Science World Journal Vol. 20(No 1) 2025 https://dx.doi.org/10.4314/swj.v20i1.33
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

PERCEPTION OF RESIDENTS ON THE IMPACTS OF CLIMATE CHANGE ON WATER RESOURCES IN KADUNA NORTH LOCAL GOVERNMENT AREA

*Nafisat Bello, Haruna Garba, Abbas Abdullahi Ako

Nigerian Defence Academy, Kaduna – Nigeria

*Corresponding Author Email Address: bellonafisa@gmail.com

ABSTRACT
This study examined public perception of the impacts of climate change on water resources and explored adaptation strategies to mitigate it. Data was obtained using a structured questionnaire randomly administered to 384 respondents. The questionnaire was analyzed using descriptive and Chi-square statistics. The results revealed that 62.4% were males, 37.7% were females, and 73.3% were below 40 years old; 65.6% were married, 28.7% were not married, and divorced and widowed were 3.5% and 2.2% respectively. For education, 80.5% of the respondents are educated up to the level of tertiary institutions, while 19.5% are educated up to the level of secondary school. For the awareness of climate change, 45% are moderately aware, 17.1% have low awareness, 13.8% have very low awareness, and 18.2% and 6.0% have high and very high awareness. With a Chi-square statistic (χ^2) of 83.85, and a p-value <0.05, the study revealed that education significantly influences climate change awareness. For the adaptive strategies, 89.4% said there were no community initiatives, and 10.6% disagreed. For mitigation, 32.8% said there is a need for new water conservation measures, 27.6% said there is a need for community engagements, 26.3% believe there is a need for improvement of water-related infrastructure, and 13.3% indicated a need for changes in government policy to address climate change. The study concluded there was moderate awareness of climate change among the general public, which strongly correlates to individuals' level of education. The study therefore recommended adequate water conservation measures to cope with the declining water resources.

Keywords: Climate change, mitigation, adaptation, Kaduna North LGA, Water resource management, climate change

INTRODUCTION

Climate change is an escalating global concern that's significantly affecting various aspects of the environment. Global climate change threatens the supply of water resources globally and alters their temporal-spatial patterns (Luo et al., 2017). The World Meteorological Organization (WMO) reports that 2023 was the hottest year recorded, with the average global temperature anticipated to increase by 2°C over the next 20 years (WMO, 2024). According to the most recent forecasts by the Intergovernmental Panel on Climate Change (IPCC, 2022), by 2100 global temperatures could rise between 1.1°C to 6.4°C. The AR6 Synthesis Report of the IPCC has established that climate change is a tangible phenomenon, with Africa being the most vulnerable continent (Ahmed et al., 2024). The warming of the African continent is expected to beat the global annual mean temperature this century, with the arid subtropical regions experiencing greater increases than the more humid tropics (WMO, 2024).

Water is central to the well-being of mankind and the functioning of sustainable ecosystems, and as such, any variations in climate can negatively impact the quality and availability of water resources (Bartlett & Dedekorkut-Howes, 2023). Anthropogenic climate change is expected to have significant impacts on global freshwater resources. These impacts include increased evapotranspiration, resulting from higher temperatures, as well as a likely increase in the frequency and intensity of droughts, with a reduction in snowpack and changes in the timing of spring runoff (Ciampittiello et al., 2024). However, the effects of climate change on temperature and precipitation patterns have a significant impact on the availability, distribution, and quality of water sources because rainfall is a major factor in determining the amount of water available to meet various demands, including those for hydroelectric power generation, domestic water supply, agriculture, and industry (Rankoana, 2020). There is a scientific consensus that climate change will alter long-term rainfall patterns, impacting water supply, as well as the possibility of increased frequency of severe droughts and floods (Pizzorni et al., 2024). Consequently, climate change poses immense threats and new opportunities for the development of water resources; Climate change is anticipated to worsen the quality and availability of water, with far-reaching consequences for household food security, hygiene, and general well-being (United Nations Global Compact (UNGC), 2009).

Rainfall in Nigeria has experienced and is still experiencing changes as a result of a combination of natural factors and human activities which influence the distribution in different timescales (Abubakar et al., 2024a; Abubakar et al., 2025). These rainfall variations have an impact on soil conservation, agriculture, water resources, and severe weather occurrences, such as floods and droughts, which have a disastrous impact on food security and are often accompanied by other tragedies and hardships (Ifabiyi & Ashaolu, 2015). These changes in water resources are critical to all sectors of the economy. However, since the effects of climate change are permanent, we must adjust to the new environment as they arise. These actions are referred to as adaptation strategies by the IPCC (2022), which emphasizes that they must operate at several scales and address both the opportunities and threats associated with climate change. Since there haven't been many mitigating measures taken thus far, adaption techniques have become more crucial to address the limited amount of change and its effects on local populations (Marquardt et al., 2023).

