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CLIMATE CHANGE AND INNOVATIVE RESPONSE STRATEGIES FOR RURAL COMMUNITY SUSTENANCE

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ABSTRACT

The fight against climate change has just become far more urgent, and could become the greatest challenge of survival for mankind ever. The evidence is clear: climate change is now occurring faster. The acceleration of global warming is nearly unstoppable – unless we act now, and unless we act ambitiously, together, as a global community. Climate change has received extensive media attention recently, and it is currently on the international public health agenda. Because of poor response capacities and the projected impacts of climate change, a consensus has emerged that developing countries are more vulnerable to climate change than developed countries. This is due to their warmer baseline climates, their heightened exposure to extreme weather events, the predominance of rain-fed agriculture in their economies and the scarcity of capital for mitigation and adaptation measures. A study of knowledge and attitudes to climate change, most especially from rural Nigerian communities, is important for developing mitigation and adaptation strategies. Recognizing this, the present study sought to investigate the response strategies to climate change impacts on health of the rural communities within southeast of Nigeria. Multi-stage sampling technique was used to interview 400 respondents using structured questionnaire. Analysis of the data utilized simple descriptive statistics while the results were presented as tables, figures and charts. Findings show that rural areas of Nigeria are vulnerable to the adverse effects of climate change. It was also found that rural dwellers have poor knowledge of the causes but good knowledge of the effects of climate change in the study area. This calls for response strategies to climate change through environmental education programmes for adequate awareness creation and appropriate mitigation and adaptation strategies to forestall its adverse effects. A basic understanding of public perception on vulnerability, attitude and the risk in relation to climate change on health will provide strategic directions for government policies, mitigation, adaptation strategies and development of

community-based guidelines. Lastly, adequate investment in research and capacity building is imperative in building resilient responses to climate change impacts in rural communities in southeast of Nigeria.

Keywords: *Climate Change, Vulnerability, Public Perception, Global Warming, Rural Health, Environmental Effect.*

INTRODUCTION

Never in the history of man has the issue of climate change been so tropical at national and international levels. Climate change and its projected impacts on the environment and socio-economic system now constitute the most important environmental problem that mankind faces at the 21st century. Two important factors account for the prominence now given to the issue of climate change in global politics, The first is the frequency of occurrences of extreme weather events such as floods, droughts and heat and cold waves experienced in different parts of the world in recent years and the devastating effects of these severe weather events on human lives and property as well as national and local economies. The second is the realization that man through his various socio-economic activities is capable of inadvertently influencing global climate for good or ill, but in many cases for ill (Ayoade,2002).

Over a long period of time climatic fluctuations or variations maybe such that a shift or a change in the type of climate prevailing over an area takes place. In such a case, we say there has been a change in climate or we say climatic change. A climatic change therefore represents a significant difference between the mean annual, seasonal or monthly climatic normals with significant impact on the ecosystem (Ogendo and Ojwang,1995)Nigeria has overtime experienced high population growth and a large part of Nigeria's economy particularly the rural milieu is dependent on natural resources that are already vulnerable to climate change impacts. When these resources are affected adversely, the health of the rural community members can be affected. Climate change is already causing several thousands of deaths every year, through shifting patterns of disease, extreme weather events, such as heat-waves and floods, and from the degradation of air quality, food and water supplies, and sanitation (World Health Organization, WHO, 2014). Between 2030 and 2050, climate change is expected to cause approximately 250,000 additional deaths per year through malnutrition, malaria, diarrhoea and heat stress (WHO, 2015).

However, the direct impacts of climate change may result in human injuries, illnesses and deaths related to extreme weather events and changes in weather patterns, rises in infectious diseases due to changes in vector-pathogen relations, and increased disease burdens from declines in water and air quality. Indirect impacts include impaired food security and nutrition as a result of changes in crop yields, as well as displacement and loss of livelihoods leading to negative health effects (Akerlof, Delamater, Boules, Upperman & Mitchell, 2015). The rise in the sea and ocean levels, as well as temperature and rainfall dynamics may increase the distribution of disease vectors such as dengue, malaria, pneumonia and incidence of diarrheal diseases, putting more people at risk (Haines *et al*, 2006). Urban floods experienced by people can make them suffer mental disorders, spread diseases, destroy houses, assets and interrupt schooling. This paper therefore, is analytically aimed at exploring the perceived causes of climate change and the health effects of climate change on rural communities of Imo State, with the intention of proffering some innovative response strategies.

Conceptual Model Showing Exposure Pathways by which Climate Change Affect Human Health.

