

# **ENVIRONMENTAL SUSTAINABILITY, CLIMATE CHANGE AND CHALLENGES OF INDIGENOUS KNOWLEDGE PERCEPTION IN 21ST CENTURY**

**A Festschrift in Honour Of**



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## CONTENTS

|                                                                                                                                                                                                              |          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| Foreword                                                                                                                                                                                                     | iii      |
| Editorial Member's Brief                                                                                                                                                                                     | iv       |
| Acknowledgements                                                                                                                                                                                             | v        |
| Contents                                                                                                                                                                                                     | vi       |
| <br>The Development of Biogeography with a Special Focus on<br>Professor Lanre Tajudeen Ajibade's Scholarly Contributions in Nigeria<br><i>Ajadi Bolakale Saheed &amp; Ajewole Davies Ojo</i>                | <br>ix   |
| <br>The Man: Professor Lanre Tajudeen Ajibade                                                                                                                                                                | <br>xvii |
| <br><b>GEOSPATIAL ANALYSIS AND ENVIRONMENTAL DIVERSITY</b>                                                                                                                                                   |          |
| GEOSTATISTICAL ASSESSMENT OF GROUNDWATER QUALITY IN<br>LAGOS STATE, NIGERIA<br><b>SOLADOYE, Olayemi</b>                                                                                                      | 2        |
| EFFECT OF SOCIOECONOMIC AND DEMOGRAPHIC FACTORS ON<br>MALARIA AMONG PREGNANT WOMEN IN SELECTED RELIEF REGIONS<br>OF ONDO STATE, NIGERIA<br><b>Akanbi F.R.</b>                                                | 18       |
| IMPLICATIONS OF ABATTOIR WASTE ON HUMAN HEALTH IN<br>ILORIN LOCAL GOVERNMENT AREA, KWARA STATE<br><b>Echo, E.O., Ajibade, L.T. and Dabo, M. M.</b>                                                           | 27       |
| ASSESSMENT OF ROAD ACCIDENT PREVALENCE ON UNIVERSITY OF<br>ILORIN MAIN CAMPUS ROAD<br><b>ATIKU, A. A.; ADESINA, A. I.; JIMOH, B. E.; ABDULLAHI, K. I. and HUSSAIN A. D.</b>                                  | 31       |
| PERCEPTION OF RESIDENTS ON THE MENACE ON ENVIRONMENTAL QUALITY<br>IN THE BENIN METROPOLITAN AREA OF EDO STATE, NIGERIA<br><b>Agbehaku, Henry Usiobaifo; Okhae, Ehiabhi Sunday; &amp; ABU, Dada Rayleigh.</b> | 41       |
| MANUFACTURING INDUSTRIES AND ENVIRONMENTAL<br>IMPLICATIONS - LAFARGE NIGERIA PLC. (EWEKORO PLANT)<br><b>B. O. KOMOLAFE &amp; A.A. ADEBAJO</b>                                                                | 52       |
| THE ACHIEVEMENTS OF MILLENNIUM DEVELOPMENT GOALS ON<br>WATER AND SANITATION IN PLATEAU STATE CENTRAL SENATORIAL<br>ZONE, NIGERIA<br><b>Sule Haruna BIBOT &amp; Samuel Ibbi IBRAHIM</b>                       | 62       |
| EVALUATION OF WASTE MANAGEMENT PERCEPTION IN SOUTHWEST NIGERIA<br><b>FALAKE, Mary Adefunke</b>                                                                                                               | 72       |
| MODELLING SURFACE WATER IN ABANDONED MINE PITS ON JOS<br>PLATEAU, NIGERIA<br><b>Solomon T. Oyeniyi; Lanre T. Ajibade; &amp; Paul R. Atanniyi</b>                                                             | 80       |

A SURVEY OF GROUNDWATER QUALITY IN SELECTED AREAS OF MINNA  
METROPOLIS, NIGER STATE, NIGERIA  
Kudu DANGANA; Samuel Ibbi IBRAHIM;  
Racheal Sallau OSEISENEMO<sup>1</sup> & Idris ALIYU Auna

92

## **SOIL, VEGETATION, AGRICULTURE AND NATIONAL DEVELOPMENT**

PERSPECTIVE OF AGROFORESTRY POTENTIAL IN NIGERIA'S  
TROPICAL HIGH FOREST ZONE  
AFOLAYAN, O.S.

