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**Article** *in* Journal of Sustainability and Environmental Management · April 2022

DOI: 10.3126/josem.v1i2.45333

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p-ISSN 2822-1729, e-ISSN 2822-1737 Available online at https://www.nepjol.info/index.php/josem

# Climate Change Vulnerability Assessment: An Evaluation of Social Dimension

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**Abstract:** Climate change vulnerability is the function of exposure, sensitivity, and adaptive capacity of its natural and socioeconomic systems. Following spatial "scale" of the assessment, administrative-territorial units were selected for this study. A field survey questionnaire was used to collect data for the study based on the sample size of 500 questionnaires that was administered to household heads in the study area. In the questionnaire, questions were designed to give respondents the opportunity to choose from several alternatives given in the instrument while descriptive statistics was for the analysis of data. Descriptive statistics analysis based on mean ranking was carried out to identify the level of peoples' vulnerability to climate change in the study area. The exposure assessment was based on the response analysis of baseline information. The sensitivity assessment for the study was analyzed by using physiographical and socioeconomic characteristics, described by a set of specific indicators and responses of the residents. The adaptive capacity was captured by general economic and agricultural indicators, taking into consideration the major occupation the predominant lifestyle of the residents. Through a ranking approach, the relative vulnerability of each ATU was calculated by summing its sensitivity and adaptive capacity ranks; the latter were obtained as combinations of their primary indicator ranks, arranged in an increasing and decreasing order, respectively. The major climate change exposure pathway in the study area were reduction in green environment, decrease in total annual rainfall, warmer weather, early cessation of rainfall, late on-set of rainfall and shrinkage of water bodies. The major sensitivity to climate change was decrease in crop yield, whereas increase in cost of food crops, drought incidents, famine, poverty, indiscriminate falling down of trees and disaster. It was also established that the major adaptive strategies to climate change in the study area were irrigation farming, use of organic manure, planting of drought tolerant varieties and early planting.

***Keywords:*** *Assessment, Climate change, Nigeria, Sensitivity, Vulnerability*

Conflicts of interest: None
Supporting agencies: None

Received 23.02.2022; Revised 17.04.2022; Accepted 23.04.2022

**Cite This Article:** Garba, A., Gana, B.A., Mohammed, I., & Adamu, H. (2022). Climate Change Vulnerability Assessment: An Evaluation of Social Dimension. *Journal of Sustainability and Environmental Management*, 1(2), 52-61.

## 1. Introduction

The world's climate is shifting rapidly, presenting new challenges and opportunities. The Intergovernmental Panel on Climate Change (IPCC, 2016) defines climate change as a change in the average state of the climate that lasts for a long time (typically decades or longer). Climate change is one of the most important environmental concerns facing humanity worldwide. Available research demonstrates that climate change is a global issue, as are its affects; nevertheless, poor countries bear the brunt of the negative consequences due to their low technical development (UNFCCC, 2014). Despite being one of the world's poorest continents, climate change poses a major threat to Africa's long-term growth and development, as well as its accomplishment of the Millennium Development Goals (MDGs). Despite the fact that the continent is one of the least accountable for its causes (Cutter, 2009). This necessitates immediate action in the areas of vulnerability, adaptation, and mitigation. Reduced agricultural production, worsening food insecurity, increased incidence of both flooding and drought, disease spread, and an increased risk of conflict over scarce land and water resources and migration due to the continent's weak adaptive capacity, limited finance, and lack of technological advancement are all issues to be concerned about.

