major emitter of GHG [6]. Indeed, Nigeria contributes more greenhouse gases than all other sources in sub-Sahara Africa combined [20, 21] mostly through gas flaring at the rate that can easily be referred to as the worst around the world [6].

## III. IMPACTS OF CLIMATE CHANGE ON WATER AND ECONOMY IN NIGERIA

Water is the medium through which many of the anticipated impacts of climate change will operate [10]. Reports have shown that extreme events such as floods and droughts, which are capable of negative impacts on lives, livelihoods, land values and investment incentives in vulnerable areas, have increased in frequency and intensity in many parts of Nigeria over the past few years [12]. The River Niger Inland Delta has reduced in size from 37,000 km<sup>2</sup> in the early 50s to about 15,000 km<sup>2</sup> since 1990 and Lake Chad which earlier covered an area of 20,000 km<sup>2</sup> before 1970 now measures less than 7,000 km<sup>2</sup> [22]. This has led to the degradation of water quality and modification of the life cycles of aquatic animals; there is also the depletion of fish stocks from about 100,000 tons per annum in the 70s to less than 60,000 tons today which is likely to reduce further in the future [20].

In addition, there is great threat to food security, poverty eradication and livelihood in the country as a result of climate change as agriculture which provides job for about 60% of the citizens has become vulnerable. Many human activities that are related to natural environment like fishing, grazing lands and forests which form the source of income for many households for their basic needs have gone into jeopardy. While flooding has hindered the ability of many fishermen to fish, drought and desertification are albatross to grazing for many pastoral farmers. This has further confirmed scientific reports that poor people are more negatively affected by climate change [2, 11]. In terms of GDP, climate change is expected to cost Nigeria some fortunes, as the country's loss is projected to be between 2 and 11% of Nigeria's GDP by 2020, soaring to between 6 and 30% by the year 2050 [23]. In the area of human health, [24] has reported the ability of floods to cause potential increase in the transmission of several

water-borne and vector-borne diseases. Furthermore, global warming which is synonymous with climate change is providing a favourable environment for the breeding of vectors of water-borne diseases like malaria and cholera which can have negative implications for the health of the citizen and further reduce their productivity. This was the situation in Ibadan in 2010 when cholera epidemic was widely recorded just after the flood that ravaged the city. A vicious circle of poverty can then arise from this, since according to common saying, health is wealth. Invasion of some inland waterways in the country by some alien species like water hyacinth, water lettuce and typha which are detrimental to navigation, fishing and functional irrigation system are also traceable to climate change [20].

#### **IV. THE CURRENT WATER RESOURCES MANAGEMENT EFFORTS IN NIGERIA**

Recognizing the importance of water to the issue at stake, attempts have been made in the past and are still being made to ensure efficient water resources management in the country, however many of the efforts are with little or no adequate knowledge/inclusion of anticipated climate change. Thus, many dams, reservoirs and water conveyance channels/structures are never constructed to accommodate the present hydrologic variability caused by climate change. Expectedly, incessant needs for rehabilitation, expansion and sometimes failure of such structures (as witnessed in Sokoto, Kebbi, and Taraba States, 2010) and also being recorded in Oyo State (Ibadan) since the past three years, has been the order of the day. There is frequent overflow of many rivers, especially in the northern parts of the country, over their dam thereby leading to widespread flooding of cropped lands causing incalculable economic loss.

Many institutions that have the responsibilities of managing river basins are not doing enough to arrest the situation. At present, there are 12 of such river basin development authorities in the country. By their operational techniques, their ability to cope with the present challenge is in doubt as many of them do not possess the necessary hydrological data to effectively plan for any adaptation to the impacts of climate change on the water resources of their respective basins. Apart from the various river basin authorities, the federal government has also set up the Nigerian Integrated Water Resources Management Commission (NIWARMC), there is a Special Climate Change Unit at the Federal Ministry of Environment and the Presidential Implementation Committee on the Clean Development domiciled in the Presidency in Abuja. It is unlikely that the citizens are fully aware of the activities of many of the agencies. A major problem with all these agencies is the poor capacity building and inadequate funding occasioned by unpreparedness of government to tackle the problem of water resources management and climate change in the country headlong. Similarly, the country enjoys the membership of some Trans-boundary river basin development agencies like Lake Chad Basin Development Commission, Niger Basin Authority, etc. However, that the international agencies have actually performed better is also doubtful. Furthermore, in view of the moribund nature of many of the meteorological stations in the country, dearth of required climatic and hydrological data is a major hindrance to many scientific researches in hydrology, water management, etc.

