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Adaptive Capacity and Climate Change Impacts in Agro-ecological zones of Taraba State, Nigeria

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ABSTRACT

Climate change threatens agricultural productivity and rural livelihoods in Sub-Saharan Africa, where communities are heavily dependent on climate-sensitive resources. Taraba State, Nigeria, with its diverse agro-ecological zones, provides a unique setting for examining how adaptive capacity varies across ecological contexts. Data were collected from 1,067 household heads across seven Local Government Areas using questionnaires, focus group discussions, key informant interviews, and field observations. Adaptive capacity was measured using five livelihood indicators: wealth, farm inputs, availability of infrastructure and institutions, irrigation potential, and literacy level. A five-point Likert scale and Chi-square test were employed to assess and compare adaptive capacity across agro-ecological zones. Findings indicate significant variation in adaptive capacity across zones. Communities with higher access to infrastructure, irrigation, and education exhibited stronger resilience, while poorer and more remote communities were found to be more vulnerable. The results also reveal that socio-economic conditions strongly influence adaptation practices, with literacy and institutional support emerging as critical factors. Strengthening livelihood assets and enhancing institutional frameworks are vital for building climate resilience in Taraba State. The study provides evidence for policymakers to design localized adaptation strategies tailored to the ecological and socio-economic realities of Nigeria's diverse regions.

Keywords: *Adaptive capacity, Agro-ecological zones, Climate change, Resilience, Taraba State.*

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Introduction

Climate change poses a formidable challenge to agriculture and livelihoods across Sub-Saharan Africa, with shifts in temperature, rainfall variability, and extreme weather events undermining production systems and rural well-being [1, 2]. In regions where farming is predominantly rain-fed and smallholder-based, such as much of Nigeria, these climatic stressors heighten vulnerability and disrupt food security [3]. Nigeria in particular has been identified as a climate hotspot, where changes in precipitation patterns and increased temperatures compound existing socio-economic and infrastructural fragilities [4, 5].

Taraba State, situated in northeastern Nigeria, spans a diversity of agro-ecological zones from the Sudan and Guinea savannas to the montane ecosystems of the Mambilla Plateau, each characterized by distinct climatic conditions, soil profiles, and cropping systems. These variations influence both exposure to climate hazards and the capacity to adapt [6, 7]. Empirical studies document that local farmers overwhelmingly perceive climate change impacts in Northern Taraba; 90% of farmers report reduced rainfall, flooding, and extreme heat as affecting their livelihoods, yet fewer than half understand the causes [8]. Similarly, in Taraba South, farmers report shifting rainfall patterns, dry spells, excessive precipitation, and low yields as primary symptoms of a changing climate, with widespread recognition of these effects on crop production [9]. Adaptive practices are diverse: in Northern Taraba, both arable farmers and pastoralists rely on indigenous knowledge forecasting, such as phenological signs and animal behavior to anticipate rainfall patterns and plan farming activities [10].

Still, adaptation is constrained by socio-economic and infrastructural limitations: among rice farmers in Wukari LGA, significant determinants of adaptation include age, education, household size, and cooperative membership, while constraints include limited finance, inadequate irrigation, and the cost of inputs [11]. More broadly, adaptation is impeded by poor access to climate information (e.g., weather forecasts), insufficient financial resources, and a lack of improved seeds or technologies [12]. At the community and policy levels, Taraba has recently undertaken significant climate resilience actions: the state government has launched large-scale reforestation efforts, planting three million trees under the Agro-Climate Resilience in Semi-Arid Landscapes (ACReSAL) project to mitigate land degradation and climate risks, and rolled out climate-smart input distributions, tractors, and community resilience funds to support farmers [13].

Despite such efforts, cross-zone evaluations remain limited: there is still a lack of systematic analysis of how climate impacts, perceptions, and adaptive behaviors vary across Taraba's agro-ecological zones, and how socio-economic factors and institutional support mediate household resilience. This study addresses this gap by (1) mapping spatial variations in climate change impacts across Taraba's agro-ecological zones; (2) assessing household-level adaptive capacity determinants; and (3) identifying opportunities and barriers for resilience enhancement. By integrating climatic trends, farmer awareness, adaptation behaviors, and policy interventions, the study aims to inform context-specific strategies for bolstering agricultural resilience within the state and in national adaptation planning frameworks.