Africa is particularly vulnerable to climate change due to its overdependence on rain-fed agriculture (over 95% of Africa's agriculture is rain-fed), which is exacerbated by widespread poverty and limited ability (Nwafor, 2007). Climate change is expected to have a significant impact on African countries and subregions, the amount of land

suitable for agriculture, the length of growing seasons, and yield potential are all predicted to diminish, especially around the edges of semi-arid and arid areas. This would have a negative impact on food security on the continent and worsen malnutrition. Rain-fed agriculture yields in some countries might be decreased by up to 50% by 2020, according to the Intergovernmental Panel on Climate Change. This would have an impact on food security, with the most vulnerable individuals bearing the brunt of the impact (IPCC 2007). Because it contains some of the world's poorest countries, the continent is particularly vulnerable to climate change. The climate of Africa is mostly tropical, and it may be divided into three primary climatic zones: humid equatorial, dry, and humid temperate. Within these zones, altitude and other localized variables significantly influence regional climates (Adejuwon, 2004).

In Nigeria, the situation is similar, as no part of the country is immune to the effects of climate change. Drought, wind erosion, and related sand dune development, drought, and desertification are the most significant climate change-related land degradations in northern Nigeria's Sahel zone. Sheet erosion, or the full disappearance of arable ground, is a severe hazard to agriculture in south-eastern Nigeria. Nigeria's 800-kilometer coastline is low-lying, making it vulnerable to coastal erosion and flooding. All of them are induced kinds of land degradation as a result of climate change (Ajani, 2012). The current climate has a significant impact on ecological organization. Forests have a crucial role in the biosphere's functioning, and they have an indirect impact on the provision of other products and services such as lumber production. Nigeria's woods would be harmed by changes in climatic and atmospheric composition. Forest resources have become very vulnerable to minor changes in climate systems due to the sensitive character of forest ecosystems. As a result of changes in temperature, precipitation, and water cycle dynamics, significant forest cover loss can occur (Odjugo, 2010).

Enete (2011) stated that extreme weather events such as drought and decreased soil moisture are on the rise as a result of rising temperatures, which causes rapid evaporation of soil moisture and, as a result, drought. Climate change might wreak havoc on biodiversity as a result of all of these factors. Climate change, according to researchers, is a single potentially cataclysmic current occurrence with no historical parallel. Due to climate change, a 0.2m rise in sea level could flood nearly 3,400 km2 of Nigeria's coastal area. According to one estimate, Nigeria will lose over $9 billion as a result of the tragedy, and at least 80% of the people in the Niger Delta will be relocated as a result of major portions of the oil-rich region being below sea level (Onyenechere, 2010). The Nigeria Meteorological Agency had predicted "above normal" rainfall in crucial sections of the country earlier in 2012, which could result in flooding events in twelve states. Lagos, Ogun, lta, Cross River, Akwa Ibom, Bauchi, Gombe, Kano, Katsina, and Jigawa were among the states. However, between July and October 2012, roughly nine states in the country experienced flooding (Ajani, 2012), resulting in the loss of lives, homes, properties, farmlands, and agricultural products, totaling millions of naira. According to the Minister of the Environment, almost 5,000 acres of agriculture have been washed away, resulting in food shortages, starvation, and increased people's vulnerability to the effects of climate change (Okocha, Muhammad & Oyeyipo, 2012).

Meanwhile, climate change vulnerability is defined as the degree to which a system is vulnerable to and unable to cope with the negative effects of climate change, and is determined by the system's exposure, sensitivity, and adaptive capability. The nature and degree to which a system is exposed to significant climatic variations is known as exposure; sensitivity is the degree to which a system is affected either negatively or positively by climate-related stimuli is known as sensitivity; and adaptive capacity is the ability of a system to adjust to climate change variability and extremes is known as adaptive capacity (Odjugo, 2010). Vulnerability to climate change impacts arises from the dangers connected with climate change's negative effects. Vulnerability is a measure of a person's, group's, or system's exposure to natural disasters, as well as the degree to which that individual, group, or system recovers from the event's effects (Onyenechere, 2010). Vulnerability is defined by Fatile and Adejobi (2012) as the capacity of a system (people) to foresee, cope with, resist, and recover from the effects of a natural hazard. It is important to emphasize that individuals' vulnerability is dictated by their access to resources and social network membership, i.e., persons with access to resources and social networks are less sensitive to climate change consequences. The poorest individuals in developing countries are widely assumed to be the worst affected, as they are primarily reliant on climate-sensitive industries (Nanda, 2009). Mani (2008) also believes that the poorest countries and populations will suffer the most as a result of their geographical position, low income, and institutional capacity, as well as their greater reliance on climate-sensitive industries such as agriculture. Furthermore, ecologically fragile places are more vulnerable to climate change stressors, and this is especially true for marginalized groups who rely on natural resources (Nath & Behera, 2011). It has also been demonstrated that the level of susceptibility varies even within areas or sectors due to differences in their adaptability to numerous pressures (IPCC, 2007).

