

An Assessment of the Impact of Climate Change on Environmental and Agricultural Sustainability in Northern Nigeria

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Abstract

Environmental preservation has remain a challenge in the globalized world of 21 century. Rapid urbanization, industrial developments, technological developments and population growth are among the numerous factors that continued to create problem for the environment especially in Africa. These problems are multifaceted and their consequences are grave. Nigeria is one of the countries in the world grappling with the problem of environmental sustainability arising from climate change and these problem often resulted and exacerbated relentless clashes between herders and famers especially in the Northern part where desertification and desert encroachment is moving fast and have since taken over farm lands and villages. This study therefore examined the impact of climate change on environmental and agricultural sustainability in Northern Nigeria and how urbanization and population growth affected environmental and agricultural sustainability overtime. Guided by three research questions and three research objectives, the study set out three null hypotheses at 0.05 level of significance. Similarly, the study used both primary and secondary sources of data through interrogation of literature, questionnaire administration and interviews. The findings revealed that human activities such as urbanization, farming and indiscriminate felling down of trees are among the factors that inhibit environmental preservation. The study recommends legislation on environmental preservation, awareness campaign and policies that are geared towards environmental protection and sustenance.

Keywords: *Environmental, Climate, Herders, Northern and Sustainability*

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Background to the Study

Environmental preservation has remain a challenge in the globalized world of 21 century. As a result of the interplay of man and the environment, activities such as rapid population growth and urbanization, industrialization and technological development the issue of environmental preservation becomes necessary. Climate change is one of the factors that create problem for environmental sustainability especially in the third world countries of Africa where issues such as desertification and desert encroachment, indiscriminate falling down of trees are exacerbating the crisis that often occur between farmers and herders especially in the North central states and other part of the Nigeria. Climate is seen as the average atmospheric condition of place over a long period of time. For instance, Salisu (2016) observed that indicators of climate are temperature, rainfall, relative humidity, atmospheric pressure, and wind among others. Climate is very important parameter in determining human activities including agricultural productivity, transportation, planning among others. In Nigeria, agriculture remain the main occupation of people of Northern Nigeria. Abdulkarim, Lawaland Salisu (2016) reported that as a result of population pressure and quest for means of livelihood, climate of northern Nigeria is drastically affected and continuous to change over time.

Objectives of the Study

This study therefore examined the perception of respondents regarding the impact of climate change on environmental sustainability in Northern Nigeria. Specifically, the study has the following objectives:

1. To assess the perception of respondents regarding the factors responsible for climate change in Northern Nigeria.
2. To assess the perception of respondents regarding the impact of climate change on environmental sustainability in Northern Nigeria.
3. To assess the perception of respondents regarding the impact of climate change on agricultural productivity in Northern Nigeria.

Research Questions

1. What is the difference in the perception of respondents regarding the factors responsible for climate change in Northern Nigeria?
2. What is the difference in the perception of respondents on the impact of climate change on environmental sustainability in Northern Nigeria?
3. What is the difference in the perception of respondents on the impact of climate change on agricultural productivity in Northern Nigeria?

Research Hypotheses

The study tested the following null hypotheses at 0.05 level of significant:

- HO1:** There is no significant difference in the perception of respondents regarding factors responsible for climate change in Northern Nigeria.
- HO2:** There is no significant difference in the perception of respondents regarding the impact of climate change on environmental sustainability in Northern Nigeria.
- HO3:** There is no significant difference in the perception of respondents regarding the impact of climate change on agricultural productivity in Northern Nigeria.

Literature Review

Climate Change and its Effects

Climate change is defined as a change in the state of the climate that can be identified by changes in the mean and or the variability of its properties, and that persists for an extended period typically decades or longer (IPCC, 2007). Although the length of time it takes the changes to manifest matters, the level of deviation from the normal and its impacts on the ecology are most paramount. According to Odjugo and Akpodiogagaa (2010), Salisu and Obeka (2014) Climate change denote inherent dynamic nature of climate on various temporal scales. Such temporal scale variations could be monthly, seasonal, annual, decadal, periodic, quasi-periodic or non-periodic. Climate change has been described as a statistical variation that persists for an extended period, typically for a decade or longer. It includes shift in the frequency and magnitude of sporadic weather events as well as the slow but continuous rise in global average surface temperature (Intergovernmental Panel on Climate Change, IPCC, 2001, Ogbuabor and Egwuchukwu, 2017).