Conceptual Framework

This study adopts an asset-based framework for assessing adaptive capacity, which emphasizes the importance of livelihood assets in shaping how communities respond to climate change. Adaptive capacity is not evenly distributed; it depends on the resources, skills, and institutions available to households and communities [14]. In particular, the Local Adaptive Capacity (LAC) framework suggests that adaptive capacity is strengthened when households have access to multiple forms of capital, financial, physical, human, social, and informational, which together enable effective decision-making and long-term resilience [15].

Building on this theoretical foundation, previous empirical studies in Sub-Saharan Africa [16, 17] have demonstrated that livelihood assets provide the most practical and measurable indicators of adaptive capacity at the community level. These studies consistently highlight that access to wealth, farm inputs, institutions, irrigation facilities, and education strongly determine how households respond to climate-related risks. Similar conclusions are drawn by [18], who stresses that adaptive capacity is best understood as the interaction of multiple livelihood assets that collectively buffer communities against shocks and enhance resilience.

Accordingly, this study operationalizes adaptive capacity using five key indicators: Wealth (W), Farm Inputs (FI), Availability of Infrastructure and Institutions (AII), Irrigation Potential (IP), and Literacy Level (LL). Each of these indicators represents a vital livelihood asset that shapes households' ability to cope with and adapt to climate stressors. For instance, wealth influences the ability to invest in adaptive technologies, while literacy enhances access to climate information and innovation. Likewise, infrastructure and institutions provide both physical access and governance support, while irrigation and farm inputs determine agricultural productivity under variable climatic conditions.

The framework conceptualizes adaptation as a progression from assets to outcomes: livelihood assets aggregate into adaptive capacity, which in turn determines community resilience and broader climate change adaptation outcomes. The relationship is dynamic, where improvement in one asset (such as education) can amplify the effectiveness of others (such as access to infrastructure). This asset-based perspective ensures that adaptive capacity is measurable, comparable across communities, and directly linked to policy interventions that can strengthen resilience.

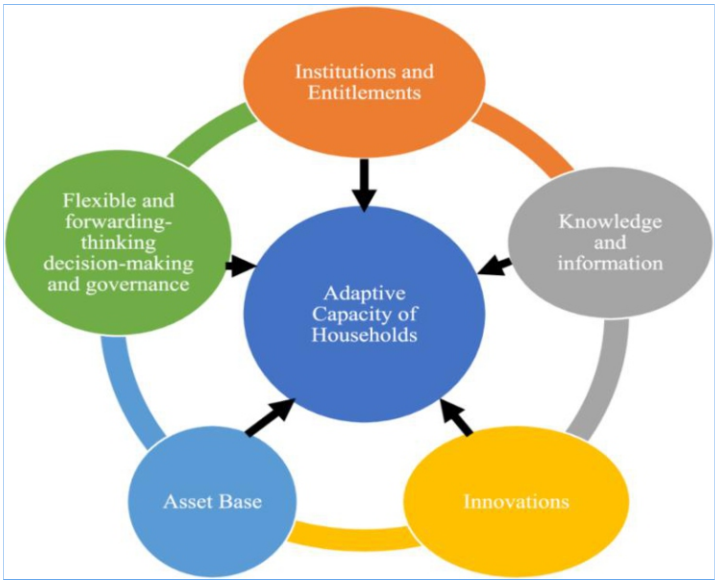

Figure 1: Conceptual framework for assessing adaptive capacity to climate change
(Adapted from Deressa [16]; Gbetibouo [17]; Jones [15]

Figure 1 illustrates the conceptual framework used in this study. It shows how the five selected livelihood assets, wealth, farm inputs, infrastructure and institutions, irrigation potential, and literacy level contribute collectively to adaptive capacity. Adaptive capacity then shapes community resilience and influences climate change adaptation outcomes.