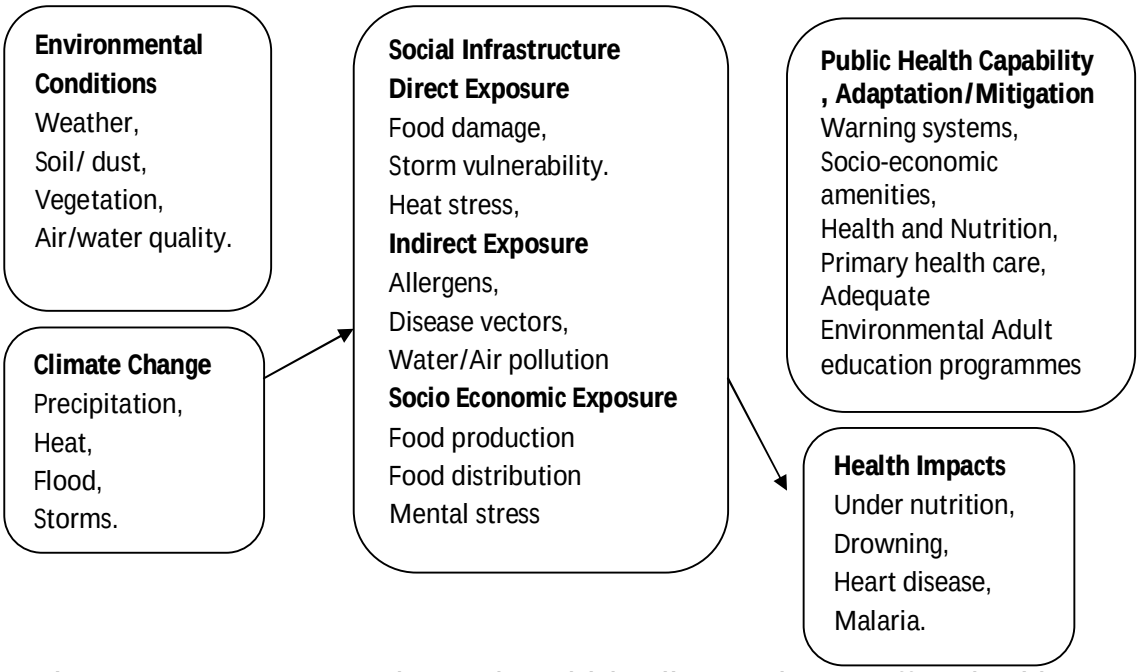

Figure 1: Exposure pathways by which climate change affect health (IPCC, 2014)

Climate Change in Perspective

Climate is the synthesis of weather at a given location or area over a period at least 30years. Climate is more than the average weather conditions (variability). Climate therefore represents a generalization of weather conditions over a period of at least 30years. It is important to point out that the global climate or the climate of any part of the earth for that matter has never been static, (IPCC, 2001) Variability is an inherent attribute of climate. What is crucial is the degree of variability that climate is subjected to as well as the duration of such variability. Minor fluctuations or variations constitute not more than a 'noise' in the climatic series and man can easily adapt to such minor variations. However, when fluctuations in climate constitute significant departures from the normal climate or become prolonged to constitute a new climate state, then there are problems of adjustment and the environment, man with his socio-economic activities become very vulnerable.

Vulnerability

According to (IPCC, 1995), vulnerability in the context of climatic change, defines the extent to which climate change may damage or harm a system. It depends not only on a system's sensitivity but also on its ability to adapt to the new climatic conditions.

Vulnerable Group

Climate change will affect vulnerable groups because of a variety of factors such as

- Low adaptive capacity
- Limited resources
- Poverty

The vulnerable and socially marginalized group generally such as the poor, children, women, elderly and indigenous group tend to bear the brunt of environmental changes. In specific context, in Nigeria, women are more vulnerable to the effect of climate change than men especially as they constitute the majority of the country's poor and are more dependent for their livelihood on natural resources that are threatened by climate change (Ayoade, 2003).

The Significance of Climate Change

The significance of climate and climate change to man cannot be overemphasized. Man is on this planet, because he has a conducive climate and atmosphere that can sustain life. There have been series of mass extinctions of animals in the earth's geological history mainly as a result of changes in climate. These changes in climate were accompanied by changes in sea level and marine plants and organisms were the most affected. Since the advent of man, climate has played a significant role in the history of human affairs as documented by (Lamb,1982) and (Burroughs ,1997). Climate has acted as a catalyst or a trigger of change bringing about breakdowns of societies and civilizations as it changed or shifted.

Global Warming

This is the term used to describe the trend of increases in the average temperature of the Earth's atmosphere and oceans that has been observed in recent decades. The scientific opinion on climate change, as expressed in the UN Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report in 2001 and explicitly endorsed by the National Science Academies of the G8 nations in 2005, is that the average global temperature has risen 0.6 +- 0.2 since the 19th century and that it is likely that most of the warming observed over the last 50years is attributable to human activities.

Impact of Climate change on Disease and physical Health condition

In Africa, including Nigeria, there is a likelihood of increased epidemics of malaria, dengue, other vector-borne diseases and climate-change attributed diarrhoea (IPCC, 2007). As a result of rising global temperatures, rainfall is predicted to increase, thereby increasing the likelihood of flooding. Droughts and flooding will result to declining crop yields and subsequent malnutrition in this region (IPCC, 2007). Additionally, Nigeria is vulnerable to flooding, mudslides and drought, which will lead to fluctuations in the quality and quantity of water, available land mass and environmental safety. Few studies have explored the spatial correlation between climate change and health outcomes (Pradhan, Shrestha, Shrestha, Pradhanang & Kayastha, 2013). The increase in temperature will cause an increase in the incidence of health disorders due to heat both in the temperate and tropical regions. In the temperate regions where the increase in temperature in summer will be highest and in the tropical during the dry season when the intensity of the solar radiation is highest. The urban areas (Ayoade, 2002) already known

for their 'heat island' phenomenon will be most affected. Heat related disorders include skin rashes, prickly heat, heat exhaustion and heat stroke even meningitis. Salt depletion which occurs under hot conditions often manifest in cramps, fatigue and anorexia.