## 1.1. Phenomenon of climate change

Climate change is defined by the United Nations Framework Convention on Climate Change (UNFCCC, 2014) as a change in climate that is caused by human activity and alters the composition of the global and/or regional atmosphere, in addition to natural climate variability observed over comparable time periods. Climate change, according to the IPCC (2007), is associated with a change in the state of the climate that can be detected (e.g., by statistical tests) by variations in the mean and/or variability of its attributes, and that lasts

for decades or more. Although the Earth's climate is always changing and global climate change is inevitable, future climate change may be faster than it has been in the last 10,000 years. Because of human actions, the majority of the world's scientists studying this topic conclude that this predicted climate change will be different from prior climate shifts. As a result, climate change is the gradual alteration of the global atmosphere's composition, which is influenced both directly and indirectly by numerous human activities, as well as natural climate variability through time (Koehler-Munro & Goddard, 2010). The alteration, according to Koehler-Munro and Goddard (2010), has a greenhouse effect on the earth's atmosphere. The energy that reaches the earth from the sun is counterbalanced by the energy that the earth sends back into space. Some of the energy that the planet releases into space is trapped by greenhouse gases (GHGs). The atmosphere's GHGs operate as a thermostat, regulating the planet's climate. The average temperature on Earth would be –18oC instead of +15oC if it weren't for the natural greenhouse effect. As a result, life as we know it would be unthinkable (Koehler-Munro & Goddard, 2010).

## 1.2. Climate change vulnerability

Vulnerability is one of the system characteristics of adaptation in the context of climate change, and can be defined as the "degree to which a system is susceptible to injury, damage, or harm" (Smit, 2000). Natural hazards, entitlement and sustainable livelihoods, resilience, and integrated research traditions can all be used to do vulnerability research (Adger, 2006; Gumel, 2022). To identify variables within a single sector, an integrated method analyses susceptibility to climate change and leans more explicitly on a modified sustainable livelihoods approach. The traditional approaches to natural hazards and disaster risk management (DRM) first focused on the biophysical vulnerability of human systems as a result of external hazards and present climatic variability (Cutter, 2009). More contemporary hazards traditions look at the dynamic processes that alter social, economic, and biophysical vulnerability to hazards, as well as the social and economic origins of these vulnerabilities (Nwafor, 2007). In recent years, natural disasters and climate change research have found common ground in order to better understand the underlying reasons of susceptibility and become more forward-thinking with climate change adaptation measures (Prabhakar, Srinivasan, & Shaw, 2009).

## 1.3. Exposure to climate change

"The nature and degree to which a system is exposed to substantial climatic fluctuations" is how exposure is defined (IPCC, 2007). The variation of numerous climatic elements (temperature, precipitation, etc.) as well as global climate change and the system's location are all intimately tied to a system's exposure (Füssel & Klein, 2006). According to Brooks (2003), a country's vulnerability is defined as the percentage of the population in a hazard-affected area who is exposed to the first-order effects of the hazard, and the number of exposures is determined by a variety of social and environmental factors. Vulnerability is frequently referred to as a social notion that is inextricably linked to exposure, which can be defined as the spatial and temporal distribution of people and assets. The IPCC defines "the presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be negatively affected" as "the presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be negatively affected" (2017). According to Hallegatte (2014), a natural phenomenon must have an impact on a human system and cause negative consequences to become a hazard. The interaction of extreme weather events or climate stressors with sensitive settings determines disaster risk (Surminski, 2013). Disaster, loss, and damage result from the interplay of hazard events with the characteristics of the exposed object or subject that render it vulnerable to destruction (Surminski, 2013).