In Nigeria like any other countries of the world, Odjugo and Akpodiogagaa (2010) stated that the emitted greenhouse gases are carbon dioxide (CO₂), chlorofluorocarbons (CFCs), Methane (CH₄) and nitrous oxide (N₂O) among others. CO₂ currently contributes the highest rate of the greenhouse gases followed by CH₄, CFCs N₂O and others (like halons, tropospheric ozone, sulphuric hexafluoride (SF₆) among others). Although CO₂ has the highest contribution to greenhouse gases, its potency is far lower.

Scholars such as Odjugo and Akpodiogagaa (2010), Abdulkarim (2010), Salisu and Okam (2014), Salisu and Obeka (2014) and Salisu (2015) were unanimous in agreeing that climate change is caused by two basic factors, which include natural processes (biogeographical) and human activities (anthropogenic). Salisu, Abdulkarim, and Samuel (2015) stated that the natural processes are the cosmological and the interplanetary factors. The former include the changes in the eccentricity of the earth's orbit, changes in the obliquity of the plane of ecliptic and changes in orbital procession while the extra-terrestrial factors are solar radiation quantity and quality among others. The later On the other hand involves human activities that either emit large amount of greenhouse gases into the atmosphere that depletes the ozone layer or activities that reduce the amount of carbons absorbed from the atmosphere. IPCC (2007) and Odjugo and Akpodiogagaa (2010) stated that the human factors that emit large amounts of greenhouse gases include industrialization, burning of fossil fuel, gas flaring, urbanization and agriculture. On the other hand, human activities that reduce the amount of carbon sinks are deforestation, alterations in land use, water pollution and agricultural practices. The human factors have been proven to be responsible for the ongoing undisputable climate change or global warming. Rapid urbanization, industrial developments, technological developments and population growth are among the numerous factors that continued to create problem for the environment especially in Africa. These problems are multifaceted and their consequences are grave. Nigeria is one of the countries in the world grappling with the problem of environmental sustainability arising from climate change and these problem often resulted and exacerbated relentless clashes between herders and famers especially in the northern part where desertification and desert encroachment is moving fast and have since taken over farm lands and villages.

Available evidences show that climate change will be global, likewise its impacts, but the biting effects will be felt more by the developing countries, like Nigeria, due to their low level of coping capabilities (Jagtap 2007). Researches have shown that Nigeria is already being plagued with diverse ecological problems, which have been directly linked to the on-going climate change (Mshelia 2005). Odjugo and Ikhuoria (2003) show that climate change has started impacting on desertification and Ayuba et al. (2007) show that climate change is impacting negatively on plant species composition in Northeastern Nigeria. These may not be the only impacts of climate change in Nigeria.

The temperature trend in Nigerian since 1901 shows increasing pattern. The increase was gradual until the late 1960s and this gave way to a sharp rise in air temperatures from the early 1970s, which continued till date. The mean air temperature in Nigeria between 1901 and 2015 was 26.6°C while the temperature increase for the 105 years was 1.1°C. This is obviously higher than the global mean temperature increase of 0.74^o recorded since 1860 when actual scientific temperature measurement started (Spore 2008; IPCC 2007). Should this trend continue unabated, Nigeria may experience between the middle (2.5°C) and high (4.5°C) risk temperature increase by the year 2100. Rainfall trend in Nigeria between 1901 and 2015 shows a general decline. Within the 115 years, rainfall amount in Nigeria dropped by 81mm. The declining rainfall became worst from the early 1970s, and the pattern has continued till date. This period of drastic rainfall decline corresponds with the period of sharp temperature rise. Although there is a general decrease in rainfall in Nigeria, the coastal areas of Nigeria like Warri, Brass and Calabar are observed to be experiencing slightly increasing rainfall in recent times (Odjugo 2007).

Increasing temperature (global warming) and decreasing precipitation in most parts of the world are the greatest impacts of climate change. These bring about either negative or positive ecological impacts in different parts of the world. The increasing temperature has led to increased landbased ice instability and its melting. The implication is that the present 0.2 m sea level rise has inundated 3,400 km² of the coastal region of Nigeria, and if the sea level rise attains the projected 1m on or before 2100 then 18,400 km² of the coastal region may be inundated (NEST 2003).

