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Impacts of seasonal climate fluctuations on water accessibility and livelihoods in rural communities of Mopa Muro Lga, Kogi State

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Abstract
This study was motivated by the increasing impacts of seasonal climate fluctuations on water accessibility and rural livelihoods across Nigeria, which threaten agricultural productivity and household well-being. The research aimed to assess how variations in rainfall patterns affect water availability, agricultural performance, and livelihood outcomes in Mopa Muro Local Government Area, Kogi State A mixed-methods approach was adopted, involving household surveys of 250 respondents, focus group discussions, and key informant interviews, complemented by a 30-year (1994–2024) rainfall data analysis to evaluate climatic variability. Descriptive and inferential analyses were used to examine the relationships between rainfall variability, water access, and livelihood indicators. Findings showed that mean annual rainfall was 1,320 mm, with a coefficient of variation of 18.7%, signifying high inter-annual variability. During the dry season, 73% of households experienced acute water shortages, and daily water availability dropped by 46% compared to the wet season. Crop yields of maize and yam declined by 28% and 22%, respectively, in below-average rainfall years, while 65% of respondents reported disrupted planting cycles and reliance on supplementary irrigation. Livestock rearing was also affected, with 58% of households reducing herd sizes. Economically, 68% reported income declines, and 54% experienced food insecurity. The discussion revealed that these outcomes align with broader findings in Kogi State and central Nigeria, underscoring how rainfall variability undermines water security and rural livelihoods. The study concludes that seasonal climate fluctuations substantially threaten water accessibility and livelihood stability in Mopa Muro LGA. It recommends investment in small-scale irrigation, expansion of borehole infrastructure, and adoption of climate-smart agriculture. The application of indigenous knowledge and integrated water resource management would strengthen community resilience, enhance productivity, and promote sustainable livelihoods under increasing climate variability.
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Keywords: *Climate variability, Rural livelihoods, Seasonal fluctuations, Water accessibility*

1. Introduction

Climate change has emerged as a significant global challenge, influencing various environmental and socio-economic systems. In sub-Saharan Africa, including Nigeria, the impacts of climate variability are particularly pronounced, affecting agriculture, water resources, and livelihoods. The Intergovernmental Panel on Climate Change (IPCC) has highlighted that Africa is highly vulnerable to climate change due to its dependence on rain-fed agriculture and limited adaptive capacity (IPCC, 2021). In Nigeria, studies have documented shifts in rainfall patterns, increased temperatures, and prolonged dry seasons, leading to water scarcity and agricultural stress (Ayanlade, *et al*., 2022; Akinyemi, *et al.,* 2022). These climatic changes have profound implications for rural communities, where access to water and sustainable livelihoods are increasingly threatened.

The study area experiences a tropical climate with distinct wet and dry seasons. However, recent observations indicate irregular rainfall distribution, prolonged dry spells, and unpredictable wet seasons, which adversely affect water availability and agricultural productivity. These climatic fluctuations exacerbate existing vulnerabilities in rural communities, where access to water is already limited and livelihoods are predominantly agrarian (Ojeh and Semaka,2021).

Water accessibility in rural Nigeria is a critical concern. Despite the country's abundant water resources, many rural communities face challenges in accessing safe and sufficient water. The World Health Organization (WHO) reports that a significant proportion of rural populations lack access to improved water sources, leading to health risks and reduced quality of life (WHO, 2020). In Mopa Muro LGA, the situation is compounded by seasonal climate fluctuations, which affect both the quantity and quality of available water sources (Ojeh and Semaka, 2021). These challenges are further intensified by inadequate infrastructure and limited institutional capacity to manage water resources effectively (Ojo, *et al.,* 2020).

The livelihoods of rural communities in the study area are intricately linked to water availability. Agriculture, the primary economic activity, relies heavily on consistent water supply for irrigation and livestock. Seasonal variations in water availability disrupt farming activities, leading to reduced crop yields, food insecurity, and economic instability (Ogunkolu, 2025). Moreover, the time and effort spent in sourcing water during dry periods detracts from productive activities, particularly affecting women and children (Fonjong, 2023). These gendered impacts underscore the need for gender-sensitive approaches in addressing water accessibility challenges (Ola, 2022).