Methodology

This study was carried out across seven Local Government Areas (LGAs) of Taraba State, Nigeria: Lau, Karim Lamido, Gassol, Gashaka, Bali, Kurmi, and Sardauna, selected to represent the state's major agro-ecological zones, namely the Sudan Savannah, Northern Guinea Savannah, Southern Guinea Savannah, and the Montane zone. These zones are characterized by ecological diversity, distinct climatic regimes, and variations in livelihood strategies, making them suitable for a comparative assessment of adaptive capacity [6, 7].

The total projected population of the study area in 2023 was 1,961,136, estimated from the 2006 National Population Census figures (NPC, 2006) using the exponential growth method of Mehta [19]. The population distribution across LGAs is presented in Table 1.

Population projections followed the exponential growth model:

Pn=Po(1+R/100)nPn = Po (1 + R/100)^n

Where:

Pn = Projected population in year *n*

Po = Base year population

R = Annual growth rate

n = Number of years between the base and projection year

Applying this method produced the following 2023 population estimates: Gassol (418,671), Karim Lamido (331,273), Gashaka (148,902), Bali (360,485), Lau (162,610), Kurmi (155,934), and Sardauna (383,261). These figures formed the basis for sample allocation.

The study adopted a sample size of 1,067 household heads, calculated using a 5% margin of error at a 95% confidence level, in line with the recommendations of Saunders, Lewis, and Thornhill [20]. This sample size is adequate for large populations and allows for generalizable conclusions across the study area. A proportional allocation method was used to ensure fair representation of respondents across LGAs. The formula applied was:

Qi=(Fi/P)×NQi = (Fi / P) \times N

Where:
Qi = Sample from each LGA
Fi = LGA population
P = Total population of all LGAs
N = Total sample size (1,067)
The resulting distribution was: Lau (88), Karim Lamido (180), Gassol (228), Gashaka (81), Bali (196), Kurmi (85), and Sardauna (209). This approach ensured that larger LGAs contributed proportionately more respondents, enhancing representativeness [21].

Research Design and Data Collection
A mixed-method design combining quantitative and qualitative approaches was adopted to provide a comprehensive understanding of adaptive capacity. This design allows triangulation of findings, thereby increasing validity and reliability [22].
Structured questionnaires were administered to household heads aged 40 years and above who had resided in their communities for at least 30 years. This criterion ensured that respondents had long-term experience of environmental and climatic changes. The questionnaire included sections on socio-economic characteristics, livelihood strategies, climate change perceptions, and adaptive responses.
FGDs were held in each LGA, with a minimum of six participants per session. Participants included community leaders, farmers, and long-term residents. Discussions explored historical and recent climate patterns, environmental shocks (e.g., droughts, floods), and coping strategies. Both male and female participants were included to capture gendered perspectives on climate impacts and adaptation [23].
KIIs were conducted with officials from government agencies, non-governmental organizations (NGOs), community-based organizations (CBOs), academics, and traditional leaders. These interviews provided insights into institutional responses, policies, and the role of local governance in facilitating adaptation.
Direct observations were carried out to assess physical conditions such as soil degradation, flood-prone areas, infrastructure quality, and evidence of adaptive practices (e.g., irrigation use, agroforestry).
These observations served as a baseline for validating survey and FGD findings [24]. Before the main fieldwork, a reconnaissance survey was undertaken to establish rapport with communities, refine instruments, and understand the socio-cultural context of the study areas.
Adaptive capacity was measured using five livelihood asset indices identified in previous studies [16, 17]:
I. Wealth (W)
ii. Farm inputs (FI)
iii. Availability of infrastructure and institutions (AII)
iv. Irrigation potential (IP)
v. Literacy level (LL)

These indicators are widely cited as robust measures of adaptive capacity [14, 25]. Data for each indicator were collected using a five-point Likert scale (5 = strongly agree, 4 = agree, 3 = undecided, 2 = disagree, 1 = strongly disagree).
The adaptive capacity index (AC) was computed as:
AC=(W+FI+AII+IP+LL)5AC = \frac{(W + FI + AII + IP + LL)}{5}
Classification of adaptive capacity followed mean score ranges:
- 0.00–2.49 = Low adaptive capacity
- 2.50–3.49 = Moderate adaptive capacity
- 3.50–5.00 = High adaptive capacity