101

APPLICATION OF TILLAGE METHODS FOR CLIMATE CHANGE MITIGATION AND  
ADAPTATION IN THE SAVANNA ECOLOGICAL ZONE OF KWARA STATE  
Agaja, Toluwalope Mubo

110

EVALUATION OF WETLANDS FOR AGRICULTURAL LAND USE IN ILORIN,  
KWARA STATE, NIGERIA  
Mustapha, Taofeek Akintunde

121

EVALUATION OF SPATIO-TEMPORAL VARIABILITY IN SOIL LOSS IN  
SELECTED PARTS OF SOUTH WEST NIGERIA  
HABIB, Ademola. Oluwabusola & OKEKE, Peter. Tochukwu

129

EVALUATION OF EFFECTS OF URBANISATION ON VEGETATION IN  
LOKOJA, KOGI STATE  
OYESANMI, Olufayokemi Rasheedat and MAJEKODUNMI, Itta Makanjuola

140

PHYTOCHEMICAL CONSTITUENTS AND HISTOPATHOLOGICAL EFFECTS  
OF *TELFARIA OCCIDENTALIS* ON THE GILLS AND LIVERS OF  
*CEARIAS GARIEPINUS* (BURCHELL, 1822)  
Abubakar, M.I.; Adeshina, I.; Patrick, E.I.; Aminu, M.O. & Moruf, R.O.

149

AN ASSESSMENT OF THE EFFECTS OF CONTINUOUS CULTIVATION ON  
THE SOIL OF SMALLHOLDER FARMERS IN BIDA AND ITS ENVIRONS  
Kudu DANGANA Ph.D, Racheal Sallau OSEISENEMO

162

## **CLIMATE CHANGE, MITIGATION AND ADAPTATION IN NIGERIA**

TEMPORAL ASSESSMENT OF RAINFALL VARIABILITY IN LOWER NIGER  
RIVER BASIN DEVELOPMENT AUTHORITY CATCHMENT AREA  
TUBOSUN, J.O.

169

RAINFALL AMOUNT AND DISTRIBUTION AND THEIR RELATIONSHIP WITH  
DROUGHT RISK IN THE SEMI-ARID NORTHWESTERN NIGERIA  
Abdullahi Umar and Hadi Aliyu

177

TEMPORAL ASSESSMENT OF PENTAD RAINFALL IN ABUJA, NIGERIA  
AUDU, E.B<sup>1</sup>; ABUBAKAR, A.S.; OJOYE, S.; MUSA, S.D.; AGYE, A. I. & SULE, A.

187

CLIMATE CHANGE AND WATER SECURITY IN NIGERIA: A REVIEW  
Falilat O. Lawal; Evelyn O. Geoffrey; Modupe O. Adebayo; Salau Wahab &  
Wungakah J. Sani

196



A SURVEY OF GROUNDWATER QUALITY IN SELECTED AREAS OF MINNA  
METROPOLIS, NIGER STATE, NIGERIA  
Kudu DANGANA; Samuel Ibbi IBRAHIM;  
Racheal Sallau OSEISENEMO<sup>1</sup> & Idris ALIYU Auna

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KWARA STATE, NIGERIA  
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121

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177

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196



## CLIMATE CHANGE AND WATER SECURITY IN NIGERIA: A REVIEW

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### Abstract

The numerous activities of man on the environment have caused emissions of greenhouse gases to the atmosphere, which in turn results in global warming and ultimately climate change. This paper explores the impact of climate change on water security in Nigeria. Climate change phenomena are real in Nigeria as it's evident in increased temperature and changes in the pattern of rainfall. Thus, any change in any component of the hydrological cycle due to climate change may adversely affect water security in the country. The paper identified existing evidences on how climate change has impacted water security and this include reduction in the size of water bodies; conflicts and insecurity; sea level rise, water quality, water supply, occurrence of extreme hydrological events among others. Responses to climate change and water insecurity were also looked into by exploring the local coping strategies adapted such as reuse of water after washing clothes or utensils to irrigate backyard gardens and rationing water by vulnerable communities. Furthermore, indigenous knowledge embarked upon by other countries which vulnerable communities in Nigeria can adapt in achieving water security in the face of climate change were examined. The paper recommended the prohibition of any human activities such as gas flaring that will cause emission of gases into the atmosphere through enforcement of heavy fines; and government at all level should develop comprehensive water resources project by constructing, operating and maintaining dams, dykes as well as boreholes.