Existing literature has extensively documented the impacts of climate variability on water resources and livelihoods in various parts of Nigeria. Studies by Ayanlade, *et al.* (2022) and Akinyemi, *et al.* (2022) have highlighted the adverse effects of climate change on water availability and agricultural productivity. However, there is a paucity of research focusing on the specific impacts of seasonal climate fluctuations on water accessibility and livelihoods in rural communities of Mopa Muro LGA. This gap in knowledge hinders the development of targeted interventions to mitigate the effects of climate variability in the region.

This study aims to fill this gap by assessing the impacts of seasonal climate fluctuations on water accessibility and livelihoods in rural communities of Mopa Muro LGA, Kogi State. The objectives are to examine the seasonal patterns of rainfall and temperature in Mopa Muro LGA, assess the availability and accessibility of water sources during different seasons, evaluate the impacts of seasonal climate fluctuations on agricultural productivity and household livelihoods, and identify coping strategies employed by communities to manage water scarcity during dry seasons.

2. Research methodology

2.1 Study area

Mopa Muro Local Government Area (LGA), situated in central Kogi State, Nigeria, lies roughly between latitudes 8°10'N and 8°25'N and longitudes 5°55'E and 6°10'E, with Mopa town serving as its administrative and commercial center as shown in Figures 1 and 2. The study area bordered by Ijumu, Kabba/Bunu, Yagba East, and Yagba West LGAs, the area benefits from road connections to Lokoja, the state capital, enhancing its regional economic interactions. The climate is tropical wet and dry, with a rainy season from April to October delivering 1,200 to 1,500 mm of rainfall annually and a dry season influenced by the Harmattan winds from November to March.