Climate change may have direct impact on human health by influencing atmospheric concentrations of pollutants. The level of concentration of pollutants in the atmosphere over a place is determined by rates of generation and dispersal or dilation of the pollutants in the atmosphere. The direct health impacts of climate change can stem from extreme events such as - heat waves, floods, drought, and wildfire, as stated by (Moss. 1999). Climate change is a significant and rising threat to public health, particularly in the lower income populations and tropical/subtropical countries of the world, Intergovernmental Panel on Climate Change (IPCC, 2001). It affects social and environmental determinants of health, such as clean air, safe drinking water, sufficient food and secure shelter (Arnell, 2004; IPCC, 2007). On of the effect of global warming, there may be more demand for energy for cooling especially in the dry season months for both the tropical and the extra tropical regions of the world. If such energy is generated by the use of fossil fuels like coal and oil, there will be tendency for pollution emissions to increase. (W.H.O, 1990). Air pollution is harmful to human life causing excess deaths due to respiratory and lung diseases. induced or exacerbated when the air is polluted. These include chronic bronchitis, bronchitis emphysema, influenza, lung cancer, asthma and pulmonary heat diseases (WHO, 1992).

Global warming and the depletion of the stratospheric ozone affect the production of ozone in the atmosphere. Photochemical reactions under sunlight involving nitrogen oxides and hydrocarbons emissions from motor vehicles is intensified with increase in incident sunlight and temperature rise. Other potential impacts of global warming and climate change on health are indirect – Adequacy of food production could be affected in the following major ways as a result of global warming and climate change particularly as food production is basically much associated with the rural localities (W.H.O, 2007) Thus

- Reduction in the quantity of water available for irrigation.
- Changes in crop fields, livestock production and fisheries productivity.

- Loss of farm land through rise in sea level.
- Changing climatic conditions may affect the type of prevalent plant pathogens and pests that can have a major effect on food productions. These also may affect food storage and distribution (warmer humid condition may encourage the growth of bacteria and moulds that will spoil and contaminate food which if consumed will have adverse effects on both man and animals.
- Food shortages will have adverse effect on the nutritional status of people especially the poor ones with implications for their health, productivity and well being.

PURPOSE AND OBJECTIVES

The purpose of the study is to examine the effects of climate change on the health of rural communities in Imo State, Nigeria. Specifically, the study sought to:

1. Determine the socio-economic characteristics of the respondents;
2. Ascertain the level of awareness of climate change among respondents in the study area;
3. Identify perceived causes of climate change in the study area;
4. Identify perceived health effects of climate change in the area;
5. Identify the response strategies for managing climate change against its health impacts.
6. Suggest innovative response strategies for sustainable management of climate change

MATERIALS AND METHODS

Description of Study Area

The study was carried out in Imo State, which is among the five states in the southeast geopolitical zone of Nigeria. It lies within latitude 4° 45, N and 7° 15, N and longitude 6° 50, E and 7° 25, E and covers an area of about 5100 km^2. It is divided into three political zones namely Owerri, Okigwe and Orlu and comprises twenty seven (27) Local Government Areas. The population of the state stands at 4.8 million people (Federal Republic of Nigeria Official Gazette, 2012). Rainfall distribution is bi-modal with peaks in August and September. Variation in annual rainfall is between 1900 and 2200 mm. Temperature is uniform in the state with mean annual temperature of about 20°C. The annual relative humidity is 75% and the state lies within the rainforest agro-ecological zone. The

major economic activity of the people is farming which confirms the predominance of rural communities in the state. Major crops grown include maize, cassava, yam and cocoyam while major livestock kept are goats, sheep and poultry (Umunakwe, 2011).

The study made use of a community-based descriptive cross-sectional survey. Multistage sampling was used to select respondents for the study. The first stage comprised the purposive selection of two Local Government Areas from each of the three political zones in Imo State(Ahiazu Mbaise and Ikeduru –(Owerri zone) ; Ohaji Egbema and Ideato South –(Orlu Zone); Obowo and Onuimo LGAs –(Okigwe zone) based on peculiar vulnerability factors which include flood, erosion, oil exploration and inherent natural disasters. The second stage comprised the purposive selection of two autonomous communities from each of the six LGAs based on the named vulnerability factors. The third stage involved the purposive selection of two villages from each of the twelve autonomous communities based on the vulnerability factors peculiar to them. The fourth stage comprised the purposive selection of 17respondents from each of the twenty- four villages. Overall, 408 respondents were chosen for the study. 400 questionnaires were duly completed and used for data analysis.

Study Instrument

Data for this study were collected using a structured questionnaire and in-depth interview schedule validated using face and content validity. The questionnaire sought information about the socio demographic characteristics of the respondents, and their knowledge, perceptions, and attitudes about the causes and effects of climate change on their health. Also secondary sources of data gathering was eminent.

