FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

CLIMATE CHANGE, ENVIRONMENTAL DEGRADATION AND OUR COMMON FUTURE

By

PROFESSOR AISHETU ABDULKADIR
NCE (ABU, Zaria), B.Tech, M.Tech., PhD (FUTMinna)
Professor of Geography

INAUGURAL LECTURE SERIES 88

19TH AUGUST, 2021

ISSN 2550 - 7087

Luradd Ventures Ltd
08034505205, 08082545865

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

CLIMATE CHANGE, ENVIRONMENTAL DEGRADATION AND OUR COMMON FUTURE

By

PROFESSOR AISHETU ABDULKADIR
NCE (ABU, Zaria), B.Tech, M.Tech., PhD (FUTMinna)
Professor of Geography

INAUGURAL LECTURE SERIES 88

19TH AUGUST, 2021

Published by:
University Seminar and Colloquium Committee,
Federal University of Technology, Minna.
© *Copyright:* 2021
All Rights Reserved

Professor Abdullahi Bala, *PhD, FSSSN*
Vice-Chancellor
Federal University of Technology, Minna
Chairman of the Occassion

PROFESSOR AISHETU ABDULKADIR

NCE (ABU, Zaria), B.Tech, M.Tech., PhD (FUTMinna)

Professor of Geography

1.0 Preamble

In the name of Allah, the Beneficent, the Merciful, all praises and thanks are for Allah, who has guided us to this day never could we have found guidance, were it not that Allah had guided us. All praise is due to the Lord of the world by whose honour and Majesty, deeds of virtue are accomplished.

I am a daughter of a famous hardworking, dedicated and successful farmer who never left any stone unturned regarding the love and training he gave to his children. His affection attracted me to him and his farm activities so much that I always joined him in the farm during every vacation. This made me to develop passion for the natural environment and raised my curiosity about nature. Hence, at an early age, I had the privilege to enjoy the fruits, games, shade, farm delicacies (roasted maize, cassava, fish, groundnut, etc.) and experienced complexity of natural biodiversity. As I experienced this phenomenon, certain questions came to my mind which were: Where? (ie the fadama, upland, natural vegetative land, settlement), what? (resources; water and vegetation), how? (the methods and reason for occurrences and distribution) and so what? (the implication and way forward). Primarily, the answers to these questions at that stage of my life did not go beyond spiritual, as the conclusion was that they were all ordered by the Almighty Allah as the Holy Book revealed the numerous mercies of our creator: "And Allah has sent down rain from the sky and given life thereby to the earth after its lifelessness. Indeed, in that is a sign for a people who listen" (Qur'an, 16:65).

My admission into the Department of Geography, Federal University of Technology, Minna in 1997 directed my focus on nature and its variability, enhanced my understanding of the physical reality of the geographical space we occupy and the transformations of the space into places that we find more comfortable to inhabit. Thus, developing the geographic concern

for the complex understanding of the earth, its resources and spatial arrangements of phenomena on the planet earth became the innermost focus. Basically, the focus has been on the interface between human activities, the resource base and socio-economic well-being in the ecological domain of sub- humid, semi- arid and dry regions of Nigeria, using integrative approaches towards analysing, interpreting and determining the spatio-temporal dynamics of the physical environment. These are in response to the fact that the primary concern of all physical geographers is the spatio-temporal structure and process of the natural environment.

The Vice-Chancellor Sir, it is with joy and deep sense of humility and fulfillment that I present myself to deliver the 88thInaugural Lecture as part of the fulfillment of the prestigious academic Professorial Chair of Geography. The 4th from the Department of Geography, after the 9th, 36th and 71st Lecture Series by Professor D.O. Adefolalu, A.S. Abubakar and G.N. Nsofor respectively. Thus, I am highly delighted that shortly after being appointed a Professor of Geography in this University (October 2019), I have the privilege today to present my Inaugural Lecture.

As a Geographer with specialization in applied climatology and environmental Management with special skill in Geographic Information System (GIS), Sir, the focus of this lecture is devoted to the systematic explanation of Topical Contemporary 21st century environmental issues on which guidance for building our common future will be tied. The title of my lecture therefore, is "Climate Change, Environmental Degradation and Our Common Future"

2.0 Introduction

Globally, climate change and environmental degradation are probably the most complex and challenging twin environmental problems facing the world today. These geographical

phenomena are products of the alteration of the natural equilibrium that exist between the complex planetary components that are fundamental to the sustainability of our common future. These imbalances generally led to the intensification of environmental problems that continued to threaten human livelihood, environmental sustainability, peaceful co-existence that is endangering national security. Ahmed *et al.* (2018) affirmed that climate change and environmental degradation pose severe threat to international peace and security. They added that the impact of ecological deterioration and climate change has a more significant consequence on the developing nations as compared to the developed economies. Correspondingly, the 21st century witnessed aggravation in numerous environmental problems (global warming, depletion of stratospheric ozone, acidification of surface waters, destruction of Tropical Rain forest that hinders carbon sequestration and extinction of species) that do not only constitute threat to natural environment but have devastating impact on the nations socio-economic well-being and human livelihoods.

Fundamentally, climate change and environmental degradation have continued to change the frequency and intensity of extreme events across the globe. These effects in turn, have influenced the intensity and frequency of extreme environmental events, such as floods, droughts, forest fires, hurricanes, heat waves and storms. By implication, this will intensify environmental degradation, dryness and wetness of a region thus, aggravating natural hazards such as drought, flood, desertification, hurricanes, tornadoes and wildfire. Hurricane Katrina of 2005 and Hurricane Sandy of 2012 are two of the costliest hurricanes in the history of the United States (Munich, 2013). Usman and Abdulkadir (2014) declared that 1970 -1980s droughts remain

topical because they had a serious impact on the agricultural sector in Nigeria which led to the disappearance of the famous groundnut pyramids following the rainfall fluctuation of 1970s. Moreover, Abdulakdir *et al.* (2015a) acknowledged that the 2012 flooding event in Nigeria was the most devastating in history as vast floodplains in the country that traditionally attracted human settlements, economic and livelihoods support experienced devastating flood. Hence, the effects of 1970-80s droughts and 2012 flooding events in Nigeria cannot be forgotten very quickly.

Consequently, the global consensus on climate change and environmental degradation due to its threat to humanity requires urgent need for increase understanding of the environmental challenges. Primarily, this is vital for the development of proactive approaches and policies as veritable tool for disaster risk reduction, enhance socio-economic livelihood, peaceful co-existence, and the sustainability of our common future.

3.0 Climate Change

Climate is defined as the long-term average weather condition of a place usually about 30-35years. It indicates the atmospheric condition of heat, moisture and circulation that affects nearly every aspect of human life; from our food sources to where we live, from the clothes we wear, livelihoods, health, shaping of vegetation and soil and even our common future. On the other hand, climate change is simply the long-term fluctuations in atmospheric conditions: temperature, precipitation, wind, and all other aspects of the earth's climate. Intergovernmental Panel on Climate Change (IPCC, 2007) defines climate change as changes over time in the averages and variability of surface temperature, precipitation, and wind as well as associated changes in earth's atmosphere, oceans and natural water

supplies, snow and ice, land surface, ecosystems, and living organisms. That is, change in climate condition over time, whether due to natural variability or because of human activity. IPCC (2013) affirmed that human interference with the climate system (mainly through the emission of greenhouse gases and changes in land use) has increased the global and annual mean air temperature on the earth's surface by roughly 0.8 °C since the 19th century. It added that if increasing temperature will continue and by 2100, the earth could warm by another 4 °C. Hence, climate has been changing and will continue to change in response to intensification of human activities with resultant long-term alteration of climate and weather patterns.

By inference, the rate and impact of change will trigger extreme weather events if left unchecked; as numerous researches have shown that human activities have dramatically increased the amount of heat-trapping greenhouse gases, primarily carbon dioxide, in the atmosphere, causing the planet to be warm. Leggett (2018) concludes that despite the uncertainties, current climate scientific assessment states high confidence (extremely likely) that human influence is the dominant cause of the observed warming over the past half-century. The resultant implications of this has grave environmental and livelihood consequences; environmental degradation will intensify which will in turn aggravate water, food and energy crisis and insecurity.

3.1 Climate Change Impacts

There has been fundamental concern about the adverse consequences of climate change, occurrence, spread, intensity and their impact on our common future. IPCC (2014) declared that there is broad agreement that a warming of this magnitude would have profound impacts both on the environment and on human societies. Similarly, Africa Progress Report (2015)

acknowledged that Africa is already experiencing more severe and more damaging impacts of climate change than other parts of the world and if left unchecked, it will reduce agricultural productivity, create conditions for mass hunger and reverse human development. Hence, climate change has continued to intensify food insecurity, poverty, famine and severe economic losses due to natural catastrophes; drought, flood, desertification among others.

Moreover, Ahmed (2018) reported that Duran *et al.* (2013) declared that as a result of climate change, about 3,852 natural catastrophes have claimed the lives of more than 780,000 persons while affecting more than two billion people as property of more than $960 billion has been lost in the process. It added that the shrinking of the glacier volume as a result of the warming temperature on the earth's surface shows the far-reaching effect of climate variability/change. Thus, there has been fundamental concern about the adverse consequences of climate change, occurrence, spread, intensity, and their impact on our common future

These challenges led to the growth of public concern over global environmental issues in the mid-1980s which gave rise to numerous International Protocols, Treaties and Agreements to collectively address the salient issues of climate change. Fundamental among efforts to tackle climate change are the; Montreal Protocol (1987) that was primarily established to protect the ozone layer, UN Framework Convention on Climate Change (UNFCCC), 1992 which was ratified by 197 countries. It was the first global treaty to explicitly address climate change and produced Kyoto Protocol and the Paris Agreement. Also, Intergovernmental Panel on Climate Change (IPCC) was established in 1988 to regularly assess the latest climate science

and to produce consensus-based reports for countries. These were to stabilize greenhouse gas concentrations at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system.