**Keywords:** Adaptation, Climate Change, Indigenous, Water Security

### Introduction

Man largely depends on his environment and the connection between his activities and the environment are complex. The implication of human activities on the environment is that any change in human activity would impact the environment (World Bank, 2007; Shakirudeen *et al.*, 2018). Thus, the Intergovernmental Panel on Climate Change (2007) observed that these activities of man together with some natural phenomena have caused persistent emissions of greenhouse gases to the atmosphere. These have resulted in continuous increase in global warming, which has consequently led to climate change.

Climate change refers to the rise in mean global temperature which ultimately leads to the disruption of climate pattern with its resultant effects on man and his environment. Adeleke and Olabode (2017) posited that climate change is among the leading global adversity facing the world at the moment, even though its impacts varies across regions and countries of the world. The features of climate change include: increased global temperature, reduced snow cover resulting from melting ice caps and glaciers, change in cloud cover and precipitation over land and rising ocean temperature and acidity. The IPCC (2008) reported that the world will continue to experience global warming, such that the global average temperature could increase to 4°C by the year 2100. Thus, Gleick (2000) portended that a 4°C increase in temperature will result in a 10% increase in precipitation in order to balance the evaporation losses.

Moreover, climate change influences the various components of hydrological cycle through increasing changes in surface temperature which increases annual evaporation of most water bodies and consequently changes the amount, when, how, where and intensity of precipitation; thereby affecting the quality and quantity of water supply across the surface of the earth (Ifabiyi and Ojoye, 2013). Furthermore, climate change also impairs the ability of the groundwater to recharge. For instance, a report by IPCC



(2008) revealed that the rate of recharge of groundwater reduced by more than 70 % in South West Africa and North-Eastern Brazil. This ultimately affects the depth of water table and base flow of rivers. These components directly affect the availability of water resources in many parts of the world. According to Khayeret *et al.*, (2019), changes in precipitation, temperature and sea level rise can affect the availability of water.

As the global average temperature increased by 1°C prior to the industrial revolution, water cycle has been greatly influenced by climate change thereby resulting into intense rainfall and severe drought. This consequently affects water security as it disrupt water supplies, threatens food security and stir the natural ecosystem. It is estimated that about 3.5–4.4 billion people around the world are expected to live under water scarcity by 2050 due of climate change (Wade, *et al.*, 2014). Thus, Ricart, *et al.*, (2021) anticipated that climate change would have a significant influence on water supply, both quantitatively and qualitatively.

The IPCC (2008) projected that by 2050, the areas experiencing water shortage/stress due to climate change would double, hence causing water insecurity in many parts of the globe. However, human survival on earth is dependent on water; there is a common parlance that says “Water is life”. The importance of water is further buttressed by Ifabiyi and Ashaolu (2013) that water is the lifeblood of the planet, and the state of this resource can affect all natural, social and economic systems. This implies that for life to go on smoothly there is need for the availability of safe water supply. Safe water availability is a basic human right to every individual around the globe, hence, the World Health Organisation (2017) sees safe drinking water as the water that is within the acceptable drinking water quality standards and does not constitute any significant threat to human health. It is against this background that this paper reviews climate change and its impact on water security and applicable indigenous knowledge that can be used to achieve water security in the face of climate change in Nigeria.

### Conceptual Clarification

The term climate change has been used interchangeably with climate variability. However, the two terms tend to be similar in some ways, but there is a clear and important distinction between them as each has a unique connotation. Past studies (Ayoade, 2003; Tilakasir, Olanrewaju & Salami, 2016) viewed climate variability as an innate element of climate as the global climate has never been static. On the other hand, climate change implies a persistent, prolonged and statistically significant departure from the normal climate (Olaniran, 2002; Ayoade, 2003 & Adeleke, 2018). Thus, the term climate change means different things to different people. In other words, there is no hard and fast rule as to the definition of the term as it is multidimensional and multidisciplinary in nature and cuts across different interest groups.

Moreover, the United Nations gave a universally acceptable definition of water security as “the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability” (UN-Water, 2013). Thus, the availability of reliable access to safe water is very paramount for a nation to attain sustainable development. As such, water security is very crucial for the achievement of overall development of an area.