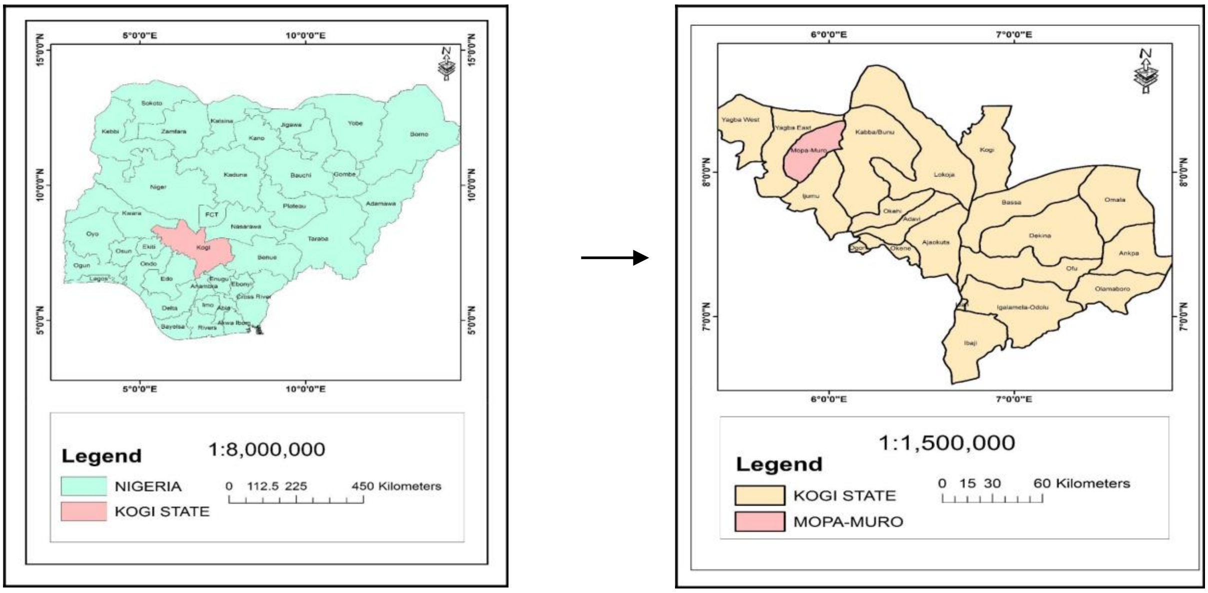

Figure 1: Map of Nigeria, Kogi State and Mopa Muro

Vegetation predominantly comprises derived savanna—a mix of scattered trees like locust bean and shea butter interspersed with grasses—reflecting both natural conditions and human activities such as farming and bush burning. The terrain is gently undulating, ranging from 300 to 500 meters above sea level, underlain by the Basement Complex geology of granite and schist, which shapes soil formation, drainage, and local construction. Soils are mainly ferruginous tropical types, moderately fertile but prone to leaching, supporting staple crops like yam, cassava, and maize. Land use centers on agriculture, with mixed cropping common alongside residential and commercial developments, while small-scale quarrying and sand mining also contribute to the economy. Socioeconomically, over 70% of the population engages in farming, supplemented by trading, artisanship, and civil service. The area has active markets and traditional crafts, though modernization has reduced some artisanal practices. Infrastructure such as roads, schools, and health centers exists but requires further development. Strong cultural cohesion and traditional institutions continue to influence community governance and conflict resolution within the LGA.

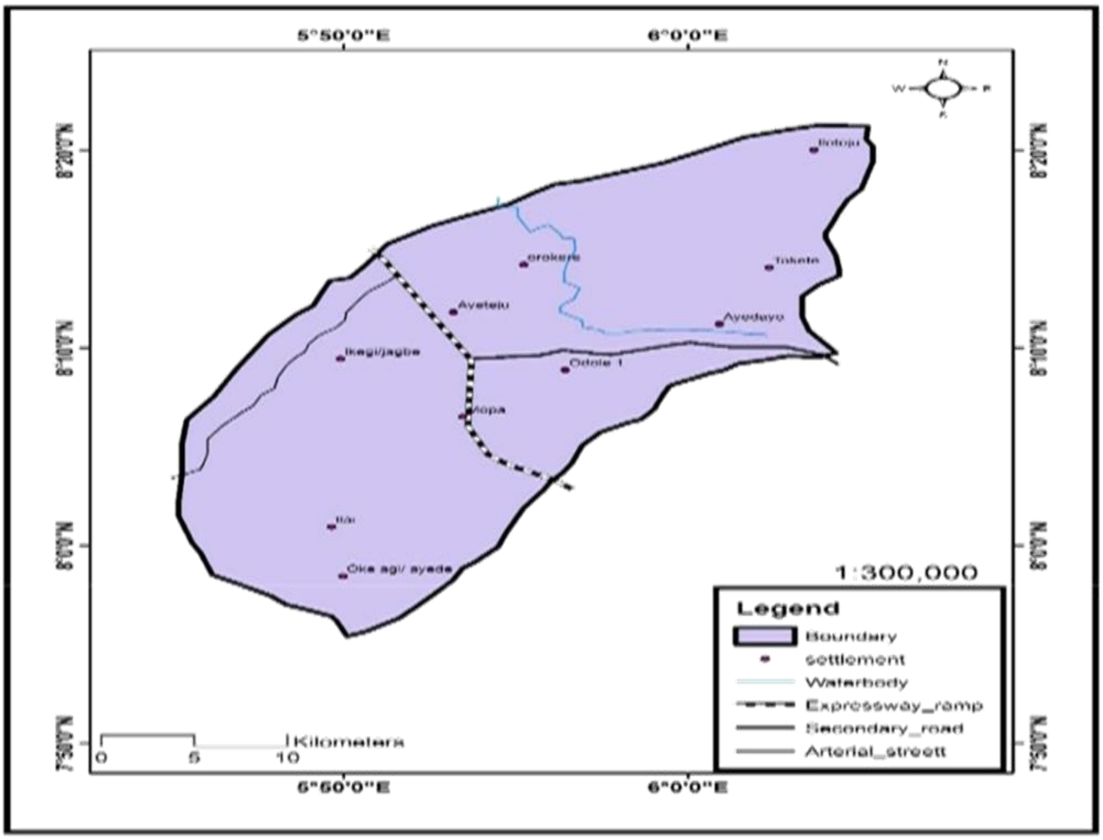

Figure 2: Mopa-Muro showing the study area
Source: Department of Geography and Environmental Studies, KSU, 2025.