However, despite all the efforts to enlighten humans generally on the need for behavioural change towards the ecosystem, there is intensification of human activities with corresponding increase in emission and climate change that have been inducing natural hazards across the globe. An indication of its threat to our common future and the need to deepen our understanding of the challenges, to mitigate, adapt and enhance our resilience to climate change.

Nigeria is the most populated country in Africa and one of the world's most populated countries with a population of over 200 million people, with a large proportion relying on climate sensitive-threatened livelihood. Thus, it is crucial to identify the impacts and develop proactive strategies to mitigate changes and adapt naturally to the changing climate without hindering socio-economic development and human livelihood as a pathway to our common future.

4.0 Environment

The word environment is derived from a French word 'environner' meaning to encircle or to surround. Environment is simply everything that make up our surroundings and affect our ability to live on earth. Enerijiofi (2018) referred to environment as the surrounding external conditions influencing the growth or development of people, animal or plants in their living or working conditions. Environment is made up of places which can be either natural or man-made. It constitutes the most abundant resources of the planet; land, air, and water that we depend on

for existence. This forms the primary components of the earth which are the Lithosphere (Land), Atmosphere (Air) and Hydrosphere (Water) and the Biosphere (Biotic) which is the product of the complex interaction between the first three. Thus, human beings live in the kingdom of nature and interact with its variables and substances constantly. Basically, man and his environment are mutually affecting each other in several ways because human beings and their environment are interdependent.

"And there is no animal that walks upon the Earth nor a bird that flies with its two wings but they are like yourselves; We have not neglected anything in the book, and then to their Lord shall they be gathered" (Qur'an 6:38).

The environment is one of Allah's blessings to humanity and He entrusted it to us with the role to preserve it so that the balance of this universe can be maintained for the benefit of all. Generally, Allah speaks of creating everything in balance, and warns that transgression beyond the balance shall have disastrous consequences. Hence, climate change and environmental degradation are consequences of human's alteration of the delicate equilibrium between the natural variables which have resulted in serious environmental problem in recent times.

The contemporary environmental interest arose primarily from concerns in the late 19th century resulting from the intensification of human activities that triggered the emergence of the Industrial Revolution in Europe. The turning point for this followed the publication by Rachel Carson in 1962, titled "Silent Spring" which led to the emergence of numerous environmental movements as it made a powerful case for the idea that "if humankind poisoned nature, nature would in turn poison

humankind." This raised global consciousness on the environment and environmental issues that resulted in the change of attitude towards the natural environment. Since then, there has been intensification of environmental issues which directly and indirectly impact not only on the natural environment but individual, communities, and livelihoods. Hence, there is no need denying the fact that intensification of human activities has resulted in numerous environmental challenges facing the planet earth today with the fundamental potential of endangering our common future.

4.1 Environmental Degradation

Environmental degradation is the deterioration of the environment in response to depletion of natural resources which include all the biotic and abiotic elements that form our surrounding; air, water, soil, plant, animals, and all other living and non-living elements of the earth. The explosion of human population leading to deforestation, unsustainability of natural resources utilization and land conversion are serious environmental problems worldwide. Abdulkadir (2009b) concludes that these coupled with climate variability and change lead to intensification of erosion, sedimentation and siltation of rivers and streams which generally constitute environmental degradation (Figure 1). This covers a variety of issues including pollution, biodiversity loss, agriculture, urbanization, animal extinction, deforestation and desertification, global warming, and a lot more.

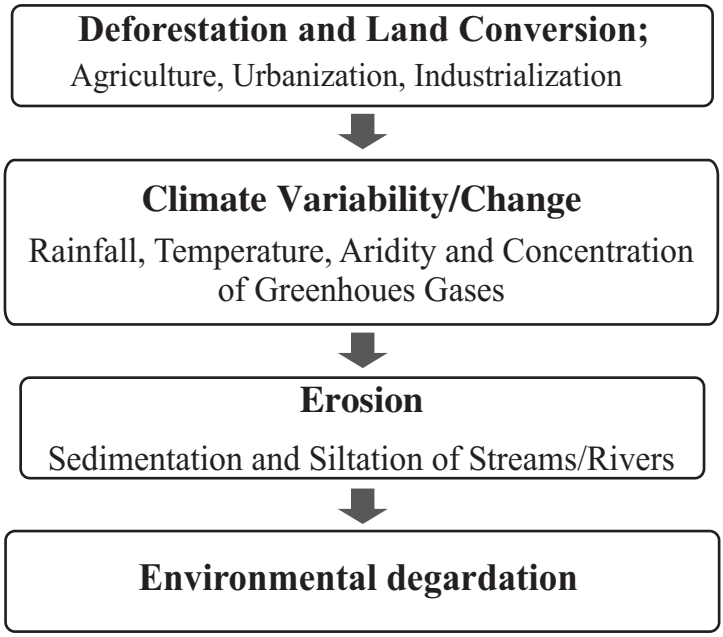

Figure 1: Environmental Degradation Process
Source: Adapted from *Abdulkadir (2009b)*

Human beings' impact on the physical environment is apparent in many ways; overpopulation, pollution, burning fossil fuels, and deforestation thereby triggering climate change. Others are soil erosion, poor air quality, desertification, lowering of water table, agricultural produce, and contamination of water sources. Land degradation has accompanied humanity at least since the widespread adoption of agriculture during Neolithic time, some 10,000 to 7,500 years ago (Dotterweich, 2013). The cumulative negative impacts reduce the capacity of natural environment to support life and livelihood which has severe consequences on human livelihood that often lead to migrations and civil unrest, which is obvious across Nigeria, especially in recent times. Maurya (2020) concludes that environmental degradation is one of the most urgent environmental issues. Consequently, there

have been environmental concern by all because of the emerging environmental challenges that are collectively threatening our common future.

4.2 Features of Environmental Degradation

Deforestation is a common practice across Nigeria, and this has resulted in decrease in forest/vegetative areas. The obvious features of environmental degradation are expansion of land clearance for agricultural purpose, uncontrolled/haphazard urbanization, construction and mining, bush burning/fire, overgrazing, fuel wood, charcoal and timber production, quarrying of stone, sand, ore and minerals mining among others. Primarily, these practices expose the land, lead to loss of soil fertility and biodiversity as forests are home to biodiversity which includes mammals, birds, insects, amphibians or plants and many of which are rare and fragile species.

Drought is fundamentally slow onset/creeping hydrometeorological hazard threatening our common future in this country. Wilhite (2000) defined drought as a severe moisture deficit below expected levels that restricts some type of activity. Furthermore, drought is categorized in terms of four basic approaches to measuring drought: meteorological, hydrological, agricultural, and socioeconomic. However, common to all types of drought is the fact that they originate from precipitation deficiency that results in water shortage for certain activity as at when required. This in turn aggravates environmental degradation.

Flood is a sudden onset, frequent incidence and most common hydrometeorological hazard triggering disaster in recent times across various ecological zones in Nigeria. Natural hazards can be further categorized into sudden- and slow-onset “creeping”

threats (UNEP, 2012). Flooding is one of the major environmental issues that is threatening not only the natural environment but human livelihood across the country, particularly the fertile wetland low-lying ecosystems. Specifically, the impact of 2012 flood was one of the worst in Nigeria leading to loss of lives and properties worth billions of Naira.

The latitudinal location of Nigeria has made it vulnerable to advancing Sahara Desert which has been moving southward. The widespread environmental degradation across the country has been affecting the productivity of dryland ecosystems through reduced plant cover, increase soil erosion, loss of soil organic matter, siltation of rivers and streams, increasing sand dunes and run-off. McSweeney (2019) described desertification as the greatest challenge of our time and that climate change is making it worse. Olagunju (2015) stated that Nigeria is one of the countries south of the Sahara faced with a rapid desert encroachment, with notable effects on the northern part of the country.

The current trend in agricultural intensification, urbanization, grazing, deforestation, and mining, coupled with rise in hydrometeorological hazards (drought, flood, desertification, and erosion) will continue to accelerate environmental degradation across terrestrial and aquatic ecosystems. This will not only intensify environmental change but will lead to loss of livelihood, sustained economic and peaceful co-existence as environmental degradation has severe effects on our common future.

4.3 Environmental Change

The alteration of the planet earth coupled with industrialization has continued to fuel environmental change. Laursen *et al.* (2018) acknowledged that environments are rapidly changing due to climate change, land use, intensive agriculture, and the impact of hunting on predator populations. On the other hand, Olsson *et al.* (2019) affirmed that land degradation processes with direct impact on soil and terrestrial biota have great relevance in terms of CO_2 exchange within the atmosphere, given the magnitude and activity of these reservoirs in the global carbon cycle. By implication, climate change and environmental degradation are intensifying one another and are fundamental factors in environmental change. These have resulted in variability and change in the occurrences of some climatic parameters; rainfall, temperature, light wind, biotic organism and abiotic components like soil. Warmer *et al.* (2010) indicates that climate change will have a progressively increasing impact on environmental degradation and environmentally dependent socio-economic systems with potential to cause substantial population displacement.

The natural environment has been changing and the changes are more rapid than ever before in response to the intensification of human activities and other natural phenomena with the attendant adverse impact on lives and properties. Maurya (2020) declared that climate change and environmental degradation are proceeding rapidly and are already affecting many communities in developing countries. The apparent impact of this led to the designation of 5th June every year as World Environment Day (WED) to stimulate awareness of the environment and enhancing political attention and public action towards enhancing environmental sustainability.

Primarily, environmental change is the price the global community is paying for decades of environment

mismanagement and neglect. Abdulkadir *et al.* (2015a) declared that these have continued to pose greater threat to the sustainability of the ecosystem and socio-economic development thereby, escalating poverty, human suffering and shock. The impact of environmental change is most visible in the rising threat of climate-related natural disasters leading to decline in the quality of environmental variables; water, air and land, intensification of natural hazards and destruction of the vital natural resources which are basic to human livelihood. Thomas (2017) affirmed that hazards of nature have always been with us, but the growing incidence of floods, storms, and droughts across the world is putting a spotlight on the need for action. The results of these include crop failure, hunger, famine, migration/displacement of people to other regions for safety with its attendant socio-cultural, socio-economic, and political challenges that are threat to our peaceful co-existence and common future.