Data Analysis

To ascertain the level of awareness of climate change, respondents were asked to indicate their knowledge of climate change and their responses were measured on a nominal scale of Know a lot = 4, know = 3, know a little = 2 and don't know = 1. The percentages of the observations on the scales were determined. To ascertain the perceived causes of climate change, a list of possible causes of climate change obtained from literature and field observations were provided and the respondents' perception were measured. The perceived effects of climate change were ascertained by providing a list of possible effects of climate change obtained from

literature and personal observations and respondents were asked to indicate the ones they perceive as effects. Data obtained were analyzed using frequency, percentage distribution and charts.

DISCUSSION OF FINDINGS

The socio-demographic characteristic of the respondents is shown in table 1. About 55.5% of the respondents are females, while 45.5% are males. In other words, a greater percentage of the respondents in the study area are females, it implies that the men have moved to the cities in search of greener pastures. It also revealed that 27.5% of the respondents fell within the age range of 31- 40 years old. This suggests that this age bracket is productive. It can also be inferred that majority of the respondents are in their active years and if the challenges of climate change are addressed, these people can help boost the food availability to avoid malnutrition. This is in agreement with Zhang and Flick (2001) who suggest that the level of involvement affirming activities is determined by age. The findings show that the majority of respondents (49.5%) are married, suggesting that there is respect for family as a social institution in the study area.

The educational status of the respondents shows that 41% of the respondents obtained tertiary institution certificates, ranging from OND to PhD degrees, while 51% have secondary and primary school leaving certificates, 8% are without formal education. The educational composition of the respondents is a clear indication that they are knowledgeable enough to provide reasonable answers to issues related to climate change and the majority of those without formal education are farmers who are used to weather conditions for their agricultural production. The occupational status of the respondents reveals that the public / civil servants made up the bulk of the respondents followed by students and those in the agricultural sector like farming, fishing and animal husbandry. 40.5 % of the respondents have stayed in the study area for over 30 years, while others have spent a little below 10 and 29 years. The respondents have been living in the study area long enough to notice changes in the weather condition overtime.

Table 1: Socio-demographic characteristic of the respondents (n= 400)

Attribute	Attribute Classification	Frequency	Percentage
Gender	Male	178	44.5
	Female	222	44.5
Age	10 – 20 years	26	6.5
	21 – 30 years	72	18.0
	31 – 40years	110	27.5
	41 – 50 years	98	24.5
	50 and above	94	23.5
Marital Status	Single	88	22.0
	Married	198	49.5
	Divorced	12	3.0
	Widowed	102	25.5
Educational Background	Primary	75	18.75
	Secondary	127	31.75
	Tertiary	164	41.0
	No formal education	34	8.5
Occupational Status	Public/Civil Servants	98	24.5
	Students	81	20.3
	Farmers	80	20
	Traders	71	17.8
	Artisans	57	14.3
	Others	13	3.3
Length of stay in the study area	Above 30 years	162	40.5
	20 – 29 years	140	35.0
	10 – 19 years	58	14.5
	Below 10 years	40	10.0
(Field Survey, 2018)			

Level of Awareness of Climate Change

Data in Figure 2 show that a greater proportion (32.3%) of the respondents know a little about climate change, 27.8 % and 14.5% know a lot about climate change, respectively. The figure further shows that a significant proportion (23.8%) of the respondents do not know about climate change. Generally put, 32.3% of the respondents have little knowledge of climate change; only 14.5% know a lot about climate change. This awareness level is relatively better than that reported by

(Pugliese and Ray, 2009) which shows that only 44% of those in Sub-Sahara Africa are aware of climate change. 23. 8% of people in the study area do not know what climate change is all about. This clearly shows that information on climate change at the grassroots is poor. This is not a good omen for Nigeria's economy because it has been established that the impact of climate change is hitting harder at those in the rural areas of African countries whereas the rural areas hold the agricultural strength of the continent (Rukevwe, 2008; Odjugo, 2010).However, personal discussions/in-depth interviews with some of those who claimed to know much about climate change reveals otherwise as their knowledge is actually poor; since majority of them could not say what climate change actually means. In general, Nigerians understand climate change in terms of change in weather pattern. And this is limited to their sensual awareness of abnormal increase in the level of heat and the effect it has on human health and comfort.