The collected data were analyzed using both descriptive and inferential statistical methods. Descriptive statistics (frequency tables, percentages, means, and standard deviations) were used to summarize household characteristics, perceptions of climate change, and adaptive strategies.
To test the relationships between variables such as adaptive capacity and socio-economic characteristics (e.g., literacy, income, and access to infrastructure), the Chi-square test (χ2\chi^2χ2) was employed. The test helped to determine whether observed differences in adaptive capacity across LGAs and agro-ecological zones were statistically significant at the 95% confidence level (p<0.05p < 0.05p<0.05). Qualitative data from FGDs and KIIs were thematically analyzed, coded, and triangulated with survey findings to provide context and a deeper understanding of adaptive strategies.

Result of the Findings

Adaptation Capacity towards Minimizing the Impacts of Climate Change

Table 1. Wealth Consideration as an Adaptation Capacity towards the Impact of Climate Change

	Sudan Savannah	Northern Guinea Savannah	Southern Guinea Savannah	Montane	Mean	Rank
Do you have other means of livelihood apart from farming?	4.3346	4.3592	4.4982	4.4498	4.4104	1st
Do you have a radio or television (TV) sets to listen and watch programs related to climate change	3.5465	4.2362	3.5160	3.5694	3.7170	2nd
Do you live in a high-quality house	3.8662	3.9935	3.3701	3.0431	3.5682	3rd
Are you involved in a community or individual level income savings?	3.8736	3.8803	2.7580	2.9426	3.3636	4th
Mean	**3.9052**	**4.1173**	**3.5356**	**3.5012**		
Rank	**2nd**	**1st**	**3rd**	**4th**		

Table 1 assesses wealth-related indicators as measures of adaptive capacity to climate change across different agroecological zones in Taraba State. The findings show that households in the Northern Guinea Savannah zone have the highest average level of adaptive capacity (mean = 4.1173), followed by those in the Sudan Savannah (3.9052), Southern Guinea Savannah (3.5356), and the Montane zone (3.5012). Among the specific indicators, having alternative means of livelihood apart from farming ranks highest (mean = 4.4104), suggesting that economic diversification is a key adaptation strategy among rural households. This is followed by ownership of radio or television sets (mean = 3.7170), which enables access to climate-related information. Living in a high-quality house (mean = 3.5682) and participation in savings activities (mean = 3.3636) rank third and fourth, respectively, indicating that material and financial assets also contribute to adaptive capacity. Overall, the data suggest that wealth indicators significantly influence the ability of households to respond to climate impacts, with regional differences reflecting varying levels of resilience and resource access.

Table 2. Test of Association between Wealth Consideration as an Adaptation Capacity towards Climate Change and the Agroecological Zones

	Value	df	Asymp. Sig. (2-sided)
Do you have other means of livelihood apart from farming?	41.624[a]	12	.000
Do you have a radio or television (TV) sets to listen and watch programs related to climate change	272.443[a]	12	.000
Do you live in a high-quality house	213.554[a]	12	.000
Are you involved in a community or individual level income savings?	267.571[a]	12	.000

Table 2 presents the test of association between wealth-related adaptation indicators and agroecological zones using the Chi-square test. All four indicators - alternative livelihoods, access to radio or TV, quality of housing, and participation in savings show statistically significant associations with agroecological zones (p-value = .000). This indicates that households' wealth status and adaptive capacity to climate change vary significantly across different agroecological zones in Taraba State. For instance, ownership of radios/TVs and engagement in savings practices are more common in certain zones, likely due to differences in socio-economic development, infrastructure, and access to resources. These findings highlight the importance of location-specific strategies in enhancing adaptive capacity to climate change impacts.