Many countries in Sub-Saharan Africa (SSA) are experiencing water stress. According to studies, water extraction in Nigeria throughout the 1990s averaged 28 cubic meters per person per year (World Bank, 2003). In 2004, the International Dialogue on

Science World Journal Vol. 20(No 1) 2025 https://dx.doi.org/10.4314/swj.v20i1.33
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Water and Climate illustrated that water stress will surge significantly in SSA. There is a growing focus on conducting climate change research using bottom-up methodologies, which means studying the local level where the risks and impacts are primarily experienced (Bardosh, 2015). Adaptation to climate change cannot be accomplished through individuals alone but must be executed by the community by sharing a common understanding of the risks, consequences, and measures required to adapt (Biswas & Rahman, 2023). A community-based adaption technique enables individuals to plan for and deal with the consequences of climate change by concentrating on community-led procedures grounded in communities' objectives, needs, knowledge, and skills (Midgley et al., 2012). The measures might be used to empower populations to apply their own understanding and decision-making processes to deal with the effects of climate change (Mugambiwa, 2018).
Furthermore, in places like Kaduna North, where there is a heavy reliance on rainfall as a source of water for domestic, agricultural and industrial uses, it becomes crucial to understand how climate change is influencing its availability, as well as the mitigation and adaptation strategies needed to address these changes. Therefore, this study explored the public perception of the status of water resources, the impact of climate change on these resources, and the community-based adaptation practices adopted to ensure the availability and accessibility of quality and safe water for household consumption. The study results prove that community-based participation in addressing water scarcity could be important in climate change adaptation to improve climate resilience in local communities through integrated and adapted water resource management.

MATERIALS AND METHODS

Study Area

Kaduna North LGA lies between latitudes 10° 04' and 10° 30' North of the Equator and between longitudes 7° 20' and 7° 30' East of the Greenwich Meridian (Figure 1). It is bounded in the North by the Igabi Local Government Area and in the West by both Kaduna South and Igabi Local Government Areas of the state. It is also bounded in the South and East by the Kaduna South Local Government Area (Baba et al., 2020). The climate of Kaduna North is characterized by alternating wet and dry periods (Köppen Aw). The rainy season spans from April to the middle of October, with a peak in August, and the dry season lasts from October to April of the following year (Abubakar et al., 2024a). The annual average rainfall in Kaduna is about 1323 mm/year. The interplay between two air masses has a direct impact on seasonal variations in rainfall (Abubakar et al., 2025).
The highest air temperature is recorded in April every year (28 ^{o}C) while the lowest is recorded every December (22.9^{o}C) until January (23.1^{o}C) (Abubakar et al., 2024a). During the wet and dry seasons, the typical atmospheric relative humidity is, respectively, 70–90% and 25–30%. The highest water loss through evaporation takes place in the dry season (Musa & Abubakar, 2024). Kaduna State is situated in the Guinea Savanna Ecological Zone, where tree densities and other vegetation decrease as one moves towards its northern region. The zone is important, both as a major provider of cereals and tubers because of its significantly greater rain in contrast to the more northern Sudan and Sahel Savannas (Abubakar & Abdussalam, 2024; Atedhor, 2016).

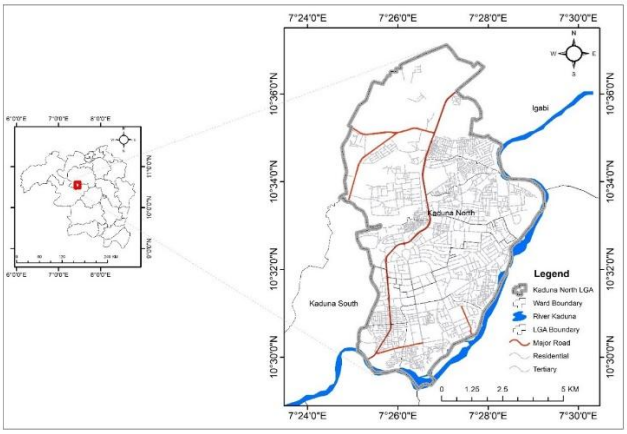


Figure 1: Map of Kaduna North Local Government Area
Source: Adapted from GRID3 - Nigeria, 2024

Data Collection

The purpose of the survey was to assess the awareness, knowledge, attitude and perception of the public on the influence of climate change on water resources management in Kaduna North LGA, Kaduna. Before data collection, an iterative process of survey conceptualization, questionnaire design, pilot interviews, and modifications was conducted.
A preliminary survey consisting of questions was created and categorized into four sections: 1) resident demographics and background; 2) residents' awareness of climate change; 3) residents' mitigation and adaptive strategies to influence climate change on water resources management. Age, gender, education level, marital status, and occupation were among the closed-ended questions in the sociodemographic variables of interest section. This applies to questions about their awareness of climate change.