The increasing temperature and decreasing rainfall have led to frequent drought and desertification. The Sahara desert is observed to be expanding to all directions trying to engulf the Sahelian region of Africa with annual expansion of 1-10 km (Odjugo and Ikhuoria 2003; Yaqub 2007). Odjugo and Ikhuoria (2003) also observe that Nigeria north of 12°N is under severe threat of desert encroachment and sand dunes are now common features of desertification in states like Yobe, Borno, Sokoto, Jigawa and Katsina. The migrating sand dunes have buried large expanse of arable lands, thus reducing viable agricultural lands and crops' production. This has prompted massive emigration and resettlement of people to areas less threatened by desertification. Such emigration gives rise to social effects like loss of dignity and social values. It often results in increasing spate of communal clashes among herdsmen and farmers and such clashes resulted in the death of 186 people in six northern states of Nigeria between 1998 and 2006 (Yaqub 2007). Akonga (2001) also shows that most

of the destitute that emigrated as a result of drought and desertification usually move to nearby urban areas to beg for alms thereby compounding the already tense urbanization problems.

Climate change will alter all aspects of the hydrological cycle ranging from evaporation through precipitation, run off and discharge (Mcguire et al. 2002). The global warming and decreasing rainfall together with the erratic pattern of rainfall produce a minimal recharge of groundwater resources, wells, lakes and rivers in most parts of the world especially in Africa thereby creating water crisis. In Nigeria, many rivers have been reported to have dried up or are becoming more seasonally navigable while Lake Chad shrunk in area from 22,902 km² in 1963 to a mere 1304 km² in 2000. This shows that what is left of Lake Chad in the year 2000 is just 5.7% of 1963 (Odjugo 2007).

Lake Chad and so many rivers in Nigeria, especially in Northern Nigeria, are in the danger of disappearing. The water scarcity will create the tendency for concentration of users around the remaining limited sources of water. Under such circumstances, there is increased possibility of additional contamination of the limited sources of water and transmission of water borne diseases like cholera, typhoid fever, guinea worm infection and river blindness. Odjugo (2000) and DeWeerd (2007) note that the increasing temperature will mean northward migration of mosquitoes and malaria fever which will extend from the tropical region to warm temperate region while the sporogony of the protozoa causing the malaria accelerates from 25 days at 10°C to 8 days at 32°C

The excessive heat, increasing water stress, air pollution and suppressed immune system occasioned by climate change will result in increasing incidence of excessive death due to heat exhaustion, famine, water related diseases (diarrhoea, cholera and skin diseases), inflammatory and respiratory diseases (cough, and asthma), depression, skin cancer and cataract. One of the greatest impacts of climate change is the worsening condition of extreme weather events like drought, flood, rainstorms, windstorms, thunderstorms, landslides, avalanches and tsunamis, among others (Changnon 2001). Odjugo (2008) notes that the frequency and magnitude of wind and rainstorms did not only increase, they also killed 199 people and destroyed property worth ₦85.03 billion in Nigeria between 1992 and 2007. Buadi and Ahmed (2006) had similar result when they reported that rainstorms claimed 42 lives in southern Cameroon between 2000 and 2005. Between 1950 and 2000, the increasing frequency and intensity of rainstorms have created enormous damages estimated at \$87 billion in property losses, \$19 billion in crop losses and losses of over 12,000 human lives in the United States of America alone (Changnon 2001).

Climate change has started to, and will continue to impact negatively on agriculture and food security especially in tropical and subtropical regions because greenhouse gas emissions would increase the risk of hunger by additional 80 million people by 2080 in Africa and southern Asia (DFID 2006; DeWeerd 2007). Odjugo (2008) shows that climate change has led to a shift in crops cultivated in northern Nigeria. Odjugo (2008) quoting Ahmed (1978) reveals that as at 1978, the preferred crops the farmers cultivated were guinea corn followed by

groundnut and maize, but due to increasing temperature and decreasing rainfall amount and duration occasioned by climate change, the farmers as a means of adaptation in 2007 shifted to the production of millet followed by maize and beans. Another major problem to agriculture in Nigeria due to climate change is the reduction of arable lands. While the sea incursion is reducing the arable land of the coastal plains, the desert encroachment with its associated sand dunes is depriving farmers of their agricultural farmlands and grazing rangelands. Moreover, the frequent droughts and lesser rains have started shortening the growing season thereby causing crops failure and food shortage. It has been shown that drought, desert encroachment and coastal inundation have started affecting the country's ecosystem leading to ecological destabilization due to climate change impact in the semi-arid region of Northern Nigeria (Ayuba et al. 2007).