5.0 Extreme Weather Events and the Occurrences of Natural Hazards

It has been observed that the extreme weather and climate events have been triggering the occurrence of natural disasters in recent decades. Seneviratne *et al.* (2012) defined extreme (weather or climate) event as the occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends ('tails') of the range of observed values of the variable. The above or below threshold usually constitutes hazard events with severe risk to the environment and human population. United Nations International Strategy for Disaster Reduction (UNISDR) defined hazard as a natural process or phenomenon that may pose negative impacts on the economy, society, and ecology, including both natural factors and human factors that are associated with the natural ones and added that hazards are the origins of disasters.

Fundamentally, the extreme weather events have constituted large proportion of global hazards and have been disastrous to human population, livelihoods, and our common future. UNISDR (2009) revealed that out of the 245 disasters which occurred in 2009, 224 were weather-related, accounting for 55 million people out of the 58 million people affected, 7000 out of 8900 of those killed, and US$15 billion out of the US$19 billion in economic damages. By implication, extreme weather events were responsible for 91.4% disaster occurrences, 94.8% of people affected, 78.6% of those killed and 79% of economic damages. This singled out the prime contribution of extreme weather/climate related hazards in triggering natural disaster across the globe. Sandra *et al.* (2014) added that extreme weather and climate events have contributed to continued and increased hardship, and degradation of natural ecosystems, with consequences often reaching disaster proportions.

African continent is prone to a wide variety of natural and human-induced hazards and disasters in response to our exposure to tropical climate. UNISDR (2009) states that in Africa alone, drought accounted for less than 20% of disaster occurrences but affected 80% of the people in the continent between 1970 and 2008. Natural hazards such as floods, hurricanes, earthquakes, tsunamis, droughts, wildfires, pest plagues, air and water pollution have been adversely affecting livelihoods of numerous communities, destroying properties, infrastructure and human lives. Abdulkadir *et al.* (2018a) affirmed higher carbon emission with intensification of human activities and indicated that ongoing population growth, urbanization, and socio-economic development signal higher rate of emission with significant environmental impact. By implication, increase exposure and vulnerability to natural and human-induced hazards and climate-related disasters in response to population growth, over-depletion of naturally existing resources that will support and enhance our common future.

World Bank Report (2010) states that majority of disasters in Africa are hydro-meteorological in nature, with droughts still affecting the largest number of people on the continent and floods occurring frequently along the major river systems and in many urban areas. These events have been disrupting the functioning of communities and socio- economic livelihood across Africa particularly, when environmental losses and impacts exceed the ability of the affected communities or societies to cope. The risks posed by hydro-meteorological hazards are anticipated to increase thus, the need to identify and develop strategies for disaster risk reduction and enhance human livelihoods as pathways to the attainment of our common future.

6.0 Occurrence of Hydro-meteorological Hazards in Nigeria

In Nigeria, hydrometeorological hazards and climate extremes are on the increase across the country and worsened by human activities. Hydrometeorological hazards result in extreme meteorological and climate events such as droughts, floods, storms, erosions, aridity which have caused severe loss of human lives and livelihoods across the country. UNESCO (2017) defines hydrometeorological hazards as the process or phenomenon of atmospheric, hydrological, or oceanographic nature that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Due to global climate change, these natural hazards are expected to rise. A few occurrences of minor earthquakes have been reported in Nigeria, but the greatest hazards posed by natural disasters during the last 20 years have been from floods, soil and gully erosion and landslides (Onuoha and Uma, 1988).

In Nigeria, hydrometeorological hazards, floods, erosions, droughts, and desertification are major hazards threatening human livelihoods and our common future. Haider (2019)

affirmed that Nigeria's climate has been changing, as evident in increases in temperature, variable rainfall, rise in sea levels and flooding, drought and desertification, land degradation, more frequent extreme weather events, polluted freshwater resources, and loss of biodiversity. These changes have resulted in the intensification and widespread seasonal hazards (drought and flood) that are disastrous across the country. From the prehistoric to biblical floods to the tragic events of recent times, humanity has been afflicted by floods, storms, and droughts (McBean, 2013). Significantly, the abundant land and water resources in Nigeria do not translate into abundant food production that will meet the demand of the growing population due to the recurring natural hazards that is typical of the rainy season across the country.

Despite the current government's effort towards diversification of the economy since 2015 as a pathway toward enhanced socio-economic development, attainment of food security and sustainable livelihood in Nigeria has remained a mirage. The 2020 Global Hunger Index ranked Nigeria 98th out of the 107 countries; revealing that there is a 'serious' level of hunger in the country with a score of 29.2. The positive hydrometeorological trend is already apparent in recurring flood and drought typical of the rainy season across the country that usually results in crop failure thereby intensifying hunger, famine and southward migration that is threatening the peaceful co-existence in the country.

Consequently, the attainment of sustainable economic diversification in a region where about two-third of the population depends on rain-fed agriculture for livelihood is a function of identifying and addressing erratic moisture challenges typical of the country and incorporating the adaptation policy into economic diversification plan and implementation. Sandra (2014) mentioned that natural hazards that lead to disasters can cause tremendous impacts on societies,

the environment, and the economic wealth of the affected countries. Identification of environmental stresses is crucial for the development of adequate and accurate information for adaptation and mitigation strategies for the attainment of our common future.

7.0 Climate Change and Environmental Degradation Threats to Our Common Future

The cumulative impact of climate change, environmental degradation and other environmental issues led to increased awareness of the environmental challenges facing the global community. Consequently, there was an urgent call by the United Nations General Assembly for the development of a long-term environmental strategy for achieving sustainable development by the year 2000 and beyond. The World Commission on Environment and Development (WCED) was established and it published "*Our Common Future*" also known as the Brundtland Report (1987). The Report believes that people can build a future that is more prosperous, just, and secured. The Report triggers international awareness on the importance of sustainable development which it defined as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Climate change and environmental degradation in addition to the resultant hydrometeorological hazards are threats to the satisfaction of human basic needs (food, clothing, shelter, and jobs) and aspirations. Nigeria is facing profound threat of climate change and the deterioration of our natural environment with potential increase in impact. This justifies the need for resilience and sustainability of our livelihood. Codjoe and Atiglo (2020) affirmed that the frequency and magnitude of extreme weather events in the region are rising at a faster rate than the population capacity can deal with the attendant disasters. Accordingly, the worry is, with intensification of climate change and environmental degradation, how well can we continue to live

with nature such that will guarantee a secure, just, and prosperous future for all. Thus, the need for concerted efforts towards adopting cost-effective measures to improve quality of life and livelihood adaptability that will guarantee sustainable development that is our common future.

WCED (1987) recommended strategies for the sustainable development (Our Common future) and these include: improved monitoring and assessment of the evolving phenomena, increased research to improve knowledge about the origins, mechanisms, and effects of the phenomena and adoption of strategies needed to minimize damage and cope with the challenges**.**

8.0 Looking at the Problems: Synopsis of Secure Future as My Contributions

The Vice Chancellor Sir, distinguished ladies and gentlemen, I specialize in Geography which is the "Mother of all Sciences" with an interdisciplinary approach and a broad area of interest for studying spatial phenomena. Thus, I will summarize some of my research contributions to the fields of applied climatology and environmental management towards a secure future.

8.1 Environmental Degradation and Peoples' Perception

Researches show that recent trends in population growth, urbanization and changes in lifestyle have exerted pressure on the environment. Abdulkadir (2009b) assessed the imbalance in the trend of urbanization, population growth and freshwater degradation using Topographic Map, Global Positioning System (GPS), satellite imageries, questionnaire, and the National Population Census data (1973 – 2006). The result affirms an inversely proportional relationship between population, urbanization, and freshwater resources. There is an indication that as population and urbanization increase, degradation of shallow water bodies (rivers and streams) are evident as most

perennial streams/rivers change to seasonal rivers. Similarly, Abdulkadir (2010) using fifty years daily rainfall data (1950 – 1999) recognized that rainfall variability trend caused environmental dryness and accelerate land degradation processes in Northern Nigeria. It was obvious that increase in the amount of total rainfall in the past decade was a function of increase in amount of rainfall per day because of the ascending trend of number of days with $\geq$ 50mm. In addition, Abdulkadir *et al.* (2015b) using empirical relationship reveal that the impact of climate change on freshwater resource is evident in increased variability and change of the resource.

An appraisal of the peoples' perception of environmental degradation issues in Niger State revealed low level of perception of environmental degradation. The awareness of the consequences of the ill actions on the environment was high, even though this was not directly proportional to the level of environmental degradation (Abdulkadir, 2009a). There were strong positive relationships between the experiences of environmental degradation for all the variables (Flooding, soil erosion, vegetation degradation, land, water and noise pollution) while little relationship exists between the experience and perception of environmental problem. Awareness was people's familiarity with the occurrence of environmental degradation while perception is the recognition of the implications of the event. In Nigeria, like any other developing country, environmental resource is the backbone of our livelihood, thus the need to understand and develop qualitatively the knowledge and perception of its problems.

Gradual and drastic changes from normal will threaten sustainability of freshwater resources as well as human livelihood since higher potential evapotranspiration and shorter hydrological season will affect availability and access to the scare resources. The environmental impact of these destroy and

degrade the vital resources (land, water, and vegetation) necessary for people's survival and livelihood, causing great danger to the inhabitants and increase poverty, food insecurity and sometimes loss of lives and properties. Hence, there is an urgent need for increased awareness and perception of the consequences of environmental degradation and associated environmental problems as a pathway towards a secured future.