Sampling Procedure, Size and Techniques

A sampling procedure and techniques were employed, where the proportion of a research population was adequately selected to represent the study population. However, since the local government has twelve (12) wards, the study area is stratified according to the political wards. These wards are Shaba, Gaji, Unguwan Liman, Maiburuji, Kabala Costain/Doki, Gabasawa, Unguwan Sarki, Badarawa, Unguwan Dosa, Kawo, Hayin Banki and Unguwan Shanu (INEC, 2015).
A sample size indicates the proportion of a research population adequately selected to represent the study population. The sample size of this study was found to be 384, and it was determined based on Cochran's (1953) formula for calculating sample size, with finite population correction.

$$S = \frac{x^2\, Np(1-p)}{e^2\,(N-1) + x^2\, p(1-p)} \qquad (1)$$

Where s = required Sampling Size (Household)
X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (0.05 = 3.841)
N = Total Number of Household
P = The Population Proportion (Assumed to be 0.50)
d = The Degree of Accuracy or Level of Precision (0.05)
S = 3.841(75000 to 1000000) 0.50(1-0.50)
0.05^2 (75000 to 1000000-1) + 3.841 X 0.50(1-0.50)
S = 384

Science World Journal Vol. 20(No 1) 2025 https://dx.doi.org/10.4314/swj.v20i1.33
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

This formula was chosen because of its ability to capture a large number of populations as it contains many statistical variables such as chi-square table value, population proportion, degree of accuracy and confidence level. As the population increases the sample size also increases at a diminishing rate and remains relatively constant at slightly more than 380 sample size cases (Krejcie & Morgan, 1970). However, the sample size used for this study can be used in a population that is greater than and equal to seventy-five thousand (≥ 75,000) and less than one million (< 1,000,000).

Reliability Test

A reliability test was carried out to measure the degree to which the research instrument (questionnaire) yields consistent results. Statistical Package for Social Sciences (SPSS v27) was used to test the validity and reliability of the questionnaire. Measured for the questionnaire, the Cronbach's alpha coefficient ranged from 0.83 to 0.92, as indicated in Table 1. As a result, the Cronbach's alpha coefficient was greater than the 0.70 cutoff point.

However, after the field survey conducted by the research team, only 369 questionnaires were usable, as some couldn't be retrieved, while others were not usable. This yielded a 92.18% response rate.

Table 1: Cronbach's Alpha for the Questionnaire

Attribute	Factor	Cronbach's alpha
1. Awareness (Awareness 1-3)	1.1 Level of Awareness 1.2 Perceived changes 1.3 Observed changes	0.84
2. Climate Change Impacts (Impacts 1-2)	2.1 How do you perceive climate change affecting water resources in your region? 2.2 In your opinion, what are the major factors contributing to the vulnerability of water resources to climate change?	0.92
3. Adaptation (Attitude 1-5)	3.1 Are there any ongoing efforts or initiatives in your community or region to adapt to the impacts of climate change on water resources? 3.2 If yes, _____ 3.3 What do you consider to be effective adaptation strategies to mitigate the consequences of climate change on water resources? 3.4 Have you personally adopted any practices or technologies to cope with changes in water availability or quality? 3.5 If yes, please specify _____	0.83

Source: Authors' Compilation, 2023

Data Analysis

Descriptive statistics and crosstabulation were used to analyze the respondents based on their sociodemographic attributes. Crosstabulation combines categorical data into a table, with each cell providing the frequency (raw or proportional) of observations that fit the categories indicated by that cell (Momeni et al., 2018). The summary data presented in cross-tabulated form can subsequently be used for a variety of statistical tests, the majority of which are based on the chi-square distribution (Putra & Wibowo, 2023).

Furthermore, to understand the relationship between residents' level of education and awareness of climate change, the Chi-Square test of independence was applied. Hypotheses tested by the study are:

- Null Hypothesis (H_0): There is no association between Education Level and Climate Change Awareness.
- Alternative Hypothesis (H_1): There is a significant association between Education Level and Climate Change Awareness.

This Chi-square is calculated using Equation (i)

$$X^2 = \sum \frac{(O-E)^2}{E} \quad (i)$$

Where O is the observed frequency, and E is the expected frequency. Additionally, if $p < 0.05$, reject H_0, which says the level of education significantly influences climate change awareness. Else, if $p > 0.05$, accept the H_0, which says there is no significant association. Data were presented in tables and charts using descriptive methods with the help of SPSS v27.

RESULTS AND DISCUSSION

This study discussed the roles of respondents' levels of education as well as community efforts in adopting and promoting strategies for water conservation using a well-structured questionnaire.

Sociodemographic Characteristics

Table 2 revealed the sociodemographic characteristics of the respondents. This includes the sex, age range, marital status, level of education, occupation and income of the respondents.

Table 2: Sociodemographic Characteristics of the Respondents

Sex	Frequency	Per cent
Male	230	62.3
Female	139	37.7
Total	**369**	**100**
Age Range		
20 – 30	88	23.8
31 – 40	184	49.9
41 – 50	70	19.0
Above 50	27	7.3
Total	**369**	**100**
Marital Status		

Science World Journal Vol. 20(No 1) 2025 https://dx.doi.org/10.4314/swj.v20i1.33
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Single	106	28.7
Married	242	65.6
Divorced	13	3.5
Widowed	8	2.2
Total	**369**	**100**
Level of Education		
Secondary	72	19.5
Tertiary	297	80.5
Total	**369**	**100**