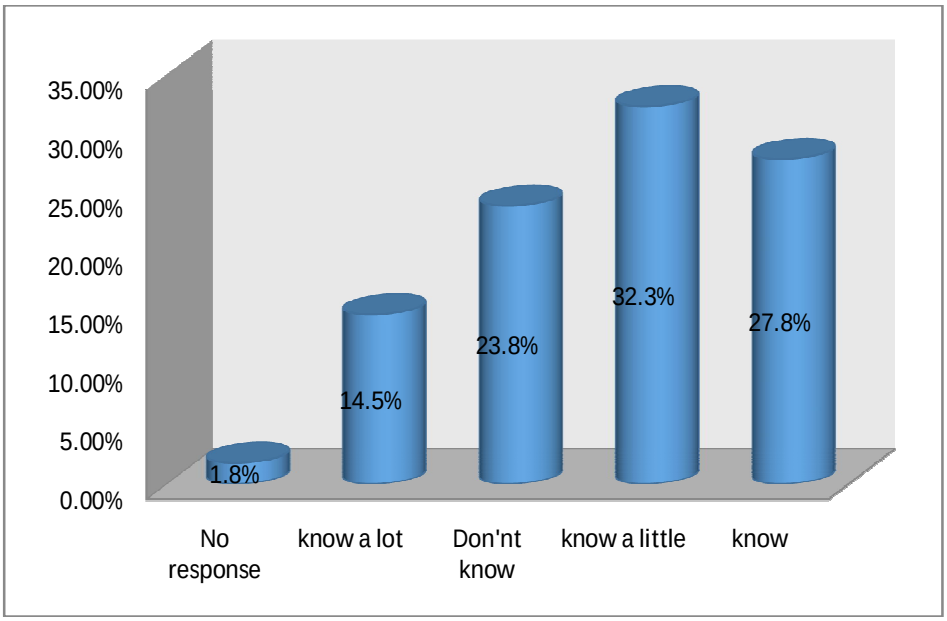

Figure 2: Level of awareness of climate change. Field Survey, 2018.

Those who are aware of climate change also made clear their sources of information as shown in Figure The respondents in the study area got to know of climate change mainly through radio and television presentations followed by personal observation and printed materials like textbooks, bulletins, newspapers, newsletters, journals and leaflets. Radio is a major source of information in the study area.

The basic truth about mostrural dwellers in Nigeria is that, majority of them cannot afford the cost of buying a television set even if the electricity is there, so the best option is the radio transistor which they can afford. Another noteworthy result from the rural areas is the 14.8% who indicated that their knowledge of climate change is based on personal observation or experience. This is so because, most
rural dwellers in Nigeria are in the agricultural sector; be it farming, fishing or animal rearing even hunting. This makes them to be in constant touch with nature, most especially when over 95% of agricultural practices in Nigeria are based on rain-fed.(Okoye and Onietan,2009).

Table 2: Perceived causes of climate change (n = 400)

S/N	Causes	Frequency	Percentage (%)
1	Industrialization	356	89.0
2	Deforestation	240	60.0
3	Poverty influence	366	91.5
4	Agriculture	247	61.8
5	Supernatural powers	382	95.5
6	Bush burning	368	92.0

Field 2018

Perceived Causes of Climate Change

As shown in Table 2 above, some of those who observed the changes in climate in recent times attributed the cause to supernatural powers (Act of God). Majority of the respondents (95.5%) believe that climate change is caused by God. The basic reason given is that climate change impacts are divine punishment being meted out on the world for the numerous sins that the entire world has committed against the environment and God who created it. This clearly shows the pervasive influence of religion on the perception of the environment; an idea (Pugliese & Ray, 2009) refer to as the 'God-frame' thinking. Religious leaders and groups as well as local people strongly believe that the changes in the weather pattern has been ordained by God so they see themselves as powerless and could do little or nothing to change events within their own environment, thereby leaving everything for fate to decide. This perception may have been influenced by their limited access to scientific information on climate change which strengthens their reliance on personal observation and

experience as sources of information on the phenomenon. As reported by (GoZ-UNDP/GEF, 2010) majority of the public in developing countries are yet to be properly and adequately informed about climate change. Other factors that the respondents scored high among the causes of climate change are bush burning (92.0%) and poverty influence (91.5%). The three major causes of climate change (Super natural powers, bush burning and poverty influence) that the respondents gave are in contrast with scientific factors researchers have observed over the years about the global causes of climate change. The scientific facts on climate change show that the major causes of global climate change are anthropogenic- (industrialization, urbanization, transportation and agriculture that release greenhouse gases (carbon, nitrous oxide, methane, chlorofluorocarbons among others) into the atmosphere (NEST, 2003; Odjugo, 2007).

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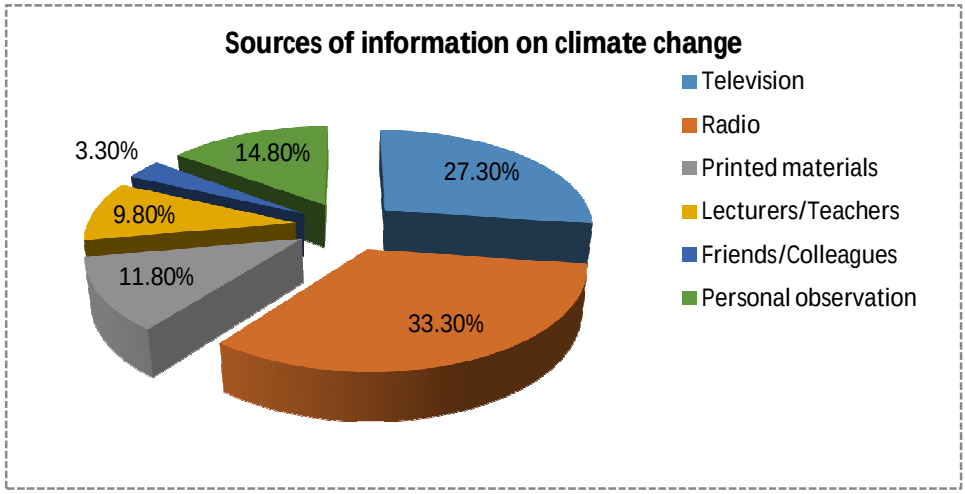