8.2 On Climate Variability and Change

Researchers have shown that climate variability and change constitute fundamental environmental challenge aggravating risk and vulnerability across the globe. Abdulkadir *et al.* (2013a) developed a multi-temporal database for the eco-climatic parameters and classes were defined for each factor using quantitative definitions for the respective time series. The derived indicators of eco-climate parameters (1950- 2006); rainfall related-onset dates, cessation dates, Moisture Quality Index, Hydrologic Growing Season (HGS) and Aridity Index (AI) were transformed to spatial data, mapped and the areal extent of each Moisture Effectiveness Zones (MEZs) was used to determine the derived eco-climatic characteristics: Aridity Index (AI), Cessation, Hydrological Growing Season (HGS), Moisture Quality Index (MQI) and Onsets (Ø). Maps of the Northern Nigeria revealed climatic variability typical of the rainfall distribution in Northern Nigeria (Figure 2-7). These maps captured the moisture stress of the sub-humid and dry ecosystems at different levels, such that the qualities of the biological and climate uncertainties were apparent.

Similarly, Abdulkadir *et al.* (2015a) revealed positive trend of hydrological parameters (rainfall amount, inflow, outflow, and evaporation) which is also an indication of climate change impact on the hydrological parameters (Figure 8- 11). Furthermore, Abdulkadir *et al.* (2015b) discovered increased potential evapotranspiration and decreased hydrological

growing season between 1950 -1978 and 1980 - 2006, an indication of water stress signifying the impact of climate change (figure 12 & 13). Fundamentally, Abdulkadir *et al. (2018a)* affirmed gradual mean temperature changes 1951- 1982 and 1983 -2014 of about .99^{0}C across Maiduguri, 1.28^{0}C Sokoto and Kano 1.2^{0}C. IPCC (2007) projected that by 2050, average temperatures in Africa would increase by 1.5 to 3°C and will continue further upwards beyond this time. Sanogo *et al.* (2021) determined the characteristic of the vegetation response to precipitation and temperature fluctuations in Fina forest reserve and revealed that vegetation response to the climate is modulated by the land-use/cover dynamics. Abubakar *et al.* (2016) also show that carbon sequestration capacity of Effan forest reserve increased with regeneration of *Gmalina arborea.* These affirmed the notion that human activities intensify climate change and the potential for climate change mitigation.

The environmental impacts of these could degrade the vital resources which are vital for people's survival and livelihood, causing great danger to the inhabitants. This could certainly intensify poverty, food insecurity and sometimes loss of lives and properties. Positive trends in the entire hydrological parameters; increased rainfall amount, evaporation and declined of hydrological growing season have been escalating inflow and outflow, consequently, accelerating the intensity and spread of flooding in recent times. In addition, the result reveals that even though the country has abundant water resource, its availability and access as at when needed is still a major challenge. Hence, there is urgent need for the adoption of mitigation strategies.

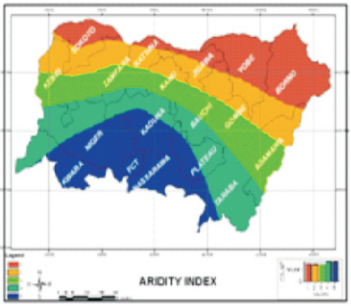

Fig. 2: Aridity Index MEZs
5,4,3,2 &1 = Lowest, Low, High, Very High & Extremely High

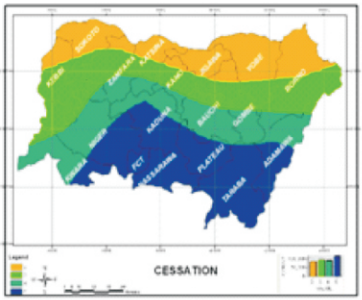

Fig. 3: Cessation MEZs
5,4,3 & 2 = Latest, Late, Early & Very Early

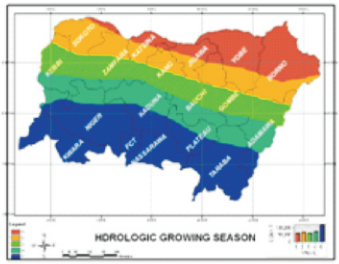

Fig. 4: Hydrological Growing Season MEZs
5, 4, 3, 2, & 1 = Longest, Long, Short, Very Short, Extremely Short

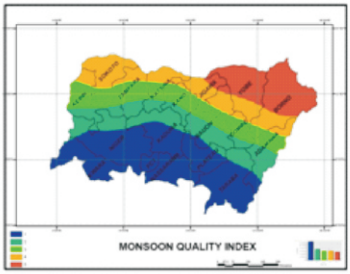

Fig. 5: Monsoon Quality
5, 4, 3, 2, & 1 = Extremely Deficient (D), Very D, D, Adequate & Abundant

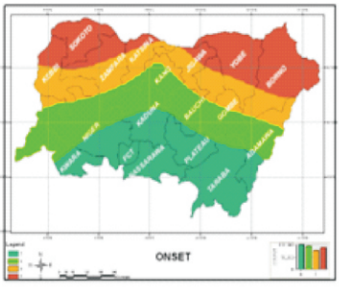

Fig. 6: Real Monsoon Onset MEZs
5, 4, 3, 2, & 1 = Extremely Late, Very Late, Late, Early & Earliest

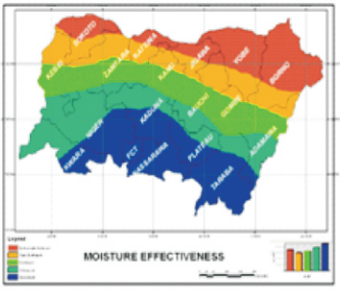

Fig. 7: Moisture Effectiveness Map
source: Abdulkadir *et al.*,2013a)

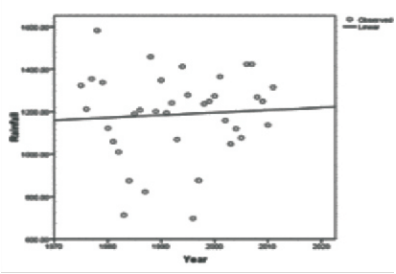

Fig.8 Rainfall Amount Trend

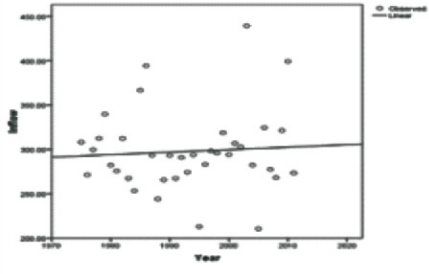

Fig.9 Inflow Trend
(source: Abdulkadir *et al.*, 2015a)

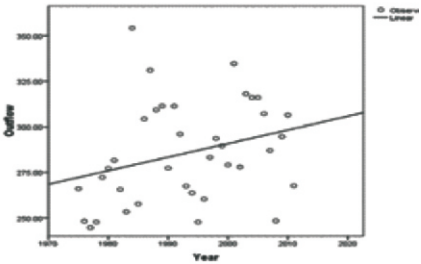

Fig.10 Outflow Trend

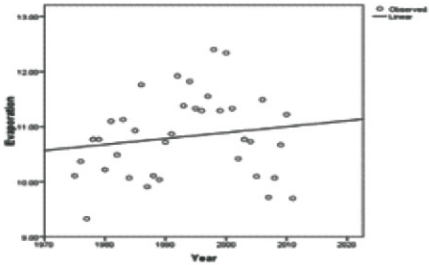

Fig.11 Evaporation Trend
(source: Abdulkadir *et al.*, 2015a)

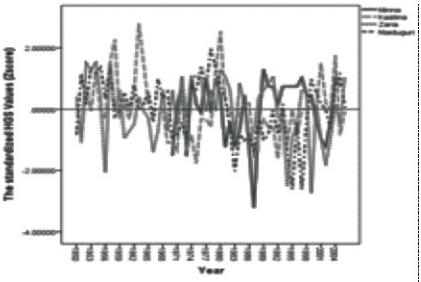

Fig. 12: Standardized HGS

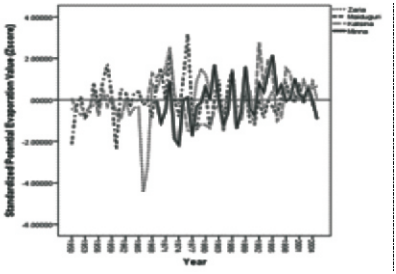

Fig.13: Standardized Potential Evapotranspiration
Source: Abdulkadir *et al.*, 2015b)

8.3 On Forecast of Extreme Climate and Hydrometeorological Hazard

Environmental degradation, climate variability and change are cumulatively intensifying the frequency and severity of extreme weather/climate events across the country. The increasing amount of rainfall has been intensifying widespread flood across the country over the last few decades. Similarly, Salihu *et al.* (2020) identified increase in the number of Consecutive Dry Days (CDD), as well as a decrease in Consecutive Wet Days (CWD) which were both not significant at the 0.05 confidence level indicating that extreme rainfall in the region will become more evenly distributed over the coming periods. The devastating consequences will include floods, erosion, droughts, and desertification across the country.

Usman and Abdulkadir (2013) developed a rainfall-only scheme to determine the moisture condition and hazard categories known as Intra-Seasonal Rainfall Monitoring Index (IRMI). It indicates that the index combines both quantity and spread and therefore holds the promise of being able to follow closely the soil moisture situation necessary for plant germination and establishment and, by inference, crop conditions (Eqn.1).

$(Cpt)2/(hpt \times Nb \times 100)$……Eqn. (1)

Where Cpt is the cumulative pentad rainfall since May 1, hpt is the highest pentad total rainfall since May 1, Nb is the number of breaks in rainfall and 100 is a factor.

IRMI capture the erratic Real Monsoon Onset (RMO) dates and hazard categories that characterize the rainfall regime more adequately. The IRMI classes 1 and 2 are indicative of abundant and adequate moisture conditions whereas classes 3, 4 and 5 are

indicative of deficient, very deficient, and extremely deficient moisture conditions respectively. These are interpreted to represent flood, no flood/drought, mild, severe and very severe drought conditions, respectively (Table 1). The index rises gradually as the rains become steady indicating varying moisture conditions; onset, break, dry spell, drought, flood, and cessation (Usman and Abdulkadir 2013 & 2014). It concluded that the scheme is easy enough to apply in guiding decisions at the peasant farmer level and yet robust enough to guarantee the same levels of accuracy as the more rigorous schemes.