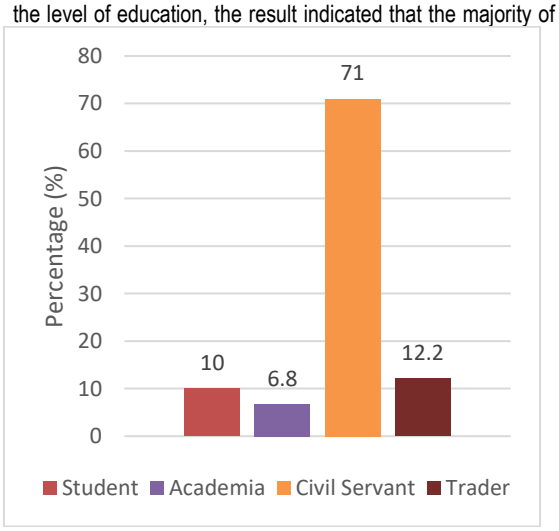
From Table 2, the majority of the respondents are male, with 62.4% of the total population, while females make up 37.7% of the population. This contradicts the study of Jibril et al. (2021) which revealed that 63% of the population were females. For the age range of the respondents, the results also showed that 73.3% of the respondents are below the age of 40, which indicates a very young population. People between the ages of 41 and 50 years make up 19% of the population, while those above 50 years of age make up only 7.3%. This is similar to the findings of Ariyo et al. (2021) that people below the age of 40 make up 60.87% of the population. The respondents' relatively young age indicates that the study reflects the perceptions and educational experiences of a younger generation, which is crucial for understanding current trends and environmental challenges.

The results also showed that 65.6% of the respondents were married, 28.7% were single, while divorced and widowed made up 3.5% and 2.2% of the respondents, respectively. This is similar to the findings of Nwankwo et al. (2023) which revealed that the majority of the residents of Kaduna North LGA were married. For the level of education, the result indicated that the majority of the respondents were educated with 80.5% up to the tertiary level. The remaining 19.5% were educated up to secondary school. This indicated the high level of education of the respondents. Higher educational attainment is typically linked with an enhanced understanding of environmental and water resource concerns, encompassing pollution, climate change, and water conservation (Ardoin et al., 2020).

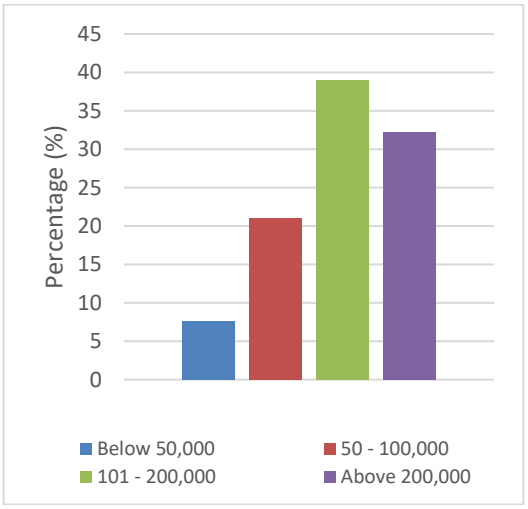
Occupation and Income of the Respondents

Civil servants make up the largest population of the respondents, with 71%, followed by traders with 12.2%. Students and staff of academia make up 10% and 6.8% respectively. This result is shown in Figure 2a. Academics and students are essential for research and education regarding the impacts of climate change. Students and members of the academia can foster innovation in water resource management practices and inform the public about adaptive measures (Wonneberger et al., 2020). For the monthly income, 39.0% of the respondents earn between ₦100,000 and ₦200,000 per month, followed by those who earn more than ₦200,000 per month. 21.1% earns between ₦50,000 and ₦100,000, while 7.6% earns below ₦50,000. This result is shown in Figure 2b.

Individuals and households with low income are particularly susceptible to price changes during droughts or shortages since they spend more of their income on essential requirements like food and water (Delbiso et al., 2024), whereas high-income levels frequently correlate with enhanced governance, improved policy execution, and institutional structures that facilitate equitable water management (Mwadzingeni et al., 2022). A considerable percentage of middle-to-high-income earners indicates the possibility for private sector investment in water infrastructure, encompassing public-private partnerships (PPPs) for water supply initiatives (Munoz-Jofre et al., 2023).



a) Occupation



b) Monthly income

Figure 2: Occupation and monthly income of the respondents

Climate Change Awareness

Table 3 revealed the residents' level of climate change awareness on water resources.