According to *Shaker, (2015)*, Sustainable development is the organizing principle for meeting human development goals while simultaneously sustaining the ability of natural systems to provide the natural resources and ecosystem services upon which the economy and society depend. The desired result is a state of society where living conditions and resource are use to continue to meet human needs without undermining the integrity and stability of the natural system. Sustainable development can be defined as development that meets the needs of the present without compromising the ability of future generations.

Rachel, (2015) stated that sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It has been argued that there is no such thing as a sustainable use of a non-renewable resource, since any positive rate of exploitation will eventually lead to the exhaustion of earth's finite stock (Turner,1988); this perspective, as observed by Nicholas (1971) and Jeremy (1980) renders the Industrial Revolution as a whole unsustainable. It has also been argued that the meaning of the concept has opportunistically been stretched from 'conservation management' to 'economic development', and that the Brundtland Report promoted nothing but a business as usual strategy for world development, with an ambiguous and insubstantial concept attached as a public relations slogan (*O'Riordan, 1993*).

Rachel, (2015) observed that Components of a healthy environment, such as clean air and water, are considered public goods in that they are non-rivalries and non-excludable. Thus, it is up to the public sector to maintain the provision of these goods and services. More recently, nations have moved towards the implementation of these market-based mechanisms to internalize the complete costs of pollution and ensure long-term stability of the environment; in other words, to ensure sustainable development.

The overall goal of sustainable development (SD) is the long-term stability of the economy and environment; this is only achievable through the integration and acknowledgement of economic, environmental, and social concerns throughout the decision making process (Stoddart, 2011). The key principle of sustainable development underlying all others is the integration of environmental, social, and economic concerns into all aspects of decision making. All other principles in the SD framework have integrated decision making at their

core (Stoddart, 2011). In practice, sustainable development requires the integration of economic, environmental, and social objectives across sectors, territories, and generations. Therefore, sustainable development requires the elimination of fragmentation; that is, environmental, social and economic concerns must be integrated throughout decision making processes in order to move towards development that is truly sustainable. It is against this background, the study assess the impact of climate change on environmental sustainability in northern Nigeria.

Methodology

The study adapt descriptive research design of survey type involving through interrogation of literature, questionnaire administration and interviews. The population of this study covers farmers of North-West Nigeria. According to National Population Commission, the Northern Nigeria comprises of 19 states namely Adamawa, Bauchi, Borno, Katsina, Kano, Gombe, Kaduna, Niger, Nasarawa, Yobe, Taraba, Jigawa, Benue, Plateue, Zamfara, Sokoto, Kebbi, Kwara and Kogi. Majority of the inhabitants aged 18 years plus are farmers practicing raining season and irrigation farming. From the entire population of the 19 Northern states, three states namely Katsina (North-West), Gombe (North-East), and Nasarawa (North-Central) were randomly selected and used as a sample. A total number of 766 farmers were randomly selected from both rural and urban areas of the selected states and used as sample.

The study used both primary and secondary sources of data through interrogation of literature, questionnaire administration, observation and focus group interview to collect data for the study. The items in the three instruments covered a total number of 35 items spread into four sub-sections. Section A deals with 5 items on personal data of the respondents, Section B are 10 items on perception on Factors responsible for climate change, Section C covered 10 items that examine the impact of climate change on Agricultural productivity and the Section D covered 10 items on impact of urbanization and population growth as agent of climate change affected environmental sustainability in Northern Nigeria.

All the three instruments were validated by fifteen experts who are senior lecturers, readers and professors in the field of climatology from eight Universities in Northern Nigeria. Pilot test were conducted to establish the reliability of the instrument. From the result obtained, reliability of the three items are 0.8, 0.7 and 0.82. The study used twelve research assistants who administered the instruments especially as it need to be translated from English to Hausa, English to Fulfulde respectively. Percentage score, Bar-Chart, mean plot were used to answer research questions. ANOVA inferential statistics was used to verify null hypotheses raised at 0.05 level of significant using SPSS package.