Table 1: IRMI-based Drought Monitoring Scheme

Onset Classification		Rainfall Receipt (Moisture Supply Condition)	Hazard Categories
IRMI Ranges	**IRMI Classes**		
IRMI>10	1	Abundant (High rainfall total within short time spans)	Flood
1<IRMI≤10	2	Adequate	No drought, No flood
0.1<IRMI≤1	3	Deficient	Mild drought
0.010.01<IRMI≤0.1	4	Very deficient	Severe drought
IRMI≤0.01	5	Extremely deficient (Low rainfall totals over long time spans)	Very severe drought

Source: Usman and Abdulkadir (2013)

8.3.1 On Impact of Drought on Agriculture

Usman and Abdulkadir (2014) affirmed that drought, in all its forms, are injurious to the well-being of the people and hampers attempts by all concerned to achieve sustainable development in a region. Thus, it used IRMI to identify drought intensity levels and developed early warning using effective onset dates (Table 2).

Table 2: Drought Intensity and Early Warning Scheme Using Effective Onset Dates

Effective Onset Dates (pentad number)	Onset Phase D rought (moisture deficit) Intensity	Early Warning Phase
30th June (36th)	Mild	Advisory
25th July(41st)	Severe	Alert
5th August (43rd)	Very severe	Emergency

Source: Usman and Abdulkadir (2014)

Similarly, it discovered that after effective onset, moisture conditions may still vary enough to distort crop growth and development, thus the use of the change in IRMI values to monitor plant moisture stress and development of early warning in the context for agricultural drought occurrences (Table 3). The change in IRMI values was computed for each pentad as the difference between current IRMI value and the preceding IRMI value (Eqn.2).

$$\Delta(IRMI) = IRMIp - IRMIp\text{-}1 \quad \text{Eqn. (2)}$$

Where Δ (IRMI) is change in IRMI value. P represents the current pentad and P-1 the previous

Table 3: Drought Early Warning Using Drop in IRMI Values

DROP IN IRMI	INTERPRETATION	EARLY WARNING STATEMENT		
		Advisory Phase	Alert Phase	Emergency Phase
Drop $\leq$0.1	Not significant	Two successive Occurrences	Three Successive Occurrences	Six Successive Occurrences
0.1<Drop<0.3	Significant	One Occurrence	Two Successive Occurrences	Four Successive Occurrences
Drop$\geq$0.3	Highly significant	_____	One Occurrence	Two Successive Occurrences

Source: Usman and Abdulkadir (2014)

Primarily, rainfall must be well distributed without long breaks and must allow the ground to retain enough water for plants to grow to maturity without interruption. After the onset of effective rainfall, breaks and dry spells may still occur to distort crop growth and development which can be adequately monitored and identified using drop in IRMI values.The change in IRMI values is vital for monitoring plant moisture stress and development of early warning in the context for agricultural drought occurrences.

8.3.2 On Flood Occurrence and Preparedness

Abdulkadir *et al.* (2018b) adopted Usman and Abdulkadir (2013) drought category to identify pentad that has IRMI>10 as an indicator of abundant moisture and was used to deduce peak runoff and river flow that will certainly trigger higher inflow necessitating discharge. The result revealed the spatio-temporal variability in Intra-Seasonal Rainfall Monitoring Index (IRMI) peak values and consistency in rainfall peak values in recent times rather than the known gradual rise and oscillatory pattern. Fundamentally, the IRMI values of 2011, 2012 and 2014 rose steadily across the rainy seasons. These years are distinguished as years of severe flood across the entire flood plain wetland ecosystem in the country. This pattern of steady rise in IRMI values is a prime contributing factor aggravating severe and devastating flood across the ecosystem and riverine communities.

Abdulkadir *et al.* (2020) visualized the factors aggravating flood vulnerability across the downstream communities and logically integrated the factors to develop a flood vulnerability index (Eqn.3).

$$\Delta IRMI \propto \Delta Inflow = \Delta Discharge + \Delta low\ terrain + \Delta Landuse + \Delta Devegetation + \Delta River\ Channel + \Delta Drainage\ Outlet = (\Delta Flood) \quad \text{..... Eqn (3)}$$

Application of this index resulted in the development of the pattern that signal the need for future flood preparedness that

incorporates proactive environment friendly and structural approaches as tools for disaster risk reduction, enhanced sustainability of wetland ecosystem and the resultant livelihood instead of reactive measures that always dominate disaster management across the country. Moreover, Sunday *et al.* (2020) reveals the intensification of fundamental factors such as land use pattern, low relief, increased in built-up and human activities affecting the natural water flow, thus leading to intensification of flood events.

8.3.3 On the Occurrences of Desertification

Abdulkadir *et al.* (2013b) determined trends in decadal extent of Moisture Effectiveness Zones (MEZs) to identify the rate of desertification using rate of change as the ratio of the differences in area of MEZs. The result reveals rapid advancement of desert conditions such that areas of deficient moisture zones grew significantly across Northern Nigeria (Fig 14-21). Spatio-temporal aridity growth rate shows fundamental desertification of the Northern Nigeria; the spread of extremely high aridity index, very deficient moisture quality index values which are more apparent across the Northeast. Similarly, the Hydrological Growing Season (HGS) affirmed long-term moisture stress between 1950s and 2000s as there was decline in Longest, Long, Short HGS moisture effectiveness zones while there was increase in the spread of very short MEZ. Real Monsoon Onset trend shows total disappearance of early onset zone.

The progressive moisture stress generally is a clear indication of desertification feature across the North with its adverse effects on plants and animals. There is evidence that eco-climatic dynamics in Northern Nigeria is mainly a function of rainfall variability aggravating desertification in the region. Fundamentally, erratic rainfall effectiveness and distribution are the major determinants of land degradation and desertification. Thus, it affirmed that the spatio-temporal moisture effectiveness is the prime factor of desertification which is an indication of progressive decline in moisture effectiveness northward that is intensifying aridity.

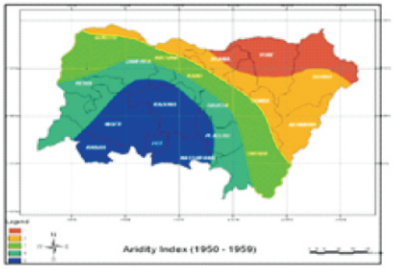

Figure 14: 1950s Decadal Aridity Index
(5,4,3,2 &1 = Lowest, Low, High, Very High & Extremely High)

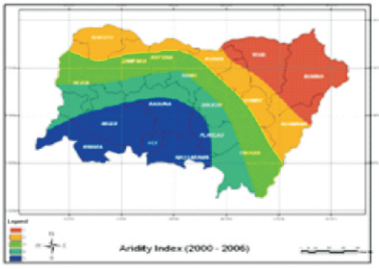

Figure 15: 2000s Decadal Aridity Index

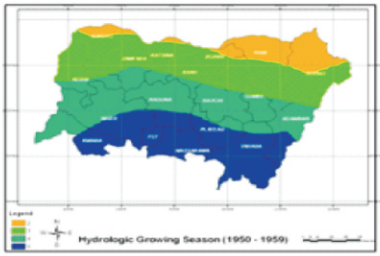

Figure 16: 1950s Decadal HGS
(5,4,3&2=Longest, Long, Short &Very Short)

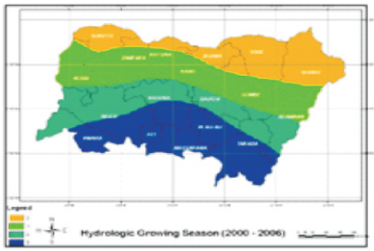

Figure 17: 2000s Decadal HGS

Figure 18: 1950s Decadal MQI
(4, 3& 2 = Very Deficient, Deficient &Adequate)

Figure 19: 2000s Decadal MQI

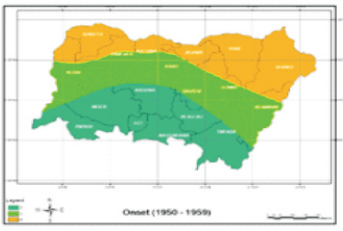

Figure 20: 1950s Real Monsoon Onset
Decadal MEZs (4, 3 & 2 = Very Late, Late & Early)

Figure 21: 2000s Real Monsoon Onset
Source: Abdulkadir *et al.*(2013b)

8.3.4 On Occurrence of Erosion

Erosion has been a fundamental hydrological hazard threatening the physical environment and human livelihood. Zorn and Komac (2013) defined erosion as a geomorphic process that detaches and removes material (soil, rock debris, and associated organic matter) from its primary location by some natural erosive agents or through human or animal activity. Abdulkadir *et al.* (2018b) used community participatory maps to unveil the effect of lateral erosion which is gradually washing away human settlements in Gurmana and Ketso. It was shown that communities are gradually pushed back annually while the river channels are expanding (*Δ*River Channel). Furthermore, natural drainage outlet and confluences are expanding and deepening (*Δ*Drainage Outlet) thus, identified as contributing factors aggravating community flood.

Also, gully erosion features are widespread across the humid and sub-humid zones in response to high rainfall intensity and runoff. These fundamentally influence the well-being of the communities, economy of the country and sustainability of the biophysical environment, thereby threatening our common future.

8.4 Towards Building Our Common Future

The trend of hydrometeorological hazards also reveals the extent to which extreme weather events are disrupting efforts toward the attainment of the sustainable development goals across the country. Consequently, a rethink of these environmental issues are proactive strategies that are fundamental in addressing the core issues spatio-temporally for enhanced resilience and provision of guidance for building of more prosperous, just, and secured future.

8.4.1 Nigeria on the Goal 2 of the Sustainable Development

Specifically, Goal 2 of the SDGs aims to "end hunger, achieve food security, improved nutrition and promote sustainable agriculture." Even though a large proportion of Nigerians depend on agriculture for livelihood, the country is still categorized with serious hunger index. This is because the sector is climate sensitive and environmental degradation has been on the increase thereby impeding efforts towards attainment of food security and sustainability. Consequently, its crucial to address the core issue and adopt global best practices as tools for risk reduction and management.