Science World Journal Vol. 20(No 1) 2025 https://dx.doi.org/10.4314/swj.v20i1.33
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Table 3: Respondents' Level of Awareness on the Impacts of Climate Change on Water Resources

How would you rate your awareness of climate change and its impacts on water resources?	**Frequency**	**Per cent**
Very Low	51	13.8
Low	63	17.1
Moderate	166	45.0
High	67	18.2
Very High	22	6.0
Total	**369**	**100**
Changes in local water availability		
Yes	214	58.0
No	155	42.0
Total	**369**	**100**
If yes, state		
Drought	76	35.5
High Rainfall / Flood	38	17.8
Irregular Rainfall	21	9.8
Low G/Water Level	36	16.8
Purity	10	4.7
Drying up of water bodies	23	10.7
Cost	10	4.7
Total	**214**	**100**

The results in Table 3 revealed the majority of the respondents (45%) have moderate awareness of climate change and its impacts on water resources availability. Also, 30.9% of the respondents' level of awareness of climate change ranged from low to very low. Those with high and very high awareness of climate change make up 24.2% of the respondents. According to Johnson et al. (2022), communities with limited climate change awareness may find it challenging to implement water conservation practices or endorse infrastructure enhancements designed to alleviate these effects. Also, 58% of the respondents observed changes in local water availability as a result of climate change, while 42% have not observed any changes. Among the 58% who reported noticing changes, the majority (35.5%) believed that climate change is responsible for low rainfall and drought occurrences, and 27.5% believed climate change is responsible for low groundwater availability or drying up of water bodies. 17.8% believed climate change is responsible for high rainfall, which causes severe floods. 9.8% believed it causes irregular rainfall (amount, onset and cessation). Those who believed climate change affects water quality and those that believed climate change is responsible for the high cost of water make up 4.7% each.

Relationship Between Level of Education and Climate Change Awareness

Table 4 reveals the result of the Chi-square statistics, showing the relationship between the level of education and climate change awareness in Kaduna North LGA.

Table 4: Relationship Between Level of Education and Climate Change Awareness

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	83.851[a]	4	.000
Likelihood Ratio	40.337	4	.000
N of Valid Cases	369		

a. 1 cells (1.3%) have expected count less than 5. The minimum expected count is 1.

Source: Authors' Analysis, 2023

From Table 4, the Chi-square revealed Chi-square statistic (χ^2) = 83.85 p-value = 2.66×10^{-17} (very small, almost zero) Degrees of freedom (df) = 4. Given that the p-value (0.0000000000000000266) is lower than the alpha (0.05), this indicates that the correlation is statistically significant. This confirms the findings of previous studies that climate change awareness is strongly influenced by education (Ayanlade & Jegede, 2016; Hess & Collins, 2018; Hoekstra et al., 2024).

Impacts of Climate Change on Water Resources

Figure 3a revealed that 34.7% of the respondents believed climate change is responsible for the increased drought, 23.8% thought it is causing more frequent and intense flood events, and 22.5% believed it is causing a decline in groundwater levels. In comparison, 17.1% thought it was causing changes in precipitation patterns. However, only 1.9% indicated others, with no reasons stated. The opinions of the respondents align with scientific data on how climate change influences water resources using both direct (e.g., temperature increase) and indirect (e.g., changed hydrological cycle) effects (Abbas et al., 2022; Bartlett & Dedekorkut-Howes, 2023; Rankoana, 2020), and soil moisture availability (Abubakar et al., 2024b). These realizations highlight the necessity of focused adaptation plans to reduce the hazards related to these developments (Ciampittiello et al., 2024).

For the major factors contributing to the vulnerability of water resources to climate change, Figure 4.3b revealed that most respondents believe pollution (41.2%) is the main problem, followed by lack of adequate storage with 34.4%. However, 24.4% of the respondents believe climate change will increase the rates of evaporation, exacerbating the loss of surface water. This agrees with the report of the IPCC (2022) that without adequate storage capacity, households may struggle to manage climate-change-driven water resource fluctuations.

Science World Journal Vol. 20(No 1) 2025 https://dx.doi.org/10.4314/swj.v20i1.33
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

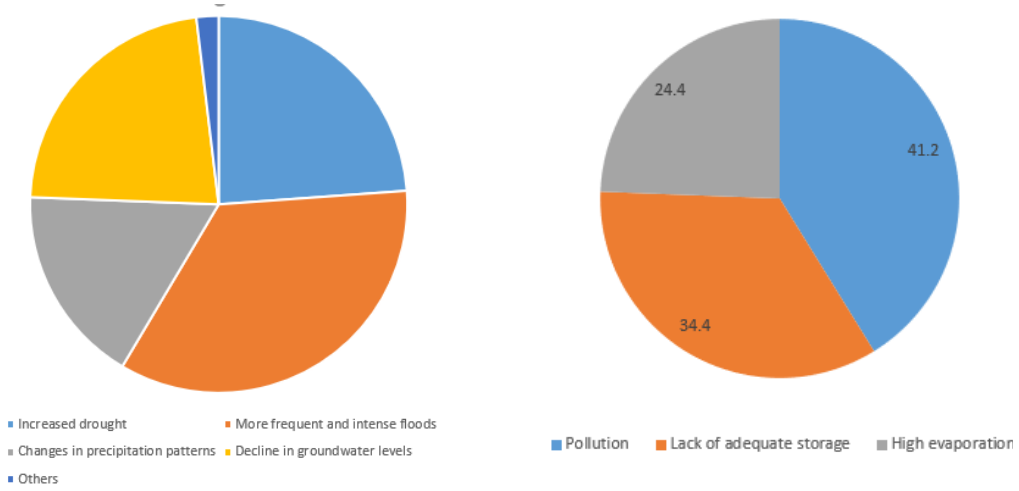


Figure 3: a) Perception of climate change effect on water resources in your region b) Major factors contributing to the vulnerability of water resources to climate change

Adaptation Strategies

Table 5 revealed that the overwhelming majority of the respondents (89.4%) said there are no community efforts/initiatives to adapt to the impacts of climate change on water resources availability in the study area, while 10.6% disagreed. While 80.5% of respondents had tertiary education (Table 2), efforts at adaption are still inadequate. This suggests that awareness by itself might not translate to action; other challenges including financial constraints or inadequate institutional support could be present. Given limited access to information and resources, the small proportion (19.5%) with secondary education may show less participation in climate adaptation.