Results

What is the difference in the perception of respondents regarding the factors responsible for climate change in Northern Nigeria?

Table 1: Shows the perception of respondents regarding the causes of climate change

Factors	Frequency	Percent
Natural factors	138	18.0
Emitted large amounts of greenhouse gases	36	4.7
Industrialization	64	8.4
Burning of fossil fuel	86	11.2
Gas flaring	56	7.3
Agricultural activities	95	12.4
Rapid urbanization	90	11.7
Technological developments	102	13.3
Population growth	99	12.9
Total	766	100.0

Source: Authors field work 2019

Table 1 shows the perception of respondents regarding the causes of climate change in Northern Nigeria. 138 respondents representing 18% shows that the causes are natural while 82% attributes the causes to man made. This is further illustrated in figure 1 below.

Fig. 1: Shows the bar chart of perception of respondents regarding the causes of climate change

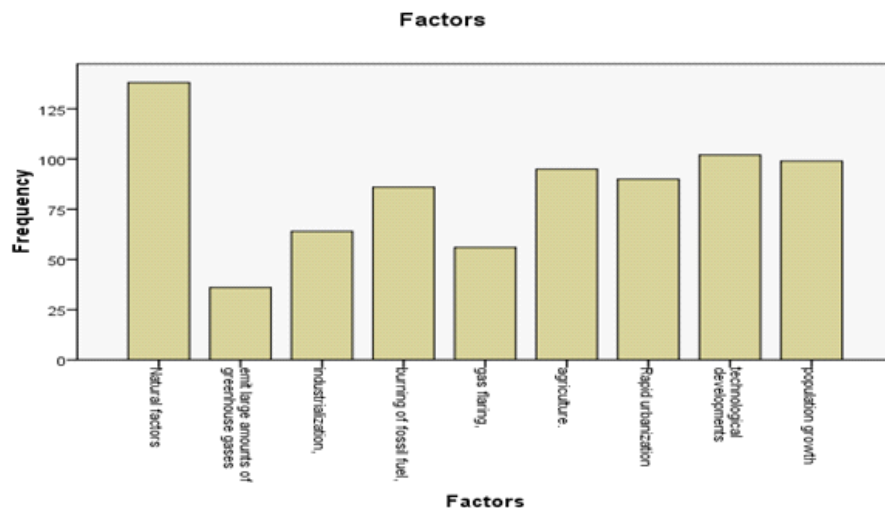
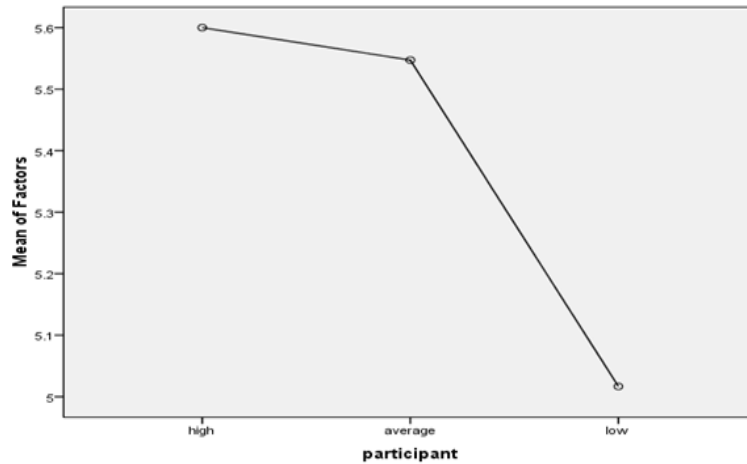


Fig. 2: Shows the Mean plot of perception of respondents regarding the causes of climate change



What is the difference in the perception of respondents on the impact of climate change on sustainability in Northern Nigeria?