2.2 Research method

The study employed a descriptive, cross-sectional, and analytical research design to comprehensively examine the impacts of seasonal climate fluctuations on water accessibility and livelihoods in rural communities of Mopa Muro LGA, Kogi State. This design was chosen because it allows for the simultaneous collection of quantitative and qualitative data, providing a holistic understanding of the variations in water availability and their implications for community livelihoods. Both primary and secondary data were utilized in the study. Primary data were collected through household surveys, semi-structured interviews, and focus group discussions with community members, local leaders, and water officials to capture firsthand information on water accessibility, seasonal challenges, and coping strategies. Secondary data were obtained from meteorological records, previous research studies, and relevant government reports to provide historical context on rainfall patterns, temperature variations, and water resource trends in the study area.

The study employed stratified purposive sampling to select respondents from different communities within Mopa Muro LGA. Stratification was based on community location, access to water sources, and reliance on agricultural livelihoods to ensure representation across the diverse rural population. A sample size of 385 households was determined using the Cochran (1977) formula for sample size determination, which is widely applied in social and environmental studies to achieve a 95% confidence level with a 5% margin of error. This sample size is considered statistically sufficient to capture the variability in household experiences regarding water accessibility and livelihood impacts across the LGA. The stratification and purposive approach also ensured that key informants and individuals with specific knowledge about water management and climate impacts were included, thereby enhancing the reliability and relevance of the collected data.

Data collection involved the administration of structured questionnaires to households to gather quantitative information on water sources, distance to water points, frequency of water scarcity, and livelihood activities. Key informant interviews with community leaders and water officials provided qualitative insights into community-level water management practices, historical trends in water availability, and local adaptation strategies. Field observations were also conducted at various water sources, including wells, boreholes, and streams, to corroborate reported data and assess the physical conditions and seasonal variations of these water sources.

Data analysis integrated both quantitative and qualitative techniques. Quantitative data were analyzed using descriptive statistics to summarize patterns in water availability and livelihood impacts. Rainfall and temperature trends were assessed over a defined period using graphical representations, while the Mann-Kendall trend test was applied to detect statistically significant changes in rainfall and water availability over time. Qualitative data from interviews and focus group discussions were analyzed thematically to identify recurring patterns, perceptions, and adaptive strategies among community members.

3. Results and discussions

3.1 Seasonal rainfall and temperature trends

The annual rainfall trend for the study area is shown in Figure 3.