Table 5: Community-Level Adaptive Strategies on the Impacts of Climate Change on Water Resources

Are there ongoing efforts/initiatives to adapt to the impacts of climate change on water resources?	**Frequency**	**Per cent**
Yes	39	10.6
No	330	89.4
Total	**369**	**100**
If yes, please specify		
Water collection and storage are being adopted	15	38.5
Drainage / Flood Control	12	30.8
Adequate Maintenance	7	17.9
Awareness	5	12.8
Total	**39**	**100**
Effective adaptation strategies to mitigate the consequences of climate change on water resources		
Water conservation measures	121	32.8
Infrastructure improvements	97	26.3
Policy changes	49	13.3
Community engagement	102	27.6
Total	**369**	**100**
Have you personally adopted any practices or technologies to cope with changes in water availability?		
Yes	72	19.5

No	297	80.5
Total	**369**	**100**
If yes, please specify		
Rain harvesting	10	13.9
Borehole Sinking	47	65.3
Using Water Efficient Appliances	15	20.8
Total	**72**	**100**

Of the respondents, 15 people responded that their communities were adopting new water collection and storage methods, and 12 responded that they were actively engaged in efforts to clear drainages for flood mitigation. 7 respondents said they carried out adequate maintenance on their water infrastructure, while 5 respondents said their communities are carrying out awareness on the impacts of climate change on water resource availability. Thus, Rankoana (2020) suggested that without community adaptation strategies including water conservation, storage, and alternate supply, water availability for households, agriculture, and enterprises becomes increasingly unsustainable.

Water conservation (32.8%) and community participation (27.6%) are recognized as significant strategies for climate adaptation. However, just 13.3% consider policy reforms vital, which demonstrates a deficit in comprehending the importance of governance in climate adaptation. Infrastructure improvement (26.3%) demonstrates a recognition of the need for modern water systems, but its low percentage implies inadequate government or private investment. Previous studies have argued that sustainable water management is critical for building resilience against climate change (Bartlett & Dedekorkut-Howes, 2023). Furthermore, community-based adaptation practices, such as traditional water harvesting techniques and local storage solutions (e.g., sand dams), improve resilience to water scarcity while empowering local populations (Rankoana, 2020). Participatory approaches also ensure that adaptation strategies are culturally relevant and address the specific needs of vulnerable communities (IPCC, 2022). Lastly, 80.5% of the respondents said they have not adopted any practice to cope with changes in water resource availability, while only 19.5% reported they have made personal efforts. Among those who responded yes, 65.3% said they dug boreholes to have adequate water supply, 20.8% said they were using water-efficient appliances, and 13.9% said they were into rain harvesting.

Conclusion

This study provides insight into public perceptions of climate change implications on water resources and examines adaptation strategies. Findings revealed moderate awareness of climate change among the general public, which strongly correlates to individuals' level of education. However, the study found a lack of individual and community-driven climate change water resources challenges. The findings highlight the critical need for sustainable water resource management, enhanced community engagement, water resource-related infrastructural development, and policy to address the looming threats posed by climate change on water resource availability.

Additionally, the study found that a few people have adopted strategies to enhance their resilience to water-related challenges such as sinking boreholes, use of water-efficient appliances, and rain harvesting. This necessitates sensitization of the general public on sustainable adaptive strategies to climate change. The study recommends focusing on community-based activities, strengthening water-related infrastructure, and providing a regulatory framework to enhance resilience to climate change. By addressing these gaps, policymakers can better equip communities to cope with the decreasing availability of water resources and minimize the adverse effects of climate change.

REFERENCES

Abbas, M., Zhao, L., & Wang, Y. (2022). Perspective Impact on Water Environment and Hydrological Regime Owing to Climate Change: A Review. *Hydrology*, *9*(11), 203. https://doi.org/10.3390/hydrology9110203

Abubakar, M. L., & Abdussalam, A. F. (2024). Geospatial analysis of land use changes and wetland dynamics in Kaduna Metropolis, Kaduna, Nigeria. *Science World Journal*, *19*(3), 687–696. https://doi.org/10.4314/swj.v19i3.15

Abubakar, M. L., Abdussalam, A. F., Ahmed, M. S., & Wada, A. I. (2024a). Spatiotemporal variability of rainfall and drought characterization in Kaduna, Nigeria. *Discover Environment*, *2*(1). https://doi.org/10.1007/s44274-024-00112-7