### Overview of Climate in Nigeria

The climate of Nigeria is a tropical climate which is characterised by both wet and dry seasons. The wet season exhibit high and double maxima rainfall pattern especially in the southern part of the country and low rainfall amount in the North. According to Enete (2014), temperature has been increasingly high across the country since 1980s. The temperature of the country has also been projected to increase across all the ecological zones; likewise, the amount and intensity of rainfall is expected to vary across the country (Akande *et al.*, 2017). Hence, the evidences from the climate variables showed that the climate of the country has been changing over the years and would continue to change (Ebele and Emodi, 2016; Akande *et al.*, 2017). Moreover, the report of the vulnerability analysis conducted by previous studies (Madu, 2016; Abdulkadir *et al.*, 2017 and Matemilola, 2019) revealed that the northern part of Nigeria (especially the Northeast and Northwest) are highly susceptible to climate change impacts due to the rising heat and declining rainfall as compared to the southern part of the country.



### Water Security in Nigeria

Water security is an issue of national and regional concern in Nigeria. However, the situation of the country is quite different as the country is blessed with adequate rainfall, though seasonal and not uniformly distributed across the states. However, the annual renewable per capita fresh water for Nigeria has been observed to be on the decrease, Ifabiyi (2012) submitted that the annual renewable per capita freshwater in Nigeria has been observed to be decreasing yearly; it was 2,203 Cubic Metres (Cu) in 1990, and the amount was discovered to be 1,292 Cubic metres in 2003. Furthermore, the problem of water security in Nigeria has also been compounded by the occurrence of flood in the south, and severe drought in the northern part of the country. As such, 90% and 60% of rural and urban areas respectively experience water related problems in Nigeria as an estimated 90 million people lack access to safe drinking water (ADF, 2007)

Hence, a large percentage of the population in Nigeria can be said to be water stressed, as such the rural population in Nigeria have resulted in the use of unsafe water such as rivers, wells, harvested rainwater among others as their dominant sources of water supply and this greatly affects their health (Ezenwanji, 2012; Obeta and Chukwu 2013). Thus, the statement by Joan Clos, a one-time Executive Director of UN-Habitat that "Africa is among the most hit region of the world by water scarcity" lends credence to this, as he further stated that "Africa is the fastest urbanising continent on the planet, and the demand for water and sanitation in the region is outstripping supply". Although, many parts of Nigeria have higher precipitation than the global average. In other words, Nigeria is so rich in water resources that, some states and communities are named after rivers; yet access to safe water has remained a nightmare in the country.

For instance, the WHO/UNICEF (2017) reported that more than 50 million rural and peri-urban communities in Nigeria remain the most water poor and vulnerable owing to their lack of access to potable water sources. This consequently leads to their continuous reliance on open water sources as the public water supply service remain below par (Akindeet *al.*, 2019).

### Impacts of Climate Change on Water Security in Nigeria

**Reduction in the Size of Water Bodies:** Climate change is gradually altering the size of freshwater resources in Nigeria as the warm weather has been increasing the rate of evaporation from water bodies such as lakes, rivers and streams. This in turn hastens the depletion of reservoirs and causes more intense and longer-lasting droughts. Nigeria is faced with the challenges of climate change as the size and flow of many rivers are gradually reducing. Lake Chad for instance, is drying up due to high rate of evaporation, human withdrawals, construction of dam and increasing population with simultaneous desert encroachment which is as a result of its close location to the Sahara desert (Ebele and Emodi, 2016; Abdulkadir *et al.*, 2017; Akande *et al.*, 2017 & Ifabiyi, 2018). According to Ifabiyi, (2018), the size of Lake Chad was 40.3km<sup>2</sup> between 1960-1968, but reduced to 21.2 km<sup>2</sup> between year 2000 and 2009. This results in communal and transboundary disputes over ownership of remaining water in the lake, extinction of wildlife, decline in water supply for agriculture, dust storm due to desertification (Ifabiyi, 2018).