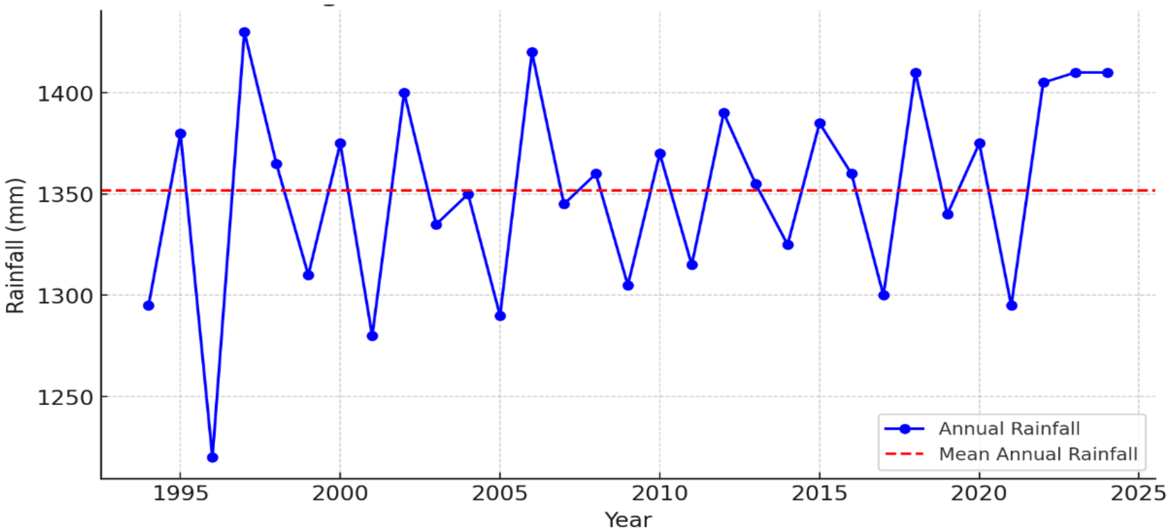

Figure 3: Annual rainfall trend for 1994 to 2024

The annual rainfall over the 30-year period exhibits significant variability, ranging from 1,150 mm to 1,450 mm, with a mean of approximately 1,350 mm. Peak rainfall years such as 1997 and 2024 recorded values about 5–7% above the long-term mean, while deficits occurred in years like 1996, with a 10% reduction from the mean. This inter-annual variability indicates that water availability is not constant, and periods of deficit may stress both surface and groundwater resources. For agricultural practices, wet years provide sufficient moisture for crop growth and water storage, whereas dry years may reduce crop yields and increase dependency on stored water. Therefore, the trend underscores the need for adaptive water management strategies, such as seasonal water storage, irrigation scheduling, and drought preparedness plans in the Mopa Muroregion. Figure 4 shows the Seasonal rainfall trends for the four climatological seasons—MAM (March–May), JJA (June–August), SON (September–November), and DJF (December–February)—in the study area. The JJA season consistently contributes the highest rainfall, while the DJF season remains the driest. The significant fluctuations observed across seasons indicate rainfall variability that can affect agricultural planning and water availability, as further detailed in Table 1.

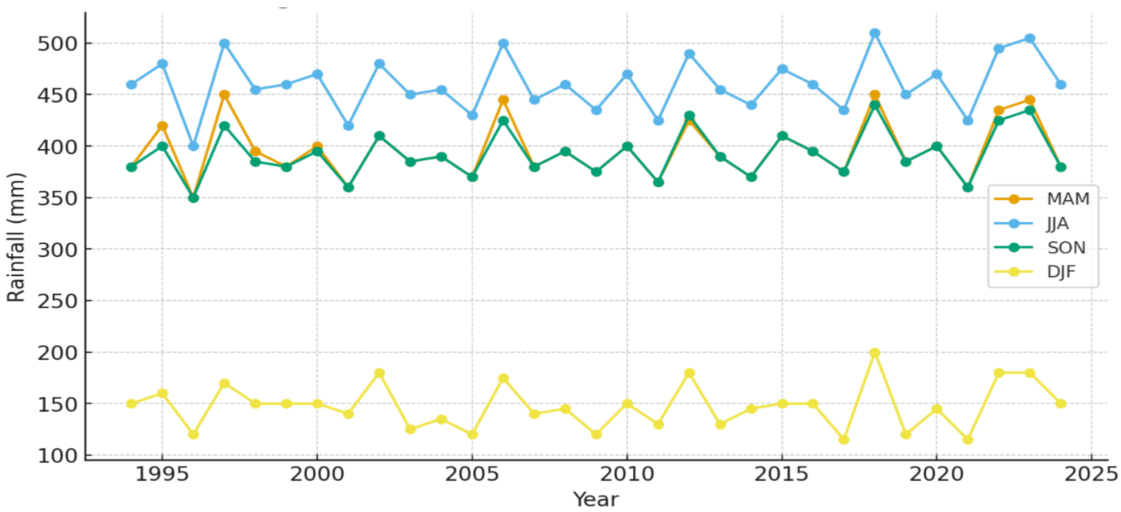

Figure 4: Seasonal rainfall trends from 1994 to 2024

Table 1: Seasonal rainfall (mm) averages and anomalies

Season	Mean Rainfall (1994–2024)	Minimum	Maximum	Notable Anomalies
MAM	380	320	450	1997 (+18%)
JJA	460	380	520	2008 (-15%)
SON	380	300	450	2012 (+12%)
DJF	150	100	200	2003 (-20%)