Abubakar, M. L., Ahmed, M. S., & Abdussalam, A. F. (2024b). Assessment of Agricultural Drought Using Vegetation Condition Index and Vegetation Health Index in Niger River Basin, Nigeria. *Geosfera Indonesia*, *9*(2), 101. https://doi.org/10.19184/geosi.v9i2.45185

Abubakar, M. L., Ahmed, M. S., Abdussalam, A. F., & Mohammed, S. (2025). Meteorological drought and long-term trends and spatial variability of rainfall in the Niger River Basin, Nigeria. *Environmental Science and Pollution Research*, *32*(9), 5302–5319. https://doi.org/10.1007/s11356-025-36048-5

Ahmed, M. S., Abubakar, M. L., Lawal, A. I., & Richifa, K. I. (2024). Influence of extreme temperature on adverse pregnancy outcomes in Kaduna State, Nigeria. *Science World Journal*, *19*(2), 409–417. https://doi.org/10.4314/swj.v19i2.17

Ardoin, N. M., Bowers, A. W., & Gaillard, E. (2020). Environmental education outcomes for conservation: A systematic review. *Biological Conservation*, *241*, 108224. https://doi.org/10.1016/j.biocon.2019.108224

Ariyo, O. C., Usman, M. B., Alabi, O. F., Olagunju, O. E., & Omodona, S. (2021). Determinants of productivity among beneficiaries and non- beneficiaries farmers of third national fadama development project in Kaduna north local government area of Kaduna state, Nigeria. *Ethiopian*

Journal of Environmental Studies and Management, *14*(5), 654–664.

Atedhor, G. O. (2016). Growing Season Rainfall Trends, Alterations and Drought Intensities in the Guinea Savanna Belt of Nigeria: Implications on Agriculture. *Journal of Environment and Earth Science*, *6*(3), 5–17.

Ayanlade, A., & Jegede, M. O. (2016). Climate Change Education and Knowledge among Nigerian University Graduates. *Weather, Climate, and Society*, *8*(4), 465–473. https://doi.org/10.1175/WCAS-D-15-0071.1

Baba, B. M., Abubakar, M. L., Raji, R. B., & Ibrahim, R. (2020). Spatial Distribution of Electric Transformers in Narayi Ward, Chikun Local Government Area of Kaduna State, Nigeria. *Kaduna Journal of Geography*, *2*(2), 114–130. https://doi.org/10.5281/zenodo.14598765

Bardosh, K. (2015). Achieving "Total Sanitation" in Rural African Geographies: Poverty, Participation and Pit Latrines in Eastern Zambia. *Geoforum*, *66*, 53–63. https://doi.org/10.1016/j.geoforum.2015.09.004

Bartlett, J. A., & Dedekorkut-Howes, A. (2023). Adaptation strategies for climate change impacts on water quality: a systematic review of the literature. *Journal of Water and Climate Change*, *14*(3), 651–675. https://doi.org/10.2166/wcc.2022.279

Biswas, R. R., & Rahman, A. (2023). Adaptation to climate change: A study on regional climate change adaptation policy and practice framework. *Journal of Environmental Management*, *336*(July 2022), 117666. https://doi.org/10.1016/j.jenvman.2023.117666

Ciampittiello, M., Marchetto, A., & Boggero, A. (2024). Water Resources Management under Climate Change: A Review. *Sustainability*, *16*(9), 3590. https://doi.org/10.3390/su16093590

Cochran, W. G. (1953). *Sampling Techniques*. John Wiley & Sons.

Darabinia, M., Heidari Gorji, A., & Gholami, S. (2017). Self-care study in the Iranian medical students based on Islamic thought. *Journal of Nursing Education and Practice*, *7*(9), 85. https://doi.org/10.5430/jnep.v7n9p85

Delbiso, T. D., Asfaw, F. M., Moges, T., Ero, D., & Kotecho, M. G. (2024). Food insecurity among low-income households in Addis Ababa, Ethiopia. *Heliyon*, *10*(8), e29633. https://doi.org/10.1016/j.heliyon.2024.e29633

GRID3 - Nigeria. (2024). *Geo-Referenced Infrastructure and Demographic Data for Development*. National Space Research and Development Agency.

Hess, D. J., & Collins, B. M. (2018). Climate change and higher education: Assessing factors that affect curriculum requirements. *Journal of Cleaner Production*, *170*, 1451–1458. https://doi.org/10.1016/j.jclepro.2017.09.215

Hoekstra, A. G., Noordzij, K., de Koster, W., & van der Waal, J. (2024). The educational divide in climate change attitudes: Understanding the role of scientific knowledge and subjective social status. *Global Environmental Change*, *86*, 102851. https://doi.org/10.1016/j.gloenvcha.2024.102851

Ifabiyi, P., & Ashaolu, E. D. (2015). Spatio-temporal pattern of rainfall distribution over Ilorin metropolis, Nigeria. *Scientia Africana*, *14*(2), 229–247.

Independent National Electoral Commission (INEC). (2015). *Directory of Polling Units Plateau State, Federal Republic of Nigeria. Revised January 2015.*

IPCC. (2022). *IPCC Sixth Assessment Report: Summary for Policymakers*.