Table 3. Indices of Adaptive Capacity Approaches to Climate Change

	Sudan Savannah	Northern Guinea Savannah	Southern Guinea Savannah	Montane	Mean	Rank
Engineering works such as redirecting rivers is an indices of adaptive capacity approaches to climate change	4.1970	4.1521	4.2705	4.2057	4.2063	1st
Technology such as green roofs is an indices of adaptive capacity approaches to climate change	3.4015	4.0065	3.3879	3.5885	3.5961	2nd
Ecosystem based: re-establishing wetlands is an indices of adaptive capacity approaches to climate change7	3.8922	3.9482	3.3167	3.3110	3.6170	3rd
Effective Enforcement of Laws and Regulations is an indices of adaptive capacity approaches to climate change	3.6431	3.9223	2.7900	2.8373	3.2982	4th
Economics tools such as insurance is an indices of adaptive capacity approaches to climate change	4.0074	3.7443	2.8932	2.7225	3.3419	5th
Information such as early warning is an indices of adaptive capacity approaches to climate change	4.1784	3.9385	2.9644	3.3541	3.6089	6th
Social services such as providing food banks is an indices of adaptive capacity approaches to climate change	3.7398	4.1392	4.5125	4.4163	4.2019	7th
Bahavioural change such as rain water harvesting is an indices of adaptive capacity approaches to climate change	3.7063	4.0324	3.5480	3.3828	3.6674	8th
Government policies, programs, services such as tax incentives to promote renewable energy sources	3.9777	3.9353	2.9075	2.9474	3.4420	9th
Mean	**3.8604**	**3.9799**	**3.3990**	**3.4184**		
Rank	**2nd**	**1st**	**4th**	**3rd**		

Table 3 presents the indices of adaptive capacity approaches to climate change across different agroecological zones, highlighting variations in how rural households perceive and apply various adaptation strategies. Engineering solutions, such as redirecting rivers, are the most recognized approach overall, with the highest mean score of 4.2063, followed by technology-based approaches like green roofs and ecosystem-based methods such as restoring wetlands. Social services, including food banks, rank highly, particularly in the Southern and Montane zones, reflecting their importance in vulnerable communities. In contrast, economic tools like insurance, government policies such as incentives for renewable energy, and law enforcement scored lower, suggesting limited awareness, access, or effectiveness in some regions. Among the zones, the Northern Guinea Savannah shows the highest overall adaptive capacity index, indicating better infrastructure, information access, or institutional support, while the Southern Guinea Savannah has the lowest scores, signaling a greater need for targeted climate resilience interventions. This data underscores the necessity for multi-dimensional, zone-specific strategies to effectively enhance adaptive capacity to climate change.

Table 4. Test of Association between Indices of Adaptive Capacity Approaches to Climate Change and the Agroecological Zones

	Chi-Square Tests		
	Value	df	Asymp. Sig. (2-sided)
Engineering works such as redirecting rivers is an indices of adaptive capacity approaches to climate change	80.181[a]	12	.000
Technology such as green roofs is an indices of adaptive capacity approaches to climate change	163.664[a]	12	.000
Ecosystem based: re-establishing wetlands is an indices of adaptive capacity approaches to climate change	121.906[a]	12	.000
Effective Enforcement of Laws and Regulations is an indices of adaptive capacity approaches to climate change	262.198[a]	12	.000
Economics tools such as insurance is an indices of adaptive capacity approaches to climate change	196.409[a]	12	.000
Information such as early warning is an indices of adaptive capacity approaches to climate change	219.571[a]	12	.000
Social services such as providing food banks is an indices of adaptive capacity approaches to climate change	252.349[a]	12	.000
Behavioural change such as rain water harvesting is an indices of adaptive capacity approaches to climate change	200.086[a]	12	.000
Government policies, programs, services such as tax incentives to promote renewable energy sources	193.655[a]	12	.000

Table 4 shows the results of Chi-square tests examining the association between various adaptive capacity approaches to climate change and the different agroecological zones. All tested indices including engineering works (like redirecting rivers), technology (such as green roofs), ecosystem-based approaches (like re-establishing wetlands), enforcement of laws, economic tools (e.g., insurance), information systems (early warning), social services (food banks), behavioral changes (rainwater harvesting), and government policies show statistically significant associations with agroecological zones ($p < 0.01$). This means that perceptions or implementation of these adaptive approaches vary significantly across the different zones, indicating that adaptation strategies are influenced by local ecological and socio-economic conditions.