## 1.4. Sensitivity and resilience

Climate sensitivity is defined as "the degree to which climate fluctuation or climate change affects a system, either negatively or positively" (IPCC, 2001). A system's sensitivity is defined by a combination of non-climatic elements and climatic activity, such as its exposure. If a system's exposure to a threat is altered, the sensitivity is altered as well, either favorably or negatively (Füssel & Klein, 2006). The term "resilience" has numerous definitions, all of which come from the concept of a country's richness in terms of natural, environmental, and social capital (Bahadur, 2010). The term comes from the field of natural sciences. Holling (1973) was the first to define ecological resilience, which he defined as a combination of persistence, resistance, and transformation. In ecological terms, resilience is defined as the amount of disturbance that can be absorbed before the system's structure changes due to changes in the variables and processes that influence behavior (Gunderson, 2000). A system's ability to persevere in the face of change may be enhanced by a certain amount of volatility (Holling, 1973). In economics, the idea of resilience has been applied to general shocks and exceptional occurrences that affect the economy. In general, economic resilience is described as an economy's or society's ability to cope, recover, and rebuild (macroeconomic resilience) while minimizing household welfare losses (microeconomic resilience) in the face of a calamity of a certain severity (Hallegatte, 2014). The concept of social resilience can be defined as "communities' ability to absorb shocks to their social infrastructure" when applied at the community level (Oyekale, 2009).

### 1.5. Adaptive capacity

A country's or region's adaptive capability is defined as "the sum of a country's or region's capabilities, resources, and institutions for implementing effective adaptation measures" (IPCC, 2007). Exposure and sensitivity are difficult to separate from a system (Hjerpe & Wilk, 2010), however by controlling exposure and sensitivity to reduce vulnerability, a system's adaptive capacity can be boosted (Yohe & Tol, 2002). Adaptive capacity is a desirable unique and positive quality of a system that has been accepted in vulnerability research since it is influenced by both biophysical and social factors (Eakin & Luers, 2006). Adaptive capacity has its origins in biology, where it was used to describe a species' or organism's ability to adapt to a specific set of environmental conditions (Gallopin, 2006).

## 2. Materials and methods

Toro is a Bauchi State Local Government Area located in the southern portion of the state with a landmass of 6,932 km2 (Hassan, 2013). Toro LGA has a population of 350,404 people, according to NPC (2006). The interaction of two air masses, the relative warm and moist tropical maritime (mT) air mass, which originates from the Atlantic Ocean and is associated with southwest winds in Nigeria, and the relatively cool, dry, and stable tropical continental (cT) air mass, which originates from the Sahara Desert and is associated with the dry, cool, and dusty North-East Trades known as the Harmattan, influences seasonal variation in rainfall in the study area. The Inter-tropical Discontinuity is the zone where these two air streams meet (ITD). The ITD's journey northwards across the state in August marks the start of the rainy season in the entire state, while its migration southwards in February marks the start of the dry season (Odekunle, 2006). Temperatures are consistently high. The highest air