/community leaders/cooperative society groups/Religious Leaders

Table 3: Perceived Health Effects of Climate Change

Variable	Yes (%)	No (%)	No Comment (%)
Sickness/ Disease	318 (79.5)	82 (20.5)	0
Increases emotional and mental stress	297 (74.3)	77(19.3)	26 (6.5)
Hunger / Malnutrition	363 (90.8)	37 (9.3)	0
Leads to salmonella infections	263 (65.8)	120 (30.0)	17 (4.3)
Dryness of the skin	170 (42.5)	222 (55.5)	8 (2.0)
Injury / Death	311 (77.8)	82 (20.5)	7 (1.8)
Increased infestation of mosquitoes	309 (77.3)	77 (19.3)	14 (3.5)
Increased incidence of diarrhoea/ cholera	309 (77.3)	80 (20.0)	11 (2.8)
Increases body pain	77 (19.3)	297 (74.3)	26 (6.5)

Field Survey, 2018.

The menace of climate change variably goes with attendant effects on human health. Results in Table 3 show that climate change could increase hunger and malnutrition as indicated by the respondents' high percentage of 90.8%. Climate change could lead to increased risk of sickness/ disease (79.5%), leads to injury and even death (77.8), increased infestations of mosquitoes causing malaria (77.3%),increased risk of diarrhoea and cholera (77.3%). Other health effects are increased risk of emotional/mental stress (74.3%), leads to increased infestation of *Salmonella typhii* from use of contaminated water (65.8%), skin damage (42.5) owing to the intense heat of the sun and increased body pain (19.3%).In a similar study that corroborates our findings, effects of climate change mentioned were health, water resources, agriculture, biodiversity, and coastal degradation, in order of importance (Maibach, Chadwick, McBride,Chuk, Ebi & Balbus, 2008). In other studies, climate change effects include heat-related illnesses, cold-related illnesses, water-contamination illnesses, and malnutrition (Syal, Wilson, Crawford & Lutz, 2011). Effects on children as reported by (Sheffield & Landrigan, 2011) include sickness, poor growth, and malnutrition.

Managing Climate Change Health Effects

This study explored how best climate change can be managed to ameliorate the health impacts on rural communities within Imo State. Some management variables were presented to the respondents and their agreement with the variables were assessed and summarized in Table 4.The result in Table 4 indicates that all the respondents surveyed, agreed that, access to sustainable and environmental friendly sources of energy (solar, wind and bio-fuel), provision of better health facilities, creation of adequate awareness using appropriate medium as mitigation and

adaptation strategies against the health impacts of climate change is highly imperative. Despite the absolute agreement with the previous variables,88.0% agreed to regular sanitation/cleaning of the environment, 73.3% of the sample supported access to potable water supply, 68.5% advocated for reduction in the rate of deforestation, while 66.8% and 65.8 % supported a ban on bush burning/ gas flaring and the use of old vehicles respectively as good response approaches to combating the health hazards of climate change. 36.8% supported reduced use of wood for cooking.

Table 4: Strategies for Managing Climate Change Health Impacts (n= 400)

Strategies	Frequency	Percentage
Provision of access to clean water supply	293	73.3
Creating awareness and disaster preparedness using environmental education toolkits	400	100
Provision of early warning information system	400	100
Provision of improved health facilities	400	100
Regular sanitation/cleaning of environment	352	88.0
Reduced use of wood for cooking	147	36.8
Access to sustainable and environmental friendly source of energy(solar, wind and bio-fuel)	400	100
Reduce deforestation	274	68.5
Stop bush burning and gas flaring	267	66.8
Stop the use of old vehicles	263	65.8

Field Survey, 2018

Personal discussion with most of the respondents showed that they are not aware of how reduction in the use of fuelwood for cooking among others will reduce climate change. This clearly depicts how ignorant majority of Nigerians are with respect to the causes and effects of climate change. Many concluded that it will be difficult to reduce the use of fuelwood for cooking, since cooking gas and kerosene are so costly and above the reach of many .This is an indication that a lot needs to be done in order to combat climate change impacts in the developing nations like Nigeria. The Nigerian government at all levels needs to bring down to the barest minimum the cost of kerosene and cooking gas so as to discourage the use of fuel wood for cooking. This can be achieved if the refineries are repaired and functional to refining crude oil instead of the country depending on importation of these commodities.

Climate Change Responses

Mitigation and adaptation are the two responses to climate change. Mitigation refers to "measures that may either reduce the increase in greenhouse emissions (abatement) or reduce increase in terrestrial storage of carbon (sequestration)", while adaptation refers to "all the responses to climate change that may be used to reduce vulnerability" (Ifeanyi-obi and Nnadi, 2014, 2). Climate change mitigation and adaptation initiatives should be integrated in development projects and programmes in order to reduce the vulnerability of people to the impact of climate change

Climate Change Mitigation

Renewable/clean energy:

In Nigeria, as elsewhere in the world, the energy sector is the most important sector for climate change mitigation (Federal Ministry of Environment, 2014). In Nigeria, conventional energy (oil and gas) with gas flaring has the highest percentage of carbon dioxide. It is important to control CO_2 emission and other associated greenhouse gases by moving towards renewable energy development and an energy efficiency mechanism . Nigeria has abundant sources of renewable energy but lacks the adequate government backing to harness these resources for electricity power (Akuru et al., 2017; Yahaya and Nwabuogo, 2016). Despite movement toward the development of policy and legislation in support of renewable energy, in particular the Renewable Energy Master Plan (REMP), developed in 2006 and updated in 2011, there has been limited progress in implementation (Elum and Momodu, 2017). Therefore it is necessary to:

- develop innovative financing schemes that will reduce the cost of low carbon technologies for consumers in addition to making it a profitable project for investors.
- Alongside opening up the energy sector for investment, government should apportion a sufficient proportion of the national budget to the energy sector and levy taxes on industries that cause a significant amount of greenhouse gas emissions.
- Timely, accurate and accessible data on renewable energy is crucial for effective policy making.
- There should be properly documenting and collecting data for traditional biomass used for heating and cooking, that will not result to estimations and inaccurate national energy statistics.