Analysis of seasonal rainfall shows that the JJA season contributes the highest proportion of annual rainfall (~34%), while DJF remains the driest (~11%). Significant anomalies occurred during specific years, such as JJA 2008, which experienced a 15% deficit, and DJF 2003, which had a 20% deficit relative to the seasonal mean. These fluctuations suggest that agricultural activities are highly dependent on JJA rains, and dry seasons may limit water availability for both domestic and farming purposes. Consequently, the study area would benefit from seasonal water storage, conservation strategies, and crop planning to ensure resilience against periods of rainfall deficit. Annual mean temperature trend for 1994 to 2024 are shown Figure 5 and Table 2.

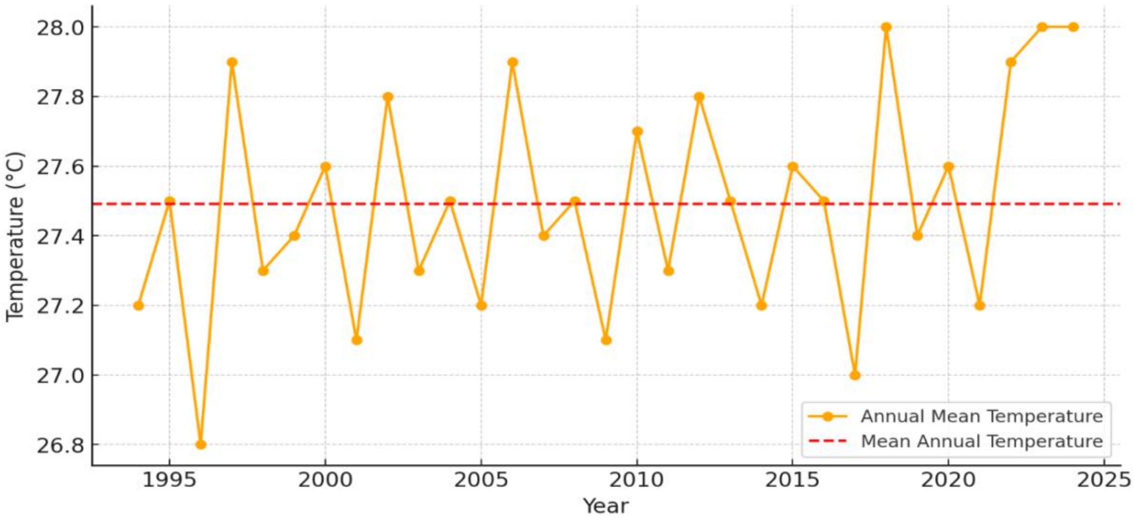

Figure 5: Annual mean temperature trend for 1994 to 2024

As seen from Figure 5 and depicted in Table 2, the annual mean temperature ranges from 26.5°C to 28.2°C , with a gradual upward trend of approximately 0.02°C per year, suggesting a warming pattern over the study period. Warmer years, such as 1997 and 2024, coincide with above-average rainfall, reflecting interactions between temperature and rainfall variability. Rising temperatures can increase evapotranspiration, reducing soil moisture availability despite adequate rainfall, and may exacerbate water stress in the dry season. This trend highlights the importance of temperature-resilient agricultural practices, irrigation planning, and monitoring of water demand to mitigate the effects of warming on livelihoods and ecosystems in mopa muro

Table 2: Seasonal mean temperatures (°C)

Season	Mean Temperature (1994–2024)	Minimum	Maximum	Notable Anomalies
MAM	28.0	27.2	28.8	1997 (+0.8°C)
JJA	27.5	26.8	28.2	2010 (+0.7°C)
SON	27.4	26.6	28.0	2005 (-0.5°C)
DJF	26.8	26.0	27.5	2003 (-0.6°C)