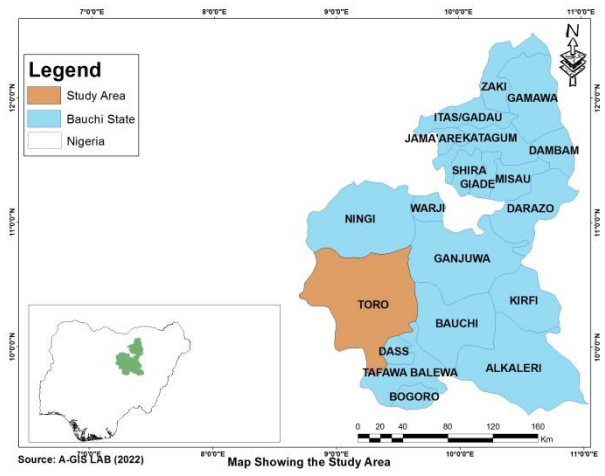


**Figure 1:** Map of the study area

temperature, which can reach 380°C - 400°C in some regions, occurs in April/May, while the lowest temperature occurs in December and January. Throughout the year, evapo-transpiration is normally high. The evaporation rate is higher during the dry season. The area's vegetation is of the Sudan Savanna variety, which contains the traits and species of both the Guinea and Sahel Savannas (Olorode, 2002).

The study used a field survey questionnaire to collect data, with a sample size of 500 questionnaires sent to household heads in the study area. Questions in the questionnaire were intended to allow respondents to choose from a variety of options provided in the instrument, while descriptive statistics were used to analyze the results. The level of people's vulnerability to climate change in the study area was determined using descriptive statistics based on mean ranking. The decision for mean ranking was taken based on the rating scale by Abd, Majid and McCaffer (1997) as Very low ($1.00 \leq \text{Mean} < 1.50$) Low ($1.50 \leq \text{Mean} < 2.50$) Moderate ($2.50 \leq \text{Mean} < 3.50$) High ($3.50 \leq \text{Mean} < 4.50$) and Very high ($4.50 \leq \text{Mean} < 5.00$). The People′s vulnerability to climate change was measured based on vulnerability indicators of exposure to climate change, sensitivity to climate change and adaptive capacity to climate change. However, in presenting results for exposure to climate change, other relevant information such as people most exposed to climate change, activities the climate change exposure is more felt on, and human reasons for climate change exposure were examined.

## 3. Results and discussion

The demographic data of the respondents' details were collected and has been presented in Table 1. The results on the age of the respondents indicated that the age between 41-50 years has the highest percentage of 39.6%, followed by age above 60yrs with 24.1%. The age between 31- 40yrs with 19.7% follows, and the least age was less than 30 years with 16.5%. This indicated that age between 41-50 years dominated the age of the respondents and less than 30yrs was the least age of the respondents in the study area. On the question of educational qualification, where Qur'anic/Non-Formal Education holders have the highest percentage of 44.9% followed by secondary school certificate holders with 21.0% percentage, then first school leaving certificate holders with 18.6% and the least education qualification was tertiary education holders with 15.5%. This means that majority of the respondents were Qur'anic/Non-formal education holders in the study area. Meanwhile, on the question on occupation of the respondents, most of them were farmers with 44.4%, followed by traders with 18.9%, then cattle rearing with 15.7%, civil servants with 11.5%, and least occupation was fisheries with 9.4% in the study area.

**Table 1:** Demographic details of the respondents

| S.N. | Questions | Options | Frequency | Percentage |
|---|---|---|---|---|
| 1 | Age | Less than 30 years | 63 | 16.5 |
| | | 31-40 years | 75 | 19.7 |
| | | 41-50 years | 151 | 39.6 |
| | | Above 60 years | 92 | 24.1 |
| 2 | Educational Level | Qur'anic/Non-Formal Education | 171 | 44.9 |
| | | Primary Education | 71 | 18.6 |
| | | Secondary Education | 80 | 21.0 |
| | | Tertiary Education | 59 | 15.5 |
| 3 | Occupation | Farming | 169 | 44.4 |
| | | Trading | 72 | 18.9 |
| | | Fishing | 36 | 9.4 |
| | | Civil Service | 44 | 11.5 |
| | | Cattle Rearing | 60 | 15.7 |