Other sectors/lifestyle choices:

As part of mitigation measures for climate change, there is a need to encourage sustainable lifestyle choices among Nigerians, such as:

- less meat or meat-products consumption,
- reduce Greenhouse gas emissions.
- reduce your carbon footprints
- phasing out inefficient appliances,
- Greater access to and use of public transportation.
- Public infrastructure and services for effective waste reduction - adoption of the 4Rs also need to be encouraged (Dioha and Emodi, 2018; Nkechi et al., 2016; Elias and Omojola, 2015),
- Production of environmental friendly machines that will be powered by renewable energy sources such as water/hydro-powered, solar-powered, wind-powered machines or making the use of eco-friendly machines mandatory through enforcement mechanism.
- Mounting adequate and appropriate environmental education awareness programmes on issues of climate change through its various strategies/techniques under formally and non-formally.

Tree planting/reforestation:

Reforestation and tree planting can help stop climate change by removing carbon dioxide from the air (carbon sinks), storing carbon in the trees and soil. There is an urgent need for a more aggressive tree planting:

- Scale up shrubs- by planting leguminous shrubs in food crops, we can increase carbon sequestration and access to energy without having to reduce agricultural lands.
- Regenerating pasturelands – by regenerating pastures, we can bring back a healthy grass-tree balance, enhance food production for livestock and improve animal welfare
- Increase tree cover on agricultural lands- with more tree cover on degraded farmlands we can triple the rate of carbon accumulation on agricultural lands around the world not just in one locality.
- Increase soil carbon sequestration- by scaling- up the practices of conservation agriculture with trees we will be protecting the soil from erosion, enhancing soil fertility and improving soil moisture so that farmers can increase and stabilize crop production and stire large amount of carbon at the same time.
- Environmental issues generally have been in the political radar for over 50yrs and environmental education has been discussed internationally since the 1970s, with leading global Organizations -

(UNESCO and UNEP) establishing programmes and guidance on how to integrate environmental teachings into education curriculum and certification schemes for schools. Since then, environmental education has been considered an elective subject of the formal and non-formal curricular in many traditional school programmes, and Nigeria is yet to recognise and adopt education as an effective counter-strategy (Amanchukwu et al., 2015).

- Nigerian children, youth and adult alike are not yet properly educated on environmental issues and thus do not have adequate knowledge on how to deal with situations caused by climate change. Challenges include inadequate teaching qualifications and infrastructure. Therefore, there is urgent need for retraining of Teachers by environmental educators to effect changes in the teaching methodology and implementation of environmental programme.
- The methods and strategies for its implementation need be activity-based and learner-centred to bring about the applicability of what is learnt and promote environmental stewardship for sustainability.
- Adequate/appropriate equipment need to be provided for Active-learning-teaching methodology and awareness-raising through the media for climate change jingles, poster, stickers, drama series, focus group discussions, poems and interactive blogs.

Environmental education should be a core subject rather than an elective subject if it must achieve its stated aims and objectives and bring about Change -Agents

Climate Change Adaptation

Adaptive capacity and capacity development:

Vulnerable groups can be more affected by climate change due to limited resources and low adaptive capacity (Bohle, 2011). Studies demonstrate that rural women in developing countries, such as Nigeria are more vulnerable to climate change as they have low adaptive capacity. Adaptive capacity is the ability of individuals and communities to adjust to climate change, to moderate potential changes, to take advantage of opportunities or to cope with the consequences (BNRCC, 2011, x This depends on adequate environmental education, assets, information and proper implementation. Adaptation refers to responses to both the adverse and positive effects of climate change. Adaptation is any adjustment made whether passive, reactive or anticipatory in response to anticipated or actual consequences of climate change. Six types of strategy for adapting

to the effects of climate change have been identified by (Carter, 1994). These are:

i. Prevention of loss: this involves anticipatory actions or measures taken to reduce the susceptibility of an exposure unit to the impacts of climate change. An exposure unit is defined as the activity, group, region or resource exposed to the effects of climate change.

ii. Tolerating Loss: Losses may be tolerated where adverse impacts can be accepted in the short-term because they can be absorbed by the exposure unit without long –term damage. In other words, nothing is done to protect the exposure unit against the effects of climate change.

iii. Spreading or sharing Loss: Here, actions are taken to distribute the burden of the impacts of climate change over a larger region or population beyond those directly affected. Examples of such include disaster relief measures by government and non-governmental organizations. Insurance schemes against negative impacts of climate change may also be included as an example of spreading or sharing loss.

iv. Changing use or activity: This involves a change in activity or resources use to adjust to the adverse as well as the positive effects of climate change. For instance, there could be a switch from arable farming to pastoral farming or a switch from the cultivation of water-demanding crops to crops that are less water demanding. For instance, millet may be grown instead of guinea corn or maize. Similarly, cassava may be grown instead of yam.

v. Changing Location: An activity is relocated to a more suitable location under the changed climate. For instance, a hydro-electric facility may be re-located due to a change in water availability. Also a settlement or industrial plants may be relocated to avoid inundation by a rise in sea level as result of climate change.

vi. Restoration: Here, the aim is to restore an exposure unit to its original state following damage or modification as a result of climate change since the exposure unit is still susceptible to flood damage.