8.4.2 Development of Early Warning System

The application of the IRMI scheme to Kano environment shows that the years of very severe drought showed enough signal (late onset of rains) at the beginning to have allowed relevant authorities avert the great human suffering witnessed in the Sudano-Sahelian zone (Table 4). It was concluded that IRMI EW scheme captured these signals adequately and apparently, this holds serious promise of an easy-to-use versatile tool for drought warning and mitigation planning.

8.4.3 Delineation of Eco-climatic Zones

Furthermore, despite the intensification of climate change and environmental degradation and the resultant impact across Northern Nigeria and the country in general, North/South climatic description still dominate decision making. Abdulkadir *et al.* (2015c) integrated the derived eco-climatic parameters using Geographic Information System (GIS) techniques to delineate the existing eco-climatic zones. The overlay was hinged on a theoretical basis which holds that the variations of the Aridity Index, cessation dates, length of the hydrologic growing

season and vegetation index are directly proportional to eco-climatic zone changes while those for onset and MQI are inversely proportional (Eqn. 4).

ECZ= AI *VI * HGS * C / Ø * MOI……Eqn. 4

Where ECZ is the Eco-climatic Zones

The quantitatively derived eco-climatic index and related maps identified five eco-climatic zones; wet, humid, sub-humid, dry sub-humid and semi-arid as against the two classic regional climatic zones (Table 5). The eco-climatic map further unveils progressive transformation or southward shifts in the boundaries of the regional climatic zones (Fig 22). The delineation of eco-climatic zones would provide accurate, current and adequate information on the state of the environment needed to achieve food security and sustainability of the physical environment that is fundamental to disaster risk reduction in the region.

Table: 4 Application of the RMO Scheme to Rainfall Data Over Kano

Year	Effective Onset Dates (Pentad No)	Inferred Drought Intensity	Possible EW statement
1970	July 25th (41st)	Severe	Alert
1971	July 30th (42nd)	Severe	Alert
1972	June 10th (32nd)	None	Normal
1973	August 10th (44th)	Very Severe	Emergency
1974	July 20th (40th)	Mild	Advisory
1975	June 30th (36th)	None	Normal
1976	June 30th (36th)	None	Normal
1977	August 10th (44th)	Very Severe	Emergency
1978	June 10th (32nd)	None	Normal
1979	July 10th (38th)	Mild	Advisory
1980	June 5th (31st)	None	Normal
1981	July 20th (40th)	Mild	Advisory
1982	July 20th (40th)	Mild	Advisory
1983	August 25th (47th)	Very severe	Emergency
1984	June 15th (33rd)	None	Normal
1985	July 5th (37th)	Mild	Advisory
1986	July 10th (38th)	Mild	Advisory
1987	August 20th (46th)	Very Severe	Emergency
1988	July 10th (38th)	Mild	Advisory
1989	August 15th (45th)	Very Severe	Emergency
1990	July 25th (41st)	severe	Alert
1991	June 10th (32nd)	None	Normal
1992	June 5th (31st)	None	Normal
1993	June 15th (33rd)	None	Normal
1994	August 15th (45th)	Very Severe	Emergency
1995	July 20th (40th)	Mild	Advisory
1996	June 10th (32nd)	None	Normal
1997	June 5th (31st)	None	Normal
1998	June 10th (32nd)	None	Normal
1999	July 10th (38th)	Mild	Advisory

Source: Usman and Abdulkadir (2014)

Table 5: Eco-climatic Class Interpretation Scheme

Eco-climatic Class	Eco-climatic Zones	Interpretation Scheme
5	Wet	$350 \leq ECZ \leq 477$
4	Humid	$250 \leq ECZ < 350$
3	Sub-humid	$150 \leq ECZ < 250$
2	Dry Sub-humid	$50 \leq ECZ < 150$
1	Semi-Arid /Arid	$ECZ < 50$

Source: Abdulkadir et al. (2015)

8.4.4 Development of Wetland suitability map

Abdulkadir *et al.* (2020) used eqn. 3 in addition to people's response classes to develop wetland suitability map. The suitability map shows that a large proportion of the wetland is not suitable and that the agricultural activities across the riverine wetland ecosystem are endangered (Fig.23). Thus, the need to develop proactive strategies that will enhance communities' capacity to live sustainably with risk; as flood risk can only be minimized and not eliminated, couple with fact that to certain a extent flood constitute a resource.

Moreover, population is attracted to this zone because of the benefits derived from floods; improved soil fertility, employment opportunities, access to food and water, sustenance of aquatic and riparian ecosystems, as well as attainment of enhanced livelihood. The very unsuitable zones are mainly water bodies which cannot be cultivated at all while the unsuitable and suitable zones can be cultivated successfully by adopting an effective cropping calendar and crop species.

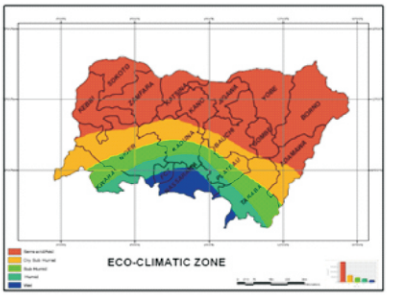

Fig: 22: Eco-climatic Zones
Source: Abdulkadir *et al.* (2015c)

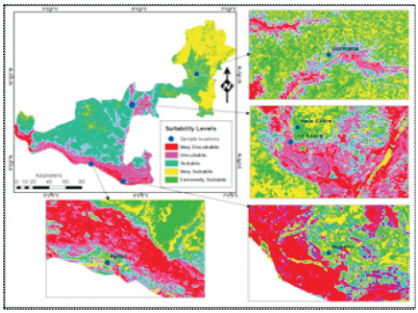

Figure 23: Wetland suitability map
Source: Abdulkadir *et al.* (2020)

8.4.5 Eco-Agriculture for Effective Solid Waste Management

Globally, contemporary trend in population growth, urbanization, socio-economic development processes and civilization have led to increased waste generation in the urban cities. Solid waste dumpsites do not only serve as incubation and proliferation centres for flies, mosquitoes and rodents but intensify environmental degradation which could constitute serious environmental and health problem to the inhabitant. Hence, Abdulkadir *et al.* (2015d) established an experimental field at Pago Niger State, used poultry droppings, decomposed household waste manure and NPK treatments to examine the influence of organic waste on vegetable performance and healthy livelihood. The result depicts variation in plant height and number of leaves at 50% flowering and the varying treatments significantly increase vegetable yield, as the control records the least yield. Also, Abdulkadir *et al.* (2015e) reveal that the treatments did not affect the concentrations of any nutritional components while the anti-nutritional analysis proved that NPK had higher oxalate content than control and organic treats. Consequently, this does not only minimize environmental degradation but fundamental to sustainability of human livelihood and our common future.

9.0 Conclusion

Globally, climate change and environmental degradation are threats to human livelihood and survival. The ever-changing state of the environment is intensifying drought and flood that are certainly triggering erosions and desertification. This is a major challenge to the attainment of our common future. In Nigeria, the spatio-temporal trend of hydrometeorological hazard calls for an increase in the understanding of its development and impact. Environmental degradation and

extreme weather events are projected to intensify as the environment in which they occur is continuously altered by man. Consequently, there is need to develop adequate knowledge on the uncertainties that threaten livelihood as a pathway towards building our common future. The primary focus should be the development of proactive and sustainable strategies that will address the challenges, minimize the hazards, and enhance resilience across the country for improved human livelihood, attainment of economic diversification, growth and food security. The empirical and logical analysis in addition, to integrated approaches towards visualizing these challenges and monitoring the hydrometeorological variables provide accurate information on the state of the environment, hazard forecasting, mapping and timely hazard early warnings which are versatile tools for reducing vulnerabilities, building resilient livelihood and attainment of our common future.

10.0 Recommendations

It is therefore recommended that;

I. Continuous monitoring of the intra-seasonal variability in the rainfall regime should be adopted at national, state, local and farm levels to signal the danger in the rainfall regime early enough for sustainable mitigation and adaptative strategies.
II. Up-date the classic and outdated climatic maps that dominate decision making across the country in order to provide timely, reliable, accurate and up-to-date information on existing eco-climatic state of the environment that could enhance agricultural productivity, quality of life, boost food security and our common future.
III. Develop and institute proven measures for reducing the catastrophes, improve preparedness, adaptation strategies

and early warnings as well as minimizing devastating losses from climate-related disasters as a tool for climate-resilient development, Disaster Risk Reduction (DRR) and attainment of our common future pathways.

IV. Efforts should focus on the development of proactive strategies such as development and institution of structural and environment friendly proactive strategies that will enhance communities' capacity to live with risk. The environment-friendly approaches include afforestation, conservation of land resources, development of more drought resistant species with shorter growing periods, development and adoption of cropping calendar based on scientific findings, rather than the reactive approaches that have dominated risk management across the country.

V. Eco-agriculture and Agroforestry should be widely accepted and promoted by the stakeholders as strategies for minimizing environmental degradation, soil amendment, higher yield, food security, poverty eradication, attainment of sustainable development and healthy livelihood.

Acknowledgments

Mr. Vice-chancellor, Sir, Ladies and Gentlemen, all praises and glory are to the Almighty Allah, by the multitude of His creation, by His pleasure, by the weight of His Throne, and by the extent of His Words that made this possible. *Alhamdulillah* for the countless bounties; for He blessed me with that which made this day possible.

At this point, I wish to express my sincere appreciation to all the people who have contributed directly or indirectly to my academic success. My sincere appreciation goes to my parents Alhaji Abubakar Muhammadu and Hajiya Zaliya Musa (May Allah forgive their shortcomings and grant them Jannatul Firdaus) for their sacrifice, love, care, support and the all-round development given to me which served as the backbone of my educational achievements. I looked back to my childhood and thank my creator and my most cherished parents that sacrificed all they had for the benefit of their children. I appreciate and thank my siblings Hajiya Amina Muhammad Jibril Faki (Nna Ayegborogi), Hajiya Aishetu Haruna (Nnawodu), Hadishatu Abubakar (May Allah accept her soul in Jannatu Firdaus), Abubakar Nma Usman and my children. Thank you all for being important part of my story.