These results imply that most of the household heads in the study area were above the dependent age i.e. not within the early youthful age range, which means that they were old enough to have climatic experience within the study area and beyond. This further implies that most of the household heads in the study area were middle age men which are of great advantage to the communities in the study area. These findings agree with the study of Fajuyi (2016) that found out that household heads in Ibadan who affected by flood were of average age of 49 years, and also agrees with the study of Enete (2011) that the respondents were of the average age of about 47 and 50 years for smallholder food crop farmers using indigenous adaptation strategy in Imo State, Nigeria. But this disagrees with the findings of Manyena (2006) which found out that small and medium-scale soybean farmers in Benue State, Nigeria had average age of about 33 and 39 years respectively. On the question of educational qualification, where Qur'anic/Non-Formal Education holders have the highest percentage of 44.9% followed by secondary school certificate holders with 21.0% percentage, then first school leaving certificate holders with 18.6% and the least education qualification was tertiary education holders with 15.5%. This implies that majority of the respondents only attended Qur'anic/Non-formal education schools in the study area. This result disagrees with the finding of Adebayo, K. (2011) that found out that a greater parentage of farmers in Akure only attempted secondary school or its equivalent. The findings agree with the findings of Mani, M (2008) that majority of the rain fed rice farmers in Kura had only attended non- formal education centers. On the question on occupation of the respondents, most of them were farmers with 44.4%, followed by traders with 18.9%, then cattle rearing with 15.7%, civil servants with 11.5%, and least occupation was fisheries with 9.4% in the study area. This implies that majority of the respondents were farmers. This suggests that farmers are more vulnerable to climate change (Folke, 2006). The findings agree with Awotoye & Mathew (2010) that more than 3.4 billion people live in rural areas, with most working on small farms to produce food for their communities, most depend on small, family farms for their income and sustenance, rural people grow the food that feeds their nations, but they are also disproportionately poor: 80 per cent of the women, children and men living in extreme poverty live in rural areas, not cities.

The results in Table 2 reported that the major climate change exposure in the study area are reduction in green environment, decrease in total annual rainfall, warmer weather, early cessation of rainfall, late on-set of rainfall and shrinkage of water bodies with mean values of 4.5827, 4.5039, 4.4331, 4.4147, 4.4016 and 4.3386 ranked 1 to 6 respectively. The least climate change exposure was pest and disease due to climate change with mean value of 3.4331 ranked 7 among the exposure to climate change. The result also indicated high level of exposure to climate change in the study area, with average mean of 4.3011. This agrees with findings of BASEED (2005) that the level of deforestation in Toro L.G.A as a result the activities of loggers and charcoal producers is extremely

alarming and it's increasing the rate of desertification the entire state.

**Table 2:** Exposure to climate change

| Exposure | Mean | Std. Deviation | Rank | Remark |
|---|---|---|---|---|
| Reduction in green environment | 4.5827 | .70458 | 4.3011 | High level of exposure |
| Decrease in total annual rainfall | 4.5039 | .78681 | | |
| Warmer weather | 4.4331 | .86988 | | |
| Early cessation of rainfall | 4.4147 | .78552 | | |
| Late on-set of rainfall | 4.4016 | .72104 | | |
| Shrinkage of water bodies | 4.3386 | .83559 | | |
| Pest and disease due to climate change | 3.4331 | 1.09249 | | |

**Table 3:** Sensitivity to climate change

| Sensitivity | Mean | Std. Deviation | Rank | Remark |
|---|---|---|---|---|
| Decrease in crop yield | 4.7113 | .51361 | 4.3581 | High Sensitivity |
| Increase in cost of food crops | 4.4252 | .73111 | | |
| Increase in drought incidents | 4.3648 | .85269 | | |
| Famine | 4.3517 | .94433 | | |
| Poverty | 4.3491 | .92704 | | |
| Indiscriminate falling down of trees | 4.3412 | .88799 | | |
| Increase in disaster | 4.3018 | .95185 | | |
| Decrease in livestock numbers | 4.2126 | .94281 | | |
| Disease out break | 4.1654 | 1.01901 | | |

Ajani (2012) also found out that the onset and cessation of the rainy season which has become irregular over the years is posing a problem for farmers as regards optimization of the seed planting and the need to adjust to the length of the growing season.