Table 5. Infrastructural and Institutional availability is an index of adaptive capacity to climate change

	Sudan Savannah	Northern Guinea Savannah	Southern Guinea Savannah	Montane	Mean	Rank
You have good sources of domestic water supply	4.2045	3.9417	3.9858	4.2775	4.1024	1st
You have good road system for transportation	3.0743	3.6667	3.1815	3.1818	3.2761	2nd
You have good health facilities in your community	3.4238	3.6149	3.1032	3.2536	3.3489	3rd
You have good schools in your community	3.4870	3.5599	3.0712	2.7608	3.2197	4th
You have access to formal and informal credit community-based loaning institution in your community	3.4126	3.1942	2.9573	2.8421	3.1016	5th
Your community is electrified and has regular electric power supply	3.6171	3.5307	3.2633	3.3493	3.4401	6th
You are involve in farmers' cooperative in your community	3.5279	3.3981	2.9217	3.2536	3.2753	7th
You have access to newspapers and agricultural books	3.7100	3.4337	3.1744	3.1531	3.3678	8th
You have good space for domesticating animal/poultry etc.	4.1784	3.5081	2.8612	2.4976	3.2613	9th
Mean	**3.6262**	**3.5387**	**3.1688**	**3.1744**		
Rank	**1st**	**2nd**	**4th**	**3rd**		

Table 5 presents the availability of infrastructural and institutional resources as indicators of adaptive capacity to climate change across four agroecological zones. The results show that access to good sources of domestic water supply ranks highest overall, indicating it is the most available and crucial adaptive resource for rural households. This is followed by the presence of a good road system for transportation and access to health facilities, reflecting the importance of mobility and healthcare in adaptation. Other factors, such as access to schools, credit institutions, regular electricity, farmers' cooperatives, information sources (newspapers and agricultural books), and space for animal domestication, rank lower, suggesting more limited availability. The Sudan Savannah scores highest overall in terms of infrastructural and institutional availability, followed by the Northern Guinea Savannah, Montane, and lastly the Southern Guinea Savannah. This indicates that adaptive capacity related to infrastructure and institutions varies significantly by zone, with some areas having better resources to cope with climate change impacts than others.

Table 6. Test of Association between Infrastructural and Institutional availability is an index of adaptive capacity to climate change and the Agroecological_Zones

	Chi-Square Tests		
	Value	Df	Asymp. Sig. (2-sided)
You have good sources of domestic water supply	83.739[a]	15	.000
You have good road system for transportation	98.854[a]	12	.000
You have good health facilities in your community	162.380[a]	12	.000
You have good schools in your community	88.353[a]	12	.000
You have access to formal and informal credit community-based loaning institution in your community	111.545[a]	15	.000
Your community is electrified and has regular electric power supply	96.421[a]	12	.000
You are involved in farmers' cooperative in your community	118.232[a]	15	.000
You have access to newspapers and agricultural books	100.388[a]	12	.000
You have good space for domesticating animal/poultry etc.	222.959[a]	12	.000

Table 6 shows the results of tests examining the association between various infrastructural and institutional factors (considered as indices of adaptive capacity to climate change) and different agroecological zones. The Chi-square values are all statistically significant ($p = 0.000$), indicating that there is a strong and meaningful relationship between the availability of these resources and the agroecological zones. In other words, factors such as access to good domestic water supply, road systems, health facilities, schools, credit institutions, electricity, farmers' cooperatives, agricultural information, and space for animal domestication vary significantly across the different agroecological zones. This suggests that the level of infrastructural and institutional support available to rural households for adapting to climate change is not uniform but depends on their specific agroecological location.