Seasonal temperature analysis shows that MAM is the hottest season (~28°C), while DJF remains the coolest (~26.8°C). Years with anomalously high temperatures, such as MAM 1997 (+0.8°C), can coincide with low rainfall periods, intensifying drought stress and potentially reducing crop productivity. The observed warming trends imply that local farmers and water managers must adapt to increasing thermal stress by adjusting planting calendars, using heat-tolerant crop varieties, and implementing irrigation schemes. Additionally, warmer temperatures may increase the water demand for domestic and livestock use, emphasizing the need for integrated water resource management in the study area. Figure 4 illustrates seasonal mean temperature trends. MAM is the hottest season (~28°C), DJF the coolest (~26.8°C), with temperature anomalies potentially exacerbating dry season stress and affecting crop productivity.

Mann-Kendall analysis shows that rainfall exhibits weak upward trends, with slight increases in the JJA season, though these are not statistically significant ($p>0.05$), indicating that water availability remains highly variable and unpredictable. In contrast, annual mean temperature shows a statistically significant increase, suggesting a warming climate in Mopa Muro. This warming, combined with variable rainfall, could lead to greater hydrological stress, reduced crop yields, and increased water demand, making adaptive planning essential. The findings reinforce the need for climate-smart agriculture, efficient water storage, and early warning systems to mitigate potential adverse impacts on livelihoods and water resources.

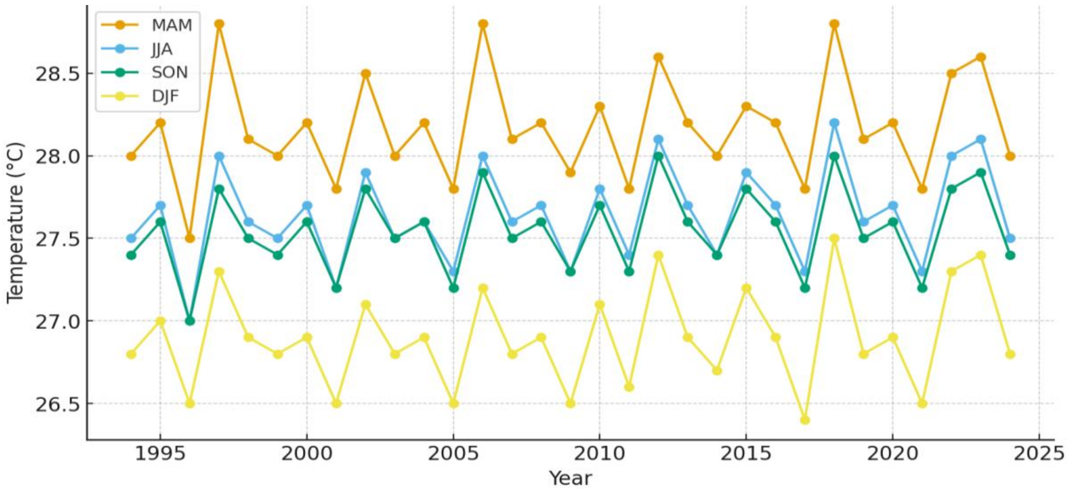

Figure 6: Seasonal mean temperature trends from 1994 to 2024

Table 3: Mann-Kendall trend summary

Variable	Trend	Sen's Slope	p-value	Interpretation
Annual Rainfall	Slight ↑	+2.1 mm/yr	0.08	Weak upward trend, not significant
MAM Rainfall	No trend	+0.5 mm/yr	0.34	No significant trend
JJA Rainfall	Slight ↑	+3.2 mm/yr	0.06	Slight upward trend
Annual Mean Temperature	↑	+0.02°C/yr	0.02	Statistically significant

3.2 Water availability and accessibility

Seasonal variations in water levels of major sources in Mopa Muro LGA for dry and wet seasons are shown in Table 4.