The results in Table 3 shows that the major sensitivity to climate change were decrease in crop yield, increase in cost of food crops, increase in drought incidents, famine, poverty, indiscriminate falling down of trees, increase in disaster, decrease in livestock numbers and disease outbreak at mean values of 4.7113, 4.4252, 4.3648, 4.3517, 4.3491, 4.3412, 4.3018, 4.2126 and 4.1654 ranked 1 to 9 respectively. The overall result also reported high level of sensitivity to climate change in the study area, with a mean score of 4.3581. This implies that decrease in crop yield was the major sensitivity pathway in the study area. Hassan (2013) opined that changes, temperature increase has the most likely negative impact on crop yields and regional temperature changes can be projected from climate models with more certainty than precipitation. It is thus necessary to quantify the impact of temperature increase on global crop yields, including any spatial variations, to first assess the risk to world food security, and then to develop targeted adaptive strategies to feed a burgeoning world population. The result also agrees Fatile & Adejobi (2012) that the destructive impacts of climate change like droughts, floods and increasingly severe storms are the primary culprits behind decreased farming output and rising hunger worldwide. Almost a quarter of the populations of least developed countries suffer food insecurity, with vulnerable populations in Nigeria and other developing countries even facing the risk of famine.

**Table 4:** Adaptive capacity to climate change: Adaptive strategies

| Adaptive Strategies | Mean | Std. Deviation | Rank | Remark |
|---|---|---|---|---|
| Irrigation farming | 4.2887 | .93786 | 3.5841 | Moderate Adaptive Capacity |
| Use of organic manure | 4.2493 | 1.17127 | | |
| Planting of drought tolerant varieties | 4.2362 | .92728 | | |
| Early Planting | 4.0945 | 1.04201 | | |
| Shifting cultivation | 3.8425 | 1.08646 | | |
| Mixed cropping | 3.7927 | 1.23397 | | |
| Construction of water reservoirs | 3.7822 | 1.18201 | | |
| Shelter Belts | 3.6063 | 1.30681 | | |
| Mulching | 3.5984 | 1.30541 | | |
| Wind Breakers | 3.3202 | 1.41694 | | |
| Use terraces | 2.9029 | 1.32923 | | |
| Empowerment strategies | 2.5092 | 1.29901 | | |
| Prompt disaster control measures | 2.3701 | 1.43529 | | |

**Table 5:** People's vulnerability to climate change in the study area

| Vulnerability Indicators | Mean | Std. Deviation | Rank | Remark |
|---|---|---|---|---|
| Sensitivity to climate change | 4.3581 | .55562 | 4.0811 | High |
| Exposure to climate change | 4.3011 | .49360 | | Vulnerability |
| Adaptive strategies | 3.5841 | .54721 | | |

Adding that the vast majority of farmers in these nations are small-scale producers and they are most vulnerable to environmental and price shocks. Climate change has compounded existing poverty. Its adverse impacts will be most striking in the developing nations because of their geographical and climatic conditions, their high dependence on natural resources, and their limited capacity to adapt to a changing climate. Within these countries, the poorest, who have the least resources and the least capacity to adapt, are the most vulnerable (IPCC, 2014).

The results in Table 4 shows that the major adaptive strategies to climate change in the study area were irrigation farming, use of organic manure, planting of drought tolerant varieties and early planting at mean scores of 4.2887, 4.2493, 4.2362 and 4.0945 ranked 1 to 4. These are followed by second major adaptive strategies to climate change in the study area which are shifting cultivation, mixed cropping, construction of water reservoirs, shelter belts, mulching and wind breakers with mean scores of 3.7927, 3.7822, 3.6063, 3.5984 and 3.3202 ranked 5 to 9 respectively. The least adaptive strategies to climate change in the study area were use terraces, empowerment strategies and prompt disaster control measures at mean scores of 2.9029, 2.5092 and 2.3701 ranked 10 to 12 respectively. This implies that major adaptive strategy used in the study area was irrigation farming. The result agrees with Agwu & Amadu (2011) that societies and individuals have adapted to changing climate conditions by a mixture of practices, these practices include early planting, irrigation farming, mulching cropping changes, new water technologies and innovative modes for resource management, it forces farmers to depend on low input and low risk technologies. Non-adoption of new technologies to derive maximum gains during favorable seasons delays recovery after disasters. The development of the irrigation system in the 70s led to increased rice production in recent years. This, however, was at the cost of other rain-fed crops, including pulses and oil seeds, which led to lower nutrition levels in