Table 2: Perception of respondents regarding the effect of climate change on sustainability

Effects	Frequency	Percent
Erratic pattern of weather elements	138	18.0
Impacting on desertification	36	4.7
Impacting negatively on plant species composition	64	8.4
Increasing temperature (global warming)	38	5.0
Decreasing precipitation	38	5.0
The increasing temperature has led to increased landbased ice instability and it melting.	38	5.0
Destruction of mangrove ecosystems, coastal wetlands and coastal beaches.	42	5.5
Population displacement resulting in communal crisis	84	11.0
Frequent drought and desertification.	42	5.5
Desert encroachment and sand dunes	114	14.9
Loss of dignity and social values.	36	4.7
Increasing spate of communal clashes among herdsmen and farmers	96	12.5
Total	766	100.0

Source: Authors field work 2019

Table 2 presents frequency and percentage scores of the difference in the perception of respondents on the impact of climate change on sustainability in Northern Nigeria. Result indicated that Erratic pattern of weather elements, Population displacement resulting in communal crisis, Destruction of mangrove ecosystems, coastal wetlands and coastal beaches, Desert encroachment and sand dunes and Increasing temperature (global warming) account for the major impact of climate change on sustainability.

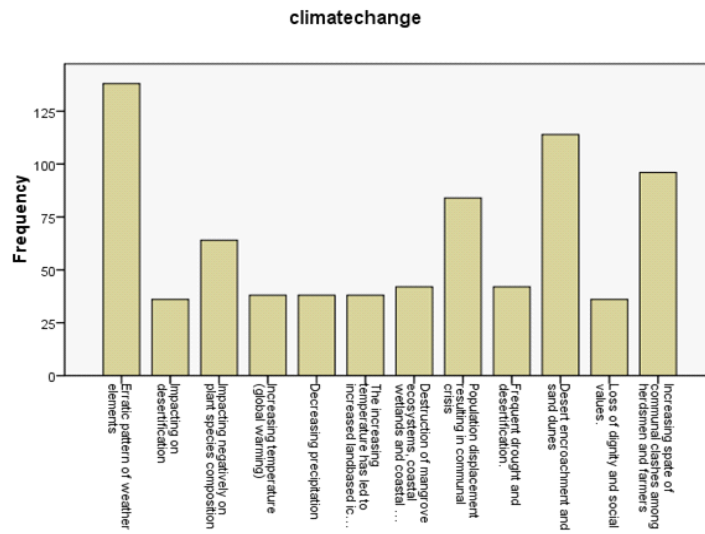


Fig. 3: Barchart on perception of respondents regarding the effect of climate change on sustainability

To what extent does respondents differ in their perception regarding the impact of climate change on climate change on Agriculture?

Table 3: Perception of respondents regarding the effect of climate change on Agriculture

Effect	Frequency	Percent
Alter all aspects of the hydrological cycle ranging from evaporation through precipitation, run off and discharge	156	20.4
Worsening condition of extreme weather events like drought, flood, rainstorms, windstorms, thunderstorms, landslides, avalanches and tsunamis	93	12.1
Impact negatively on agriculture and food security especially in tropical and subtropical regions because greenhouse gas emissions would increase the risk of hunger	106	13.8
Shifted to the production of millet followed by maize and beans.	122	15.9
Reduction of arable lands	116	15.1
Crops failure and food shortage.	38	5.0
Desert encroachment with its associated sand dunes is depriving farmers of their agricultural farmlands and grazing rangelands.	135	17.6
Total	766	100.0