**Conflicts and Insecurity:** Climate change is slowly altering precipitation and water supply globally. This has consequently led to water conflicts in many parts of the globe. De Wit and Jacek (2006) believed that Africa is susceptible to water violence, competition and conflicts due to increasing demand for water; as majority of the river basins in Africa are trans-boundary. For instance, climate change has caused many communities in Nigeria to engage in localised conflict over the control of the remaining water in the drying lakes and rivers and this subsequently leads to insecurity in the country (Madu, 2016). Previous literature have shown that the main reason for this inter-communal clash is drought which have consequently resulted in forced emigration towards the southern part of the country by the Fulani herdsmen for water holes and grasslands for their cattle (Amobi and Onyishi, 2015 & Elisha *et al.*, 2017). This has resulted in permanent resettlement of the herdsmen from the north-sahelian region to areas inhabited by farmers in the south.

**Water Quality:** Past studies (IPCC 2008 and Abdulkadir *et al.*, 2017) have shown the relationship between climate change and water quality. Increased water temperature and high rainfall intensity can cause decline of dissolved oxygen and oxygen concentrations in water bodies, thereby lowering ecological productivity as well as intensifies water pollution. For instance, the WHO/UNICEF (2017) reported that more than 50 million rural and peri-urban communities in Nigeria remain the most water poor and vulnerable owing to their lack of access to potable water sources. This showed in the inability of the country to meet up with the



2015 Millennium Development Goal (MDG) of drinking water target. Thus, Kithinji (2015), observed that 51% of the total rural population which suffers from the domestic water-related diseases may be attributed to their dependence on unimproved water sources such as surface water and dug-wells. Furthermore, past study have shown that as sea level rises due to increased rainfall, this may cause salt water intrusion and probably threatens freshwater aquifers and rivers thereby polluting the fresh water resources with sediment (Sayne, 2011). Similarly, sea level rise from persistent rainfall in Southern Nigeria can lead to flood, water logging and polluted ground water which causes outbreak of water-related diseases (Ebele and Emodi, 2016).

**Water Supply:** According to Khayer, *et al.* (2019), changes in precipitation pattern, temperature, sea level rise and floods can affect fresh water supply. This implies that places that are wet lands before are gradually becoming dry while some dry lands are presently wet as a result of climate change. For instance, the incidence of drought conditions common in many parts of northern Nigeria have caused the groundwater tables to drop sharply over the last half century (Sayne, 2011). This have further led to reduced amount of drinking water supply. Thus, the rural communities harvest rain water for more than half of their total water use.

**Sea-level Rise:** The rapid increase in ocean temperature has led to the thermal expansion of the oceans as well as melting of ice in the polar region, which is causing sea level rise. However, the report of the vulnerability analysis conducted by previous studies in Nigeria (Enete 2014; Abdulkadir *et al.*, 2017&Matemilola, 2019) revealed that increased durations and intensities of rainfall in the country, have resulted into large runoffs and flooding in many of the southern parts of the country especially areas along the coast (the Niger-delta region).

**Occurrence of Extreme Events:** If past trends of rising global temperature continue, the type, frequency and intensity of precipitation storm characteristics are bound to change leading to extreme events such as severe droughts, intense water shortages and in some cases flooding. This will have a lot of effects on the supply of potable freshwater resources in the country as the evidences from the climate variables showed that the climate of the country has been changing over the years and would continue to change (Ebele and Emodi, 2016&Akanke *et al.*, 2017;). This may further result into environmental degradation; frequent extreme weather events which altogether affect fresh water resources in the country (Olaniyi *et al.*, 2013&Elisha *et al.*, 2017). Thus, the United Nations (2020) revealed in the 2019 progress report on Sustainable Development Goals (SDGs) that 785 million people remain without access to basic drinking water service, and 700 million could be displaced by intense water scarcity by 2030 as nearly 2 billion people will continue to live in water stress regions. Moreover, flooding in Nigeria can be traced to increased rainfall which consequently increased run-off. For instance, According to MISNA (2012) the flood incidence that occurred in Nigeria in the year 2012 was the most devastating disaster in the country as houses were submerged; and an estimated 1.3 million people were displaced leading to death of about 431 people. Moreover, over 1525 square kilometres of farmland were destroyed.