the population, as large areas were converted to rice farms. However, contrary result was reported by Cardona (2012) that farmers preferred to cultivate more crops during the risky dry season due to its associated high demand, new ways and methods are needed to better inform farmers to help them identify alternative, technically viable options for livelihood adaptation (Chikaire, Ajaero, & Atoma, 2022). Better access to climate information could encourage farmers to adopt new risk/opportunity management practices under changing climatic conditions. Similar result was also reported by Smit & Wandel (2006) that adaptation strategies will not be successful unless there is a willingness to adapt among those affected, as well as a degree of consensus regarding what types of actions are appropriate. Adaptive capacity, therefore, depends on the ability of a society to act collectively, and to resolve conflicts between its members. Nonetheless, it must be recognized that adaptation will ultimately be a localized phenomenon.

The results in Table 5 shows that the pattern of peoples' vulnerability to climate change in the study area is more on sensitivity to climate change, followed by exposure to climate change, and adaptive strategies at mean values of 4.3581, 4.3011 and 3.5841. The results show that high level of Peoples' vulnerability to climate change in the study, with mean value of 4.0811. The result implies that there is high level of Peoples' vulnerability to climate change in the study area. IPCC (2014) reports that developing countries are the most vulnerable to climate change impacts because they have fewer resources to adapt: socially, technologically and financially, climate change is anticipated to have far reaching effects on the sustainable development of developing countries, many developing countries' governments have given adaptation action a high, even urgent, priority. Hinkel (2011) opined a similar result that developing countries have very different individual circumstances and the vulnerability to climate change of a country depend on the climate it experiences as well as its geographical, social, cultural, economic and political situations. As a result, countries require a diversity of adaptation measures very much depending on individual circumstances. From a global perspective, it is more likely that people living at or below poverty will be affected the most by climate change and is thus the most vulnerable, because they will have the least amount of resource to invest in resiliency infrastructure. UNHabitat (2007) reported that around the world, climate change affects rural communities that heavily depend on their agriculture and natural resources for their livelihood. Increased frequency and severity of climate events disproportionately affects women, rural, dryland, and island communities, this leads to more drastic changes in their lifestyles and forces them to adapt to this change. It is becoming more important for local and government agencies to create strategies to react to change and adapt infrastructure to meet the needs of those impacted. USAID (2007) also reported that various organizations work to create adaptation, mitigation, and resilience plans that will help rural and at risk communities around the world that depend on the earth's resources to survive, those in poverty have a higher chance of experiencing the ill-effects of climate change due to the increased exposure and vulnerability.

# 4. Conclusion

Reduced greenery, decreased total annual rainfall, warmer weather, early cessation of rainfall, late on-set of rainfall, and shrinking of water bodies were the key climate change exposure pathways in the research area. Farmers and fishermen were the most affected by climate change in the study area. Low income, insufficient understanding, bad farming practices, industrial activity, and poor planning were the key human causes of climate change vulnerability. The major sensitivity to climate change were decrease in crop yield, increase in cost of food crops, increase in drought incidents, famine, poverty, indiscriminate falling down of trees, increase in disaster, decrease in livestock numbers and disease outbreak; the overall result also reported high level of sensitivity to climate change in the study area. It was also established that the major adaptive strategies to climate change in the study area were irrigation farming, use of organic manure, planting of drought tolerant varieties and early planting.

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