Jibril, M. S., Ariyo, M. O., Butu, A. W., & Emeribe, C. N. (2021). EFFECTS OF HUMAN ACTIVITIES ON THE AFAKA AFFORESTATION PROJECT, KADUNA NORTH, KADUNA STATE, NIGERIA. *Jurnal Geografi Lingkungan Tropik*, *5*(2). https://doi.org/10.7454/jglitrop.v5i2.133

Johnson, T., Butcher, J., Santell, S., Schwartz, S., Julius, S., & LeDuc, S. (2022). A review of climate change effects on practices for mitigating water quality impacts. *Journal of Water and Climate Change*, *13*(4), 1684–1705. https://doi.org/10.2166/wcc.2022.363

Krejcie, R. V., & Morgan, D. W. (1970). Determining Sample Size for Research Activities. *Educational and Psychological Measurement*, *30*, 607–610. https://doi.org/10.1891/9780826138446.0006

Luo, M., Meng, F., Liu, T., Duan, Y., Frankl, A., Kurban, A., & De Maeyer, P. (2017). Multi–Model Ensemble Approaches to Assessment of Effects of Local Climate Change on Water Resources of the Hotan River Basin in Xinjiang, China. *Water*, *9*(8), 584. https://doi.org/10.3390/w9080584

Marquardt, J., Fünfgeld, A., & Elsässer, J. P. (2023). Institutionalizing climate change mitigation in the Global South: Current trends and future research. *Earth System Governance*, *15*(June 2022). https://doi.org/10.1016/j.esg.2022.100163

Midgley, G., Marais, S., Barnett, M., & Wågsæther, K. (2012). *Biodiversity, Climate Change and Sustainable Development–Harnessing Synergies and Celebrating Successes. Final Technical Report*.

Momeni, A., Pincus, M., & Libien, J. (2018). Cross Tabulation and Categorical Data Analysis. In *Introduction to Statistical Methods in Pathology* (pp. 93–120). Springer International Publishing. https://doi.org/10.1007/978-3-319-60543-2_5

Mugambiwa, S. S. (2018). Adaptation measures to sustain indigenous practices and the use of indigenous knowledge systems to adapt to climate change in Mutoko rural district of Zimbabwe. *Jàmbá: Journal of Disaster Risk Studies*, *10*(1). https://doi.org/10.4102/jamba.v10i1.388

Munoz-Jofre, J., Hinojosa, S., Mascle-Allemand, A.-L., & Temprano, J. (2023). A selectivity index for public-private partnership projects in the urban water and sanitation sector in Latin America and the caribbean. *Journal of Environmental Management*, *335*, 117564. https://doi.org/10.1016/j.jenvman.2023.117564

Musa, K., & Abubakar, M. L. (2024). Monitoring urban growth and landscape fragmentation in Kaduna, Nigeria, using remote sensing approach. *Journal of Degraded and Mining Lands Management*, *12*(1), 6757–6769. https://doi.org/10.15243/jdmlm.2024.121.6757

Mwadzingeni, L., Mugandani, R., & Mafongoya, P. L. (2022). Socio-demographic, institutional and governance factors influencing adaptive capacity of smallholder irrigators in Zimbabwe. *PLOS ONE*, *17*(8), e0273648. https://doi.org/10.1371/journal.pone.0273648

Nwankwo, B., Kakamor, M. D., Usman, N. O., Omole, V. N., & Oyefabi, A. M. (2023). Knowledge and preventive practices regarding malnutrition among mothers of under-fives in Kaduna North Local Government Area. *Journal of Clinical Sciences*, *20*(2), 52–58. https://doi.org/10.4103/jcls.jcls_2_23

Pizzorni, M., Innocenti, A., & Tollin, N. (2024). Droughts and floods

in a changing climate and implications for multi-hazard urban planning: A review. *City and Environment Interactions*, *24*, 100169. https://doi.org/10.1016/j.cacint.2024.100169

Putra, A. S. B., & Wibowo, S. (2023). Increasing Production Efficiency in Handicraft Small Industries in West Java Through the Utilization of Technological Innovation. *West Science Journal Economic and Entrepreneurship*, *1*(04), 145–152. https://doi.org/10.58812/wsjee.v1i04.391

Rankoana, S. A. (2020). Climate change impacts on water resources in a rural community in Limpopo province, South Africa: a community-based adaptation to water insecurity. *International Journal of Climate Change Strategies and Management*, *12*(5), 587–598. https://doi.org/10.1108/IJCCSM-04-2020-0033

United Nations Global Compact (UNGC). (2009). *"Climate change and the global water crisis: what businesses need to know and do", May 2009*.

WMO. (2024). *State of the Global Climate 2023*.

Wonneberger, A., Meijers, M. H. C., & Schuck, A. R. T. (2020). Shifting public engagement: How media coverage of climate change conferences affects climate change audience segments. *Public Understanding of Science*, *29*(2), 176–193. https://doi.org/10.1177/0963662519886474

World Bank. (2003). *World Development Report 2003: Sustainable Development in a Dynamic World. Transforming Institutions, Growth and Quality of Life.*