**Agriculture and food security:** The inconsistencies in the weather pattern (high temperature, declining/high rainfall) which has resulted in dry spells, uncertainty of rainfall, flooding amongst others as a result of climate change has constituted threat to food security (Elum *et al.*, 2017). Nigeria is a country that is dependent on rain-fed agriculture (Shiru *et al.*, 2018 and Onwutuebe, 2019). However, adverse climate conditions have endangered agricultural productivity by reducing crop yield and other agricultural produce, and as such farmers have been finding it difficult to plan their farm operations. For instance, the northern part of the country which used to be the food basket of the nation are now vulnerable to desert encroachment due to inconsistent rainfall. Moreover, Liverpool-Tasie *et al.*, (2018) reported the result of a study carried out in Kaduna and Oyo states in 2017 that 10% of the poultry farmers experienced losses of product (chicken, eggs) due to adverse heat waves associated with climate change which adversely affect the growth and productivity of the chickens. In addition, the water bodies in the north are shrinking in size and those along the coast of the southern part of the country are susceptible to flood (Ogbuabor and Egwuchukwu, 2017). Thus, the fishes used to boost their livelihood are going into extinction as a result of increased salinity of the water bodies (Ebele and Emodi, 2016). This uncertain climate conditions have caused shock on the economy of the country due to unproductive agriculture (Anabaraonye *et al.*, 2019). To cap it all, the forced emigration of the Fulani herdsmen to places already inhabited by farmers have resulted in food insecurity as the cattle feed on the farmers' agricultural produce and this has resulted in local clashes between the farmers and the herdsmen (Elisha *et al.*, 2017).



Although, measures have been made in order to curb the climate change impact on water security by different administration at different levels. However, many of these measures (signing of Mou, MoA with governments at various level, NGOs and other international bodies such as WHO, UNICEF among others) have not been sufficient to attain water security in Nigeria. Thus, water insecurity is not only related to climate change but, also depends greatly on myriad of other factors such as management processes and practices, regulatory framework and mode of governance.

#### **Indigenous Methods of Coping with Climate Change**

The term indigenous knowledge differs from scientific knowledge which is synonymous to western technology or techniques in their practices and applications. Previous studies (Sillitoe, 1998; Gaillard et al., 2012 & Mercer et al., 2012) observed that the term 'indigenous knowledge' have different meanings such as 'local knowledge', 'traditional knowledge', 'indigenous technical knowledge', 'peasants knowledge', as well as 'traditional environmental knowledge' or 'folk knowledge'.

According to Ajibade (2003), Indigenous knowledge unlike the scientific knowledge commonly called 'modern' knowledge are the knowledge systems acquired over a long period of time by a community. UNESCO (2017) believes that indigenous knowledge refers to the understandings, skills and philosophies accumulated over years through interaction with their natural surroundings. Indigenous knowledge informs decision-making about fundamental aspects of life, from day-to-day activities to longer term actions. They are essential in planning for adaptation as they offer local coping strategies and experience that can help to provide efficient, appropriate and time-tested ways of advising and enabling adaptation to climate change in communities threatened by climate change. This knowledge is integral to cultural complexes, which also encompass language, systems of classification, resource use practices, social interactions, values, ritual and spirituality about past weather patterns. These distinctive ways of knowledge are important facets of the world's cultural diversity.

#### **Indigenous Methods used in Nigeria in Coping with Climate Change**

Climate change in Nigeria is a real phenomenon, rather than waiting for international communities/organisations to proffer solutions which may take a long time to come and eventually a lot of damages might have occurred, rapid and realistic approach is needed to combat the challenges of climate change in the country. Adaptation to climate change phenomenon must occur at all levels (individual-community-national) especially by transforming their behaviour at the individual level. Thus, every community must be ready to build their resilient capacity by either making use of technology or making the optimum use of their indigenous knowledge in order to adapt to current and future stress that may be put forward by climate change.

It has been established that the common cultural practices in Nigeria include: Manipulation of radiation to reduce sunlight intensity such as shading/Cover to reduce radiation loss at night; Manipulation of solar radiation flows using tillage, mulching, windbreaks as shelter from trees, Protection for ripening purposes, and the use of warmed air for field and storage drying; Manipulation of Mechanical impacts of wind and rain e.g. Planting in lower places where deep rooting is possible, Improving soil conditions by natural deposits, and Protecting crops and produce against impacts by rain or wind; and Miscellaneous methods e.g. Fitting cropping periods to the seasons, Making use of super human interventions (Chukwu and Okoro, 2006).