Source: Authors field work 2019

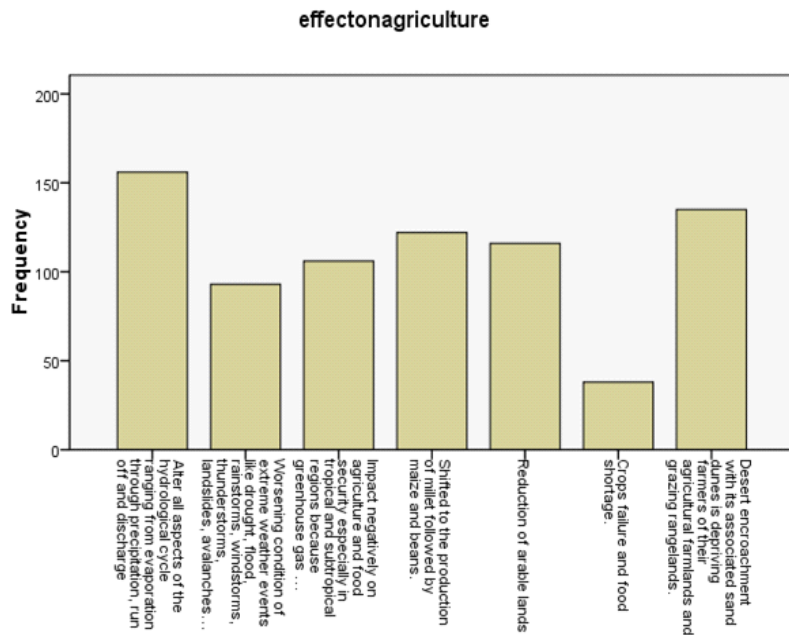


Fig. 4: Shows the bar chart of perception of respondents regarding the effect of climate change on Environmental Sustainability

Table 3 and figure 4 presents frequency, percentage scores and bar chart of the difference in the perception of respondents on the impact of climate change on agriculture in Northern Nigeria. Result indicated that climate change affect agriculture when it alter all aspects of the hydrological cycle ranging from evaporation through precipitation, run off and discharge, Desert encroachment with its associated sand dunes is depriving farmers of their agricultural farmlands and grazing rangelands among others.

HO1: There is no significant difference in the perception of respondents regarding factors responsible for climate change in Northern Nigeria.

Table 4: ANOVA of Significant difference in the perception of respondents regarding the causes of climate change

Sources	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	37.848	2	18.924	2.498	0.083
Within Groups	5779.302	763	7.574		
Total	5817.150	765			

Table 4 presents ANOVA of Significant difference in the perception of respondents regarding the factors responsible for climate change. From the result, sum of square between groups is 37.848; sum of square within is 5779.302 Mean square within is 18.92 and f-ratio is 2.49 while p-value is 0.083. P-value observed is greater than alpha, null hypothesis is retained. And therefore, the difference is significant.

Ho2: There is no significant difference in the perception of respondents regarding the impact of urbanization and population growth as agent of climate change affected sustainability in Northern Nigeria.

Table 5: ANOVA of Significant difference in the perception of respondents regarding the effect of climate change on sustainability

Sources	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1960.717	2	980.359	78.326	0.000
Within Groups	9549.967	763	12.516		
Total	11510.684	765			

Table 5 presents ANOVA of Significant difference in the perception of respondents regarding the effect of climate change on sustainability. From the result, sum of square between groups is 1960.717; sum of square within is 9549.967 Mean square within is 980.359 and f-ratio is 78.32 while p-value is 0.000. P-value observed is less than alpha, null hypothesis is rejected. The difference is significant.

HO3: There is no significant difference in the perception of respondents regarding the impact of climate change on agricultural productivity in Northern Nigeria.

Table 6: ANOVA of Significant difference in the perception of respondents regarding the effect of climate change on Agriculture

Sources	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	739.204	2	369.602	108.836	0.000
Within Groups	2591.111	763	3.396		
Total	3330.315	765			

Table 6 above presents ANOVA of Significant difference in the perception of respondents regarding the effect of climate change on agriculture. From the result, sum of square between groups is 739.20; sum of square within is 2591.11. Mean square within is 369.602 and f-ratio is 108.83 while p-value is 0.000. P-value observed is less than alpha, null hypothesis is rejected. The difference is significant.

Conclusion

The study shows that respondents did not differ significantly in their perception regarding the causes of climate change. However, majority of the respondents opined that the causes are man-made rather than natural. Significant difference exist in the perception of respondents regarding the impact of climate change on environmental sustainability and agricultural productivity in Northern Nigeria.

Recommendations

From the finding of the study, the researchers recommended that:

1. The level of exposure to climate change among respondents is low. There is a need for government to engage the media through adverts and jingles to educate and train farmers on healthy environmental practice.
2. There is also need for stiffer legislation and sanctions for harmful environmental practice.
3. Government and governmental Agencies directly linked with environmental issues such as NIMET and other specialized agencies should be organizing conferences and workshops in communities especially the rural dwellers on the need for conserving our environment.
4. Non-governmental Organizations, Civil Society Organizations and indeed the entire community should be deeply involved in advocating the need to protect the environment.

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