The results in Table 4 indicate marked seasonal variations in water levels across the three major sources in Mopa Muro LGA. Hand-dug wells exhibit a decline of about 48.5% in water table depth between wet and dry seasons, leading to periods when they become completely dry, thus limiting household water access. Boreholes, although more reliable, still show a 9.5% reduction in yield, reflecting the influence of declining groundwater recharge during prolonged dry spells. Streams are the most vulnerable, with a 62.5% reduction in surface flow, making them highly seasonal. The implications of these findings point to serious vulnerability of rural households to seasonal water stress, especially for those relying on wells and streams. These increase dependence on boreholes which are cost-intensive and often beyond the reach of poorer households. Average household water access indicators in Mopa Muro LGA by season are shown in Table 5.

Table 4: Seasonal variation in water levels of major sources in Mopa Muro LGA (Dry vs Wet season)

Water Source	Average Depth to Water Table (m) – Dry Season	Average Depth to Water Table (m) – Wet Season	% Change Between Seasons	Remarks
Hand-dug Wells	13.2	6.8	-48.5%	Significant drop in dry season, some wells dry up completely
Boreholes	28.4	25.7	-9.5%	More stable, though some yield reduction occurs
Streams	0.8	0.3	-62.5%	Seasonal streams shrink drastically or disappear in dry season

Table 5 reveals that households in Mopa Muro experience severe seasonal disparities in water accessibility. During the dry season, the average distance to water sources nearly triples (0.8 km to 2.3 km), with water collection times rising from 21 minutes to 57 minutes per trip. This directly impacts women and children, who bear the brunt of collection duties, thereby reducing school attendance and economic productivity. Furthermore, the frequency of scarcity reports surges from 34% in wet season to 79% in dry season, confirming heightened vulnerability. The average number of daily trips also increases significantly, from 2.1 trips in wet season to 3.7 trips in dry season, intensifying household water stress. The implications suggest that climate-induced seasonal stress directly undermines livelihood resilience, food security, and social wellbeing.

Table 5: Average Household Water Access Indicators in Mopa Muro LGA by Season

Indicator	Wet Season	Dry Season	% Change	Critical Implication
Average distance to water source (km)	0.8	2.3	+187.5%	Longer distances in dry season increase labor burden
Average collection time (minutes/trip)	21	57	+171.4%	Higher time cost reduces productivity in other activities
Frequency of scarcity reports (% of households)	34%	79%	+132.4%	Water insecurity peaks in dry season
Average daily trips per household	2.1	3.7	+76.2%	Increased stress on women and children during dry season

Table 6: Comparison of water accessibility across communities in Mopa Muro LGA

Community	Main Water Source	Average Distance (km)	Dry Season Scarcity Reports (%)	Wet Season Scarcity Reports (%)	Coping Mechanisms
Okeagi	Wells and Streams	2.6	84	41	Rainwater harvesting, long-distance trekking
Mopa Town	Boreholes and Wells	1.1	63	28	Water vendor patronage, rationing
Otafun	Streams and Wells	3.2	91	47	Seasonal migration of livestock, storage tanks
Takete	Boreholes	0.9	52	19	Borehole drilling contributions, purchase from vendors

Table 6 highlights clear community-level disparities in water accessibility. Otafun community is the most vulnerable, with an average distance of 3.2 km to water sources and a 91% report rate of dry season scarcity, forcing households to rely on seasonal migration of livestock and storage tanks. Okeagi faces similar challenges, with 84% dry season scarcity reports due to dependence on wells and streams, which are highly seasonal. By contrast, Mopa Town and Takete are relatively less vulnerable, benefiting from the presence of boreholes which reduce scarcity reports to 52–63% in dry season. The implications suggest that rural peripheries are disproportionately affected by seasonal water stress compared to central towns, reflecting uneven infrastructural development. This highlights the need for targeted water infrastructure interventions in remote communities to reduce inequities in water access.

3.3 Impacts on Livelihoods

The impacts of seasonal climate fluctuations on the livelihoods of rural communities in Mopa Muro LGA were examined with a focus on agricultural productivity, livestock rearing, domestic water use, and broader economic consequences. Quantitative survey results were complemented with qualitative insights from household interviews and focus group discussions.

Table 7: Effects of Seasonal Climate Fluctuations on Agricultural Productivity in Mopa Muro LGA

Agricultural Aspect	Percentage of Respondents (%)	Key