Table 7. Irrigation Potentials as indices of Adaptive capacity to climate change

	Sudan Savannah	Northern Guinea Savannah	Southern Guinea Savannah	Montane	Mean	Rank
You have the potential of opening irrigation lands	4.0223	4.4239	4.4164	4.4211	4.3209	1st
You have rivers within your community boundaries	4.1859	4.0000	3.9715	3.7416	3.9748	2nd
Wide range of crops can be grown on the flood plain during dry seasons	3.9665	4.1942	3.4342	3.2632	3.7145	3rd
The flood plain is often used for irrigation during dry season	3.5799	4.2395	3.5801	3.4163	3.7039	4th
You are engaged in irrigation agriculture during dry season	3.5316	4.0550	3.0498	3.2297	3.4665	5th
You are a potential beneficiary of fadama developmental program	3.9071	3.5728	2.9146	2.7799	3.2936	6th
Mean	**3.8656**	**4.0809**	**3.5611**	**3.4753**		
Rank	**2nd**	**1st**	**3rd**	**4th**		

Table 7 presents irrigation potentials as important indices of adaptive capacity to climate change across different agroecological zones. The Northern Guinea Savannah scored highest overall, indicating the greatest irrigation potential, followed by the Sudan Savannah, Southern Guinea Savannah, and Montane zones. Specifically, the availability of irrigation lands is ranked first, with all zones showing high mean values, reflecting strong potential for irrigation development. Access to rivers within community boundaries ranks second, supporting irrigation possibilities. The capacity to grow a wide range of crops on flood plains during dry seasons and the use of flood plains for irrigation are also significant factors, ranked third and fourth, respectively, showing moderate potential in most zones. Engagement in irrigation agriculture during the dry season ranks fifth, with varying participation across zones. Lastly, the potential to benefit from developmental programs like the FADAMA initiative is ranked sixth, indicating lower but still relevant adaptive support. Overall, these findings highlight that irrigation capacity varies by zone, influencing the ability of rural households to adapt to climate change through water management and dry-season farming.

Table 8. Test of Association between Irrigation Potentials as indices of Adaptive capacity to climate change and the Agroecological Zones

	Chi-Square Tests		
	Value	df	Asymp. Sig. (2-sided)
You have rivers within your community boundaries	71.850[a]	12	.000
You have the potential of opening irrigation lands	98.344[a]	12	.000
The flood plain is often used for irrigation during dry season	174.149[a]	12	.000
Wide range of crops can be grown on the flood plain during dry seasons	181.986[a]	12	.000
You are engaged in irrigation agriculture during dry season	155.527[a]	12	.000
You are a potential beneficiary of fadama developmental program	150.858[a]	12	.000

Table 8 shows the results of Chi-Square tests examining the association between irrigation potentials considered as adaptive capacity indicators to climate change and different agroecological zones. All variables tested, including the presence of rivers within community boundaries, potential for opening irrigation lands, use of flood plains for dry season irrigation, ability to grow diverse crops on flood plains during dry seasons, engagement in dry season irrigation agriculture, and potential to benefit from the fadama developmental program, have Chi-Square values with p-values of .000. This indicates statistically significant associations between each irrigation potential factor and the agroecological zones. In other words, the irrigation-related adaptive capacities vary significantly across the different zones, reflecting differences in water resources, land characteristics, and access to irrigation programs depending on the specific ecological and geographic context of each zone.

Table 9. Level of adaptation capacity among the Agro-Ecological Zones

	Sudan Savannah	Northern Guinea Savannah	Southern Guinea Savannah	Montane	Mean
Wealth Consideration as Adaptive capacity to climate change	3.91	4.12	3.54	3.50	3.76
Indices of Adaptive capacity approaches to climate change	3.86	3.98	3.40	3.42	3.66
Infrastructural and Institutional availability is an index of adaptive capacity to climate change	3.63	3.54	3.17	3.17	3.38
Irrigation Potentials as indices of Adaptive capacity to climate change	3.87	4.08	3.56	3.48	3.75
Awareness level as Indices of Adaptive/resilience capacity to climate change	3.80	4.11	3.47	3.43	3.70
Mean	3.81	3.97	3.43	3.40	3.65

Note: 0.00 – 2.49 is Low adaptive, 2.50 – 3.49 is Moderately adaptive and 3.50-5.00 is Highly adaptive

Table 9 presents the level of adaptation capacity across four agro-ecological zones - Sudan Savannah, Northern Guinea Savannah, Southern Guinea Savannah, and Montane based on five key indicators: Wealth Consideration, Indices of Adaptive Capacity Approaches, Infrastructural and Institutional Availability, Irrigation Potentials, and Awareness Level related to climate change.