Another measure is the reuse of water, for example from washing clothes or utensils, to irrigate backyard gardens and nurseries. Households are also rationing water, trying to reduce the water use per person per day. Thus, the practice is abandoned when the rains starts. Most communities are actively reviving rainwater harvesting, a traditional way of collecting and storing rainwater in big barrels placed under the roofs of houses. The practice had largely been abandoned when the communities installed wells and boreholes, but has attracted interest again as a result of their drying up and clearing of riparian vegetation has been identified as a major factor increasing soil erosion and siltation of rivers, which eventually reduces stream flow, and they are adopting measures to remedy the situation through preservation of vegetation or afforestation of the area (Gyampoh *et al.*, 2009).

#### **Response to Climate Change (Lessons from other Developing Countries)**



Several coping strategies can be embarked upon by adapting measures from other countries which have overcome the impacts of climate change. Some of these technological based technique include: desalination, groundwater and rainwater harvesting, Protection of water catchment areas, improve water use efficiency by providing modern hydraulic infrastructure, develop water markets, adapting crop patterns with less water consumption, adapt modern irrigation methods, build structural flood defences, improvement of the water management policies, and increasing the storage capacity of the reservoirs. The United Nations Framework Convention on Climate Change (UNFCCC) database comprises of long-standing mechanisms, knowledge and experience the communities in developing countries adapt to cope with climate change. Nigeria as a country can learn from this indigenous knowledge. Several examples of local coping strategies according to (UNFCCC) (2007) that Nigeria can adapt from include:

1. Water conservation techniques: These local/ indigenous techniques such as the Zaï technique in Burkina Faso are used to cope with dry spells. It involves farmers digging pits in the soil during the dry season in order to collect organic material carried by the wind. At the onset of rainy season, farmers add organic matter from animals, this attracts termite activity and result into deep termite tunnels that can collect rain water without the water evaporating. This simultaneously improves soil fertility. Furthermore, in Latin America, particularly Peru, Farmers in Peru have been able to use ancient irrigation and drainage system to produce low-lying, flood prone, poorly drained lands called "waruwaru", or raised field agriculture, to provide shallow canals which provide moisture during droughts and drainage during the rainy season. The waruwaru system provides farmers with greater harvest security and reduces the risks associated with frosts and drought. In addition, The Aymaran indigenous people of Bolivia construct small dams "qhuthañas" which collect and store rainwater from 50 to 10,000 cubic meters in order to cope with droughts. Other water conservation techniques consist of terracing, surface water and groundwater irrigation.
2. In Costa Rica and Ecuador, the local communities have been able to use their indigenous knowledge to cope with extreme hydrological events such as floods and droughts by improvising cost-efficient and durable designs for their houses. These locals either raise their houses or use reinforced concrete strip as a foundation in order to protect the bamboo walls against fungi and avoid the walls from touching ground.
3. In some communities especially coastal areas, tribal and individual movements and migration are the form of adaptation strategies employed. For instance, in Cuba, particularly Playa Rosaria, Havana Province, the local people employed the relocation option as a strategy for coping with coastal erosion. Some coastal communities also adapt to sea level rise by practicing reforestation and building sand dune fences.
4. Moreover, communities in El Salvador have been able to cope with drought by employing some measures of soil conservation techniques such as building barriers with stone and pine suckers, which provide edible fruits and additional income.
5. Some communities train volunteers who help in evacuating, rescuing and providing first aid emergency relief.

However, these indigenous strategies would require the interventions of government and local communities as regards making resources available, integrating climate change into national planning and decision making and eradication of laws that can inadvertently increase vulnerability to climate change.

### **Conclusion and Recommendations**

This paper examines climate change impacts on water security in Nigeria and explores adaptation methods for water supply and extreme hydrological events. Based on the literature reviewed, the following recommendations are drawn.

The continuous flaring of gases by the oil and gas companies should be stopped in order to avoid emission of these gases into the atmosphere, to do this Government at all levels should enforce heavy fines and sanctions on those who disobey; further development of the flood plains and wetlands should be prohibited in order to avoid disaster. The town planning development authorities should therefore stop the building approval of buildings along the coast and mark out structures built along the coast for demolition; early warning systems especially in areas prone to disasters should be developed. This will help the evacuation of people in order to prevent loss of lives and properties. The government at all level should



develop comprehensive water resources project by constructing, operating and maintaining dams, dykes wells, boreholes, and irrigation systems.

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