Also, I wish to acknowledge with immense gratitude, the support and encouragement of the Vice Chancellor, Prof. Abdullahi Bala for putting me on my toes and making today a dream come true for me. Similarly, I wish to acknowledge that my appointment to serve in this University came during the era of Vice-Chancellor, Professor Saad Tukur. I also have to acknowledge his successors; Professor M. S. Audu, and M. A. Akanji for their motivation and encouragements. My profund gratitude goes to the Principal Officers (past and present) of the Federal University of Technology, Minna. I appreciate the chairman (Prof. B.

Ayanwale) and members of the University Seminar and Colloquium Committee. Thank you immensely for the encouragement and support.

I would also like to appreciate the members of my academic family for their mentorship. Adopting the words of Isaac Newton, "If I have seen further than others, it is by standing upon the shoulders of giants." Mr. Vice-Chancellor Sir, Ladies and Gentlemen, permit me to acknowledgement my Mentors and Teachers. I wish to specially appreciate my own Prof. Muhammad Tsowa Usman for his unique mentorship style that is cherished by all. His wisdom and knowledge have had a great impact on my life. Thank you for your support, motivation and encouragement that have yielded this result. I will forever remain grateful, may the Almighty Allah continue to bless you and your family

My immense appreciation and thanks go to all the Professors in the department of Geography: Late Prof. J. M. Baba (RIP) Late Prof. D. O. Adefolalu (RIP), Prof. G. N. Nsofor, Prof. A.S. Abubakar and Prof. A. A. Okhimamhe. Thank you for always putting me on track. I am thankful to have you all as my mentors. Special thanks go to all my colleagues and other members of staff in the Department of Geography. Thanks for the support and encouragement. My immense appreciation again goes to the staff of the School of Physical Sciences and particularly, the Deans (past and present) and Professors for their affection, solidarity, support, and encouragement.

To my lecturers at the Niger State College of Education, Minna; Mr O. Rasak, Mrs Yisa C. L and Mr. Sakoma J.K., I am thankful for the knowledge and learning experience gained. I also appreciate my teachers at primary and secondary schools that are too

numerous to mention. Thank you sincerely, you all inspired me to work hard and dream big. Thank you for being great teachers.

I sincerely appreciate the Federal Government of Nigeria and the Federal University of Technology, Minna for sponsoring my M.Tech and PhD Programmes respectively. Others include; the University Network for Disaster Risk Reduction in Africa (UNEDRA) that gave me grant to participate in the UNEDRA Course on Writing for Publication and Grant Proposal and Geo-Information for Food Security in Tshwane, South Africa as well as the User and the Global Earth Observing System of Systems (GEOSS) Architecture Series IEEE/ISPRS/OGC XVIII WORKSHOP at Ouagadougou, Burkina Faso. Netherlands Universities Foundation for International Cooperation (Nuffic) for giving me grants to participate in Environmental Monitoring and Modeling at UNESCO-IHE Delft, Netherlands. Likewise, I appreciate Disaster Resilience Leadership Academy for sponsoring me to participate in 1st and 2nd Practitioners Training Workshop on Strengthening Leadership in Disaster Resilience Program (SLDRP) at Sandpiper Hotel Accra, Ghana. I also appreciate the Tertiary Education Trust Fund (TETFund) for supporting me to attend two international conferences. In addition, I acknowledge the Institute of Electrical and Electronics Engineers (IEEE), Geoscience and Remote Sensing Society and African Association of Remote Sensing of the Environment (IEEE GRSS/AARSE) as well as Global Friend-Water for supporting me with grant to participate in 12th International Conference of the African Association of Remote Sensing and the Environment and 8th Global FRIEND-Water Conference held in Egypt 2018 and Beijing, China respectively.

I wish to appreciate all my students both past and present in my teaching and lecturing career for their accomplishment and commitment. You are all great.

My family members, brothers, sisters, classmates, in-laws and all my friends both far and near at all levels have been great source of joy and inspiration to me always. I appreciate you all.
Generally, I duly acknowledge and appreciate everybody who is here on this occasion of my Inaugural Lecture, even though I am not able to mention your names directly, may the Almighty Allah reward you, and grant you journey mercies back to your respective places of destination.

Finally, I wish to express my heartfelt appreciation to the man behind this success story today, my beloved husband Mallam Abdullahi Abdulkadir. I sincerely appreciate the love, understanding, encouragement, support and cooperation that led to this achievement. Thank you for the countless times you went out of your way to make sure that I am comfortable. Just like the stars in the sky, my appreciation for you is countless. To the children, Ramatu Abdulkadir-Muhammad, Fatima Abdulkadir-Abdul, Khadijat Abdulkadir-Idris, Lt. Ahmad Abdulkadir, Cadet Abubakar Sadeeq Abdulkadir and Zulaikhat Ummi Abdulkadir, thank you all for making me happy.

REFERENCES

Abdulkadir, A. (2009a). An appraisal of the peoples' perception of environmental degradation issues in Minna, Niger State, *Nigeria. Abuja Journal of Geography and Development*, 2 (3), 104 -126.

Abdulkadir, A. (2009b). Trends in urbanization, population and fresh water degradation in Minna, Nigeria. *Journal of Science and Science Education*, 2 (1), 104-116.

Abdulkadir, A. (2010). Rainfall variability and its effects on land degradation processes in Sub-humid and Semi-arid Regions of Nigeria. *Journal of Science, Technology and Mathematics Education (JOSTMED)*, 7 (1), 1-8.

Abdulkadir, A., Abdullahi, J., Abubakar, A.S, Saidu, S., Sakoma, J.K., & Muhammad S.Y. (2015b). Climate change and challenges of freshwater resources to sustainable livelihood in some states in Northern Nigeria. *Geo-Studies Forum*, 8 (1), 46-62.

Abdulkadir, A., Abdullahi, J., Christie, L. Y. Mohammed, M., Liman, H., & Hassan, A. B. (2015a). Climate change and vulnerability of the riverine community in Niger State, Nigeria. *Nigeria Geographical Journal,* 10 (2), 14-23.

Abdulkadir, A., Bello, Y., Okhimamhe, A., Ibrahim, H., Matazu, M., & Barau, L. (2015d). Eco-Agriculture for effective solid waste management in Minna, Nigeria. *International Journal of Biological, Biomolecular, Agricultural, Food and Biotechnological Engineering*, 9 (9), 999 – 1003.

Abdulkadir, A., Okhimamhe, A. A., Bello, Y., Ibrahim, H., Makun, D., & Usman, M. (2015e). The influence of organic waste on vegetable nutritional components and healthy livelihood, Minna, Niger State, Nigeria. *International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering*, 9(9), 1147- 1152.

Abdulkadir, A., Suleiman, Y. M., Yahaya, T. I., Mohammad, M., Usman, M.T., & Abubakar A. S. (2018b). Spatio-temporal hydro-meteorological variability challenges on floodplain wetland ecosystem sustainability downstream of hydroelectric dams, Niger State, Nigeria. *Proceeding of the 8th Global FRIEND-Water Conference*.

Abdulkadir, A., Usman, M. T., & Shaba A. H. (2013b). Climate change, aridity trend and agricultural sustainability of the Sudano-sahelian Belt of Nigeria. *International Journal of Development and Sustainability (IJDS)*, (Special Issue: Development and Sustainability in Africa – Part 1) 2 (2), 1436-1456.

Abdulkadir, A., Usman, M. T., & Shaba, A. H. (2015c). An integrated approach to delineation of the eco-climatic zones in Northern Nigeria. *Journal of Ecology and the Natural Environment*. 7(9), 247-255.

Abdulkadir, A., Usman, M. T., Abubakar, A. S., Jibrin, A., Emigilati, M. A., & Abubakar A. (2018a). Influence of climate variability and change on natural hazard in selected states in Northern Nigeria. *ATBU Journal of Environmental Technology*11(1), 55-68.

Abdulkadir, A., Usman, M. T., Shaba, A. H., & Saidu, S. (2013a). An appraisal of eco-climatic characteristic of Northern Nigeria. *African Journal of Environmental Science and Technology*, 7(8), 748-757.

Abdulkadir, A., Yahaya, T.I., Suleiman, Y.M., Muhammed, M., Sule, I. & Godwin N.N. (2020). Land use, land cover dynamics and sustainability of wetland downstream of the hydroelectric dams, Niger State, Nigeria. *FUTY Journal of the Environment 14 (2), 65-75.*

Abubakar A., **Abdulkadir A.,** Abdullahi J., Mohammed M., Musa J., & Abubakar B.R (2016). Forest degradation and carbon sequestration in Effan Forest Reserve, Edu Local Government Area, Kwara State. *Sokoto Journal of the Social Sciences, 6(2), 260-270.*

Africa Progress Report (2015). Power People Planet: Seizing Africa's energy and climate opportunities. APP_REPORT_2015_FINAL_low1 climate.pdf(Accessed, 4/4/21)

Ahmed, N., Khan, T. I., & Augustin, A. (2018). Climate change and environmental degradation: A serious threat to global security. *European Journal of Social Sciences Studies,* 3 (1), 161-172.

Codjoe, S. N.A., & Atiglo D.Y. (2020). The implications of extreme weather events for attaining the sustainable development goals in Sub-Saharan Africa. *Frontiers in Climate*, 10 December. https://doi.org/10.3389/fclim.2020.592658

Dotterweich, M. (2013). The history of human-induced soil erosion: Geomorphic legacies, early descriptions and research, and the development of soil conservation – A global synopsis. *Geomorphology*, 201, 1–34, doi:10.1016/J.GEOMORPH.2013.07.021.

Enerijiofi K. E. (2018). Elements of Environmental Studies. In Ogbe, F. M., Inegbeboh, B.O., Ngamen C. K., & E. A. Esezobor (eds), *General Studies Compendium* (pp. 177 – 188.). Ogwa, Edo State: Samuel Adegboyega University.