The mean scores for each zone show that the Northern Guinea Savannah has the highest overall adaptation capacity (mean = 3.97), followed by the Sudan Savannah (3.81), Southern Guinea Savannah (3.43), and the Montane zone (3.40). According to the given scale, scores between 3.50 and 5.00 indicate a "Highly adaptive" capacity, scores between 2.50 and 3.49 indicate "Moderately adaptive," and scores below 2.50 indicate "Low adaptive."

Based on these thresholds:

- Northern Guinea Savannah and Sudan Savannah zones are classified as highly adaptive, with mean scores above 3.5 across most indicators.
- Southern Guinea Savannah and Montane zones fall into the moderately adaptive category, with mean scores mostly between 3.17 and 3.56, showing comparatively lower adaptation capacities.

This suggests that people and communities in the Northern Guinea and Sudan Savannah zones possess stronger adaptive capacities to climate change, likely due to better wealth resources, infrastructure, irrigation potential, and awareness. Meanwhile, the Southern Guinea Savannah and Montane zones may require more targeted support to enhance their adaptive capacity.

Conclusion

This study has demonstrated that adaptive capacity to climate change in Taraba State varies significantly across agro-ecological zones, reflecting differences in socio-economic resources, institutional support, and ecological conditions. Communities with greater access to infrastructure, irrigation facilities, and educational opportunities exhibited higher resilience, while remote and resource-poor areas were found to be more vulnerable. The findings confirm that adaptive capacity is a function of livelihood assets, with wealth, literacy, and institutional presence emerging as critical determinants of households' ability to cope with climate variability and shocks.

The implications are twofold. First, climate change adaptation strategies in Taraba State should be context-specific, recognizing the distinct challenges and opportunities across the Sudan Savannah, Guinea Savannah, and Montane zones. Second, targeted interventions that strengthen rural infrastructure, expand access to agricultural inputs, promote irrigation technologies, and invest in human capital development are essential for enhancing resilience. Furthermore, building strong local institutions and community-based organizations will provide the governance framework necessary to support sustainable adaptation.

Overall, the study highlights the urgent need for integrated adaptation planning that bridges ecological and socio-economic disparities. By aligning policies with the realities of vulnerable communities, Taraba State can strengthen its adaptive capacity and safeguard livelihoods in the face of climate change.

Recommendations

Based on the findings of the study, the following recommendations were made;

I. Improve Infrastructure and Institutional Support (Infrastructure/Institutions): Strengthen rural infrastructure such as roads, storage facilities, and markets, while empowering local institutions and extension services to deliver climate information and adaptation training. This will enhance farmers' access to services and governance structures critical for adaptation.

ii. Expand Irrigation and Water Management (Irrigation Potential): Develop small- and medium-scale irrigation schemes, promote water harvesting technologies, and rehabilitate existing irrigation systems to reduce dependence on erratic rainfall and ensure sustainable year-round farming.

iii. Support Access to Inputs and Credit (Farm Inputs): Provide timely access to improved seeds, fertilizers, and adaptive crop varieties, alongside affordable credit schemes and crop insurance. This will enable smallholders to manage risks and adopt more resilient farming practices.

iv. Promote Literacy and Climate Education (Literacy): Integrate climate change awareness into literacy programs, expand farmer field schools, and support climate education at the community level. Improved literacy enhances farmers' ability to interpret climate information and make informed adaptation decisions.

v. Strengthen Livelihood Assets and Wealth Creation (Wealth): Encourage livelihood diversification through value addition, non-farm employment, and cooperatives to reduce dependence on climate-sensitive agriculture. Strengthening household wealth buffers enhances resilience to shocks and long-term climate risks.

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