Agricultural initiatives:

The adoption of existing and new technologies for adapting to climate change and variability is a high priority for many ecological regions in

Nigeria. This includes intensification of agriculture by way of crop diversification, the adoption of drought-tolerant and early maturing varieties of crops; and crop cover and also extension of agricultural lands by establishments of Farm settlements and use of marginal lands. In addition, agricultural extension services are essential to improving agricultural productivity by providing farmers with useful farming and weather related information and skills training that can enhance their productivity. The current irregularity of extension services in Nigeria is a constraint to agricultural adaptation (Oluwole et al., 2016; Federal Ministry of Environment, 2014).

Insurance and other financial tools:
Insurance provision has the potential to reduce the impact of climate change on insurance policy holders. Nigerian insurers have not, however, paid sufficient attention to the impact of climate change (Elum and Simonyan, 2016; Federal Ministry of Environment, 2014). The Nigerian government therefore should support private insurance firms through policies that would encourage public-private partnerships. Efforts to scale up agricultural insurance also requires building the capacity of farming communities to understand and effectively demand appropriate insurance products. Access to credit, such as through microfinance institutions, is also essential to the ability of farmers to adapt to climate change .

Infrastructure:
Irrigation facilities are increasingly important as rain fed agriculture becomes more unreliable, yet they are extremely lacking in Nigeria (Federal Ministry of Environment, 2014). Good roads are also important for efficient distribution of necessary agricultural inputs to rural farmers. Residential developments, for example, require the maintenance of adequate spaces to allow for easy infiltration of surface runoffs during rainfall .

Skills and knowledge:
In order to integrate climate change adaptation into every aspect of national life, Nigerians must have awareness and knowledge – and access to knowledge – of what climate change is, how it is impacting them and how they can adapt. They also need to be equipped with specialised skills to enable individuals, communities and the country to address climate change risks and implement adaptation. Information and knowledge sharing must be made accessible to a wide range of people, particularly

those most vulnerable using environmental education toolkits for effective programming..

Information and awareness:

The level of public awareness on issues related to climate change in Nigeria is considered to be low (BNRCC, 2011). Studies indicate that the Nigerian media and environmental educators have not given adequate attention to climate change issues. The degree of information available influences the level of awareness on climate change issues (Duru and Emetumah, 2016). Access to specific weather information, early warning and forecast technologies can also help farmers to develop and readjust coping or adaptation strategies .

Agricultural extension services:

Farmers need to have access to adaptive technology and innovations. The greater contact farmers have with agricultural extension personnel and services, the better their production, productivity, efficiency in use of resources and profitability (Otitoju and Enete, 2016). Farmers with better access to information of the changing climate through extension services also have a greater likelihood of adopting adaptation measures. Recognition of the need for agricultural extension services has not, however, been matched with corresponding capacity for extension professionals. They require training to act as educators and information/service providers (Dimelu et al., 2014).

Education and school curricula:

Nigeria has yet to recognise and adopt education as an effective counter-strategy (Amanchukwu et al., 2015). Nigerian children and youth are not yet properly educated on environmental issues and thus do not have adequate knowledge on how to deal with situations caused by climate change. The inclusion and integration of environmental education, then climate change in the Nigerian educational curricula at all levels of education (both formal and non-formal) is essential. Challenges include inadequate teaching qualifications and infrastructure. In-retraining of Teacheron active-learning methodology and adequate/appropriate equipment needs to be provided. Alternative strategies of teaching and awareness-raising that can be effective include use of media for climate change jingles, poster, stickers, drama series, focus group discussions, poems and interactive blogs.

Indigenous knowledge:

There is a growing awareness of the importance of indigenous knowledge and its value for environmental management and sustainable development. Various adaptive practices in agriculture, for example, have a strong element of indigenous knowledge (Federal Ministry of Environment, 2014). Indigenous knowledge must be documented, in order to counter its gradual disappearance. It should also be incorporated into agricultural education and extension curriculums translated in local languages, and into policy guidelines to address climate change issues. This would allow for more comprehensive measures.

Institutional capacity:

The efforts of the government and different agencies in Nigeria have been inadequate (Ifeanyi-obi and Nnadi, 2014). Institutional capacity building will be necessary for all institutional stakeholders engaged in climate change adaptation in Nigeria. The Special Climate Change Unit in the Federal Ministry of Environment, for example, needs to be strengthened . There is a need also for new institutions, such as Public-Private Partnerships that can take research findings into the field and help smallholder farmers adapt to a changing climate

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