Haider, H. (2019). Climate change in Nigeria: Impacts and Responses. K4D Helpdesk Report 675. Brighton, UK: Institute of Development Studies. https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/14761(Accessed, 4/4/21)

Intergovernmental Panel on Climate Change [IPCC] (2007). Glossary of terms used in the IPCC Fourth Assessment report: Working Group II (WG2). Retrieved from http://www.ipcc.ch/glossary/ (Accessed, 5/4/21)

IPCC (2013). Climate Change: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M. (Eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC (2014). Climate Change: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R., White, L.L. (Eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Laursen, K., Balbontín, J., Thorup, O., Haaning N. H., Asferg, T., & Møller, A. P. (2018). Multiple components of environmental change drive population of breeding waders in semi-natural grassland. *Ecology and Evolution*, *8*(21), 10489–10496. https://doi.org/10.1002/ece3.4514

Leggett, A. J. (2018). Evolving assessments of human and natural contributions to climate change. CRS Report, https://www.everycrsreport.com/files/20180201_R45086_474dc20cfa5283005e9a59ccec647f8a937a98d8.pdf(Accessed, 14/4/21)

Maurya, P. K., Ali, S. A., Ahmad, A., Zhou, O., Castro, J. S., Khan, E. K., & Ali H. (2020). An introduction to environmental degradation: Causes, consequence and mitigation. In: Environmental Degradation: Causes and Remediation Strategies DOI: 10.26832/aesa-2020-edcrs-01

McBean, G. (2013). Hydrometeorological Hazards. In: Bobrowsky, P.T. (eds) *Encyclopedia of earth sciences series*. Springer, Dordrecht. https://doi.org/10.1007/978-1-4020-4399-4179

McSweeney, R. (2019). Explainer: 'Desertification' and the Role of Climate Change. Carbon Brief. https://www.carbonbrief.org/explainer-desertification-and-the-role-of-climate-change(Accessed, 174/21)

Munich, R.E. (2013). Global Natural Catastrophe Update. 2012 Natural Catastrophe Year in Review. http://www.munichreamerica.com/webinars/2013_01_natcatreview MunichRe_III_NatCat01032013. pdf . (Accessed, 16/4/21)

Olagunju, T. E. (2015) Drought, desertification and the Nigerian environment: A review. *Journal of Ecology and the Natural Environment*, 7(7), 196-209. DOI: 10.5897/JENE2015.0523

Olsson, L. H., Barbosa, S., Bhadwal, A., Cowie, K., Delusca, D., Flores-Renteria, K., Hermans, E., Jobbagy, W., Kurz, D., Li, D.J., Sonwa, L. S. (2019). Land Degradation. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press.

Onuoha K.M., & Uma K.O. (1988) An appraisal of recent geologic and hydrologic hazards in Nigeria. In: M.I. El-Sabh, & T.S. Murty (eds.), *Natural and man-made hazards*. Dordrecht: Springer https://doi.org/10.1007/978-94-009-1433-911

Salihu, A. C., **Abdulkadir A.,** Nsofor, G. N., & Otache, M. Y. (2020). Projected extreme rainfall indices in Guinea and Sudano-Sahelian ecological zones, Nigeria. *International Journal of Multidisciplinary Studies (IJMS),* 7 (1), 32-52.

Sandra, B., James K., & Simon D. (2014). The impact of climate change on natural disasters; Chapter 2. In book: Reducing Disaster: Early Warning Systems for Climate Change. DOI: 10.1007/978-94-017-8598-3_2

Sanogo, K., Birhanu, Z. B.,Souleymane, S., **Abdulkadir, A.** & Abdramane, B. (2021).Spatiotemporal response of vegetation to rainfall and air temperature fluctuations in the sahel: Case study in the Forest Reserve of Fina, Mali. *Sustainability 13*, 1-17. https://doi.org/10.3390/su13116250

Seneviratne, S.I., Nicholls, N., Easterling, D., Goodess, C.M., Kanae, S., Kossin, J., Luo, Y., Marengo, J., McInnes, K., Rahimi, M., Reichstein, M., Sorteberg, A., Vera, C., & Zhang, X. (2012). Changes in Climate Extremes and their Impacts on the Natural Physical Environment. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., Barros, V., Stocker, T.F., Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J., Plattner, G. K., Allen, S.K., Tignor, M., & Midgley P.M. (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 109-230.

Sunday, A., **Abdulkadir A.,** & Anene, N.C. (2020). Simulation and prediction of urbanization in Makurdi City, Nigeria using CA-Markov Technique. *FUTY Journal of the Environment*, 14 (1), 13-21.

Thomas, V. (2017). *Climate change and natural disasters: Transforming economies and policies for a sustainable future*. London: Routledge. http://dx.doi.org/10.4324/9781315081045

UNDP (2018). Five approaches to build functional early warning systems.https://www.eurasia.undp.org/content/rbec/en/home/library/environment_energy/five-approaches-to-build-functional-early-warning-systems.html(Accessed, 17/4/21)

UNEP (2012). Early warning systems: A state-of-the-art analysis and future directions. *Division of Early Warning and Assessment (DEWA)*, Nairobi *UNEP*. https://gsdrc.org/document-library/early-warning-systems-a-state-of-the-art-analysis-and-future-directions/(Accessed, 25/4/21).

UNESCO (2017). Disaster risk reduction. http://www.unesco.org/new/en/natural-sciences/special-themes/disaster-risk-reduction/natural-hazards/hydro-meteorological-hazards/(Accessed, 14/4/21).

UNISDR (2009). Global assessment report on disaster risk reduction. Geneva: United Nations. https://www.preventionweb.net/english/hyogo/gar/report/documents/GARPrelims2009eng.pdf(Accessed, 25/4/21).

Usman, M. T. & **Abdulkadir, A.** (2014). An experiment in intra-seasonal agricultural drought monitoring and early warning in the Sudano-Sahelian Belt of Nigeria. *International Journal of Climatology*, 34(7), 2129–2135.

Usman, M.T., & **Abdulkadir A.** (2013). On determining the 'real' onset date of seasonal rains in the Semi-Arid and Sub-Humid areas of West Africa. *Natural Hazard (NHAZ),*66 (2), 749-758.

Warner, K., Hamza, M., Oliver-Smith, A. Renaud, F., & Julca, A. (2010). Climate change, environmental degradation and migration. *Natural Hazards,* 55, 689–715. https://doi.org/10.1007/s11069-009-9419-7

WCED (1987). *Our common future*. New York: Oxford University Press. https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf(Accessed,14/4/21)

Wilhite, D.A. (2000). Drought planning and risk assessment: Status and future directions. *Annals of Arid Zone*, 39(3), 211-230.

World Bank Report (2010). The Status of Disaster Risk Reduction in Sub-Saharan Africa. https://daraint.org/wp-content/uploads/2012/01/2010_Status_DRR_Africa.pdf(Accessed, 4/4/21)

Zorn, M., & Komac, B. (2013) Erosion. In: P.T. Bobrowsky (ed.), *Encyclopedia of Earth Sciences Series*. Springer Dordrecht. https://doi.org/10.1007/978-1-4020-4399-4_120(Accessed, 24/4/21)

Profile of the Inaugural Lecturer

Professor Aishetu Abdulkadir is a descendant of Lafiagi, Edu Local Government Area of Kwara State. She was born on 10th October, 1968 to the family of Mallam Abubakar Muhammad and Mallama Zaliya Musa in Agaie, Niger State. She had her primary education at Dzamata Primary School, Lafiagi and Central Primary School, Minna between 1975-1980. She then attended Women Teachers College, Minna between 1980 and 1985. She started her tertiary education at the Niger State College of Education, Minna from 1985 to 1988, obtained her NCE certificate from ABU Zaria. Then proceeded to the prestigious Federal University of Technology, Minna obtaining her B.Tech Geography with Meteorology (Second Class Upper Division), M Tech Remote Sensing Applications, and PhD Environmental Management in 2000, 2005 and 2011 respectively.

Professor Aishetu Abdulkadir started her lecturing career at the Niger State College of Education, Minna, in 2003, from where she joined the services of the Federal University of Technology, Minna in 2005. She rose steadily through the ranks and was promoted to the rank of Professor in October 2019.

She served the University administratively as Level Adviser (2005-2009), Examination Officer (2009-2011), Deputy Director, Centre for Disaster Risk Management and Development Studies (CDRM &DS) 2011-2014 and Head of Department, Geography (2014-2019). Also, she has served as committee and board member within and outside the university.

Professor Aishetu Abdulkadir has attended numerous National, Regional and International workshops. From 25th March to 4th April 2007, she had the opportunity to attend the University Network for Disaster Risk Reduction in Africa (UNEDRA) Course on Writing for Publication and Grant Proposal, and The UNEDRA Workshop on Geo-Information for Food Security held in Tshwane, South Africa. She

participated in the regional workshop on Strengthening Leadership in Disaster Resilience Program (SLDRP) in Accra, Ghana and a short-term course on Environmental Monitoring and Modelling in Delft, Netherlands. She has over 50 publications in reputable journals.

The passionate scholar developed research interest in Applied Climatology, Environmental Management and Geographical Information System. Her research focus has been on the management of the environment especially the interface between human activities, the resource base and socio-economic well-being in the semi- arid and dry, sub- humid zones of Nigeria. Her high-profile research output includes delineation of eco-climatic zones, climate change/variability and its impacts, aridity trend and agricultural sustainability, flood vulnerability assessment, determining the 'real' onset date of seasonal rains, intra- seasonal agricultural drought monitoring and early warning, resource degradation and perception of environmental problems.

She has successfully supervised 8 PhD., 18 M Tech and about 100 undergraduate students and has served as internal and external examiner for both undergraduate and postgraduate students in her area of specialization.

Professor Aishetu is a member of Association of Nigerian Geographers (ANG), Meteorological Society of Nigeria (MSN), Nigerian Hydrological Society, Teachers Registration Council of Nigeria (TRCN), African Association of Remote Sensing of the Environment (AARSE), and Disaster Resilience leadership Fellow.

She is an advocate of girl-child education, environmental sustainability, and Disaster Risk Reduction (DRR). She has aired numerous programmes on the above issues on local and national media. Also, she has delivered numerous papers on them at local, state, and national levels. She is happily married with children.