In the area of groundwater management, available evidences are to the effect that adequate balance between discharge and recharge are not being maintained. Apart from lack of adequate data on groundwater resources of the country, there is no deliberate effort to ensure its safety and quality. There has been indiscriminate and widespread sinking of boreholes especially in the present political era when every community seeks for the provision of borehole from their elected and unelected representatives as a way of alleviating water scarcity problems. In many developed and developing economies, the practice is not allowed because of the awareness that it is capable of causing imbalance in the groundwater hydrology of a whole country. Additionally, many water storage facilities like dams and reservoirs are under-utilized; storing water that is not being used efficiently. In many urban towns and cities in Nigeria where pipe borne water is provided, leakages in pipe networks is a common source of waste in addition to deliberate wastage by many consumers because water is taken from taps without paying a dime in many of the towns and cities.

An unfortunate testimony of poor water resources management in Nigeria is high rate of water pollution. Arguably, as a result of lack of awareness, many river bodies suffer perennial and deliberate pollution from both stakeholders and non- stakeholders. While the release of industrial wastes to water bodies by some industries has become a common occurrence, many households also find rivers and streams as appropriate waste disposal sites. There is also heavy dumping of animal wastes from poultry houses and other related activities on many water bodies. Oil spillage, a common phenomenon in the Niger-Delta area has caused a lot of pollution problems, thus making water unfit for consumption and leading to the loss of many aquatic lives. It is sufficient to add here that, the situation has remained so because of the apparent negligence of governments at all levels in many instances, when the citizens commit such a crime against the nature. But for Nigeria to achieve her developmental agenda as stated in both the Millennium Development Goals and the Vision 20:20:20, efforts must be geared towards combating the menace of climate change. This calls for proper re-orientation and thus throws up challenges for all professionals especially water resources engineers.

#### **V. CONCLUSION**

From the foregoing, it has become apparent that nothing much has been done in Nigeria in the area of climate change adaptation generally and water resources management in particular. Many of the policies and programmes of governments, both at the national and local levels are yet to be properly coordinated thereby making mainstreaming of climate change adaptation difficult. Duplication of agencies and roles which breeds inefficiency in the system suggests lack of policy direction. It is not likely that the country has actually identified the key areas that require immediate attention in climate change adaptation strategies. At individual levels, there is still growing skepticism as regards whether climate change is real in Nigeria and as such many cannot see the need for attitudinal change. Inadequate awareness amongst the relevant stakeholders is also a major issue that requires urgent attention.

For the country to achieve its Millennium Development Goals and Vision 20:20:20 as highlighted in its development plan, adaptation to climate change must be vigorously pursued. As earlier posited, such an adaptation policy should take note of the critical role of water, since climate change is expected to have most negative impacts on the developing world through water. Therefore, the following recommendations are made:

- (1) There is the need to enact and enforce laws that seek to protect all water bodies against refuse dumps which sometimes encourages flooding when water cannot move freely along constructed channels; all environmental laws should be revived and enforced. The people should be enlightened to treat water as an important and invaluable resource that is exhaustible like oil.
- (2) Investment in water storage and flood control facilities to improve water management should be vigorously pursued and where dams and reservoirs are built, they should be optimally used. The people should also be encouraged to embark on rain water harvesting for both domestic and agricultural uses.
- (3) Proper coordination of government agencies saddled with the responsibilities of water resources management in the country should be undertaken. Agencies like Nigeria Meteorological Agency (NIMET) should be strengthened to perform their duties beyond forecasting alone and further provide early time warning systems that will enable the citizens prepare for emergency situations.
- (4) Farmers who are perhaps the most affected group by climate change impacts should be properly educated to adopt modern farming techniques which include the use of drought resistant varieties of crops. Similarly, areas prone to seasonal floods should be avoided while also embracing conservation tillage as against the old practice of slash and burn.
- (5) Mainstreaming adaptation to climate change through water resources management is an important option which should also be urgently pursued to achieve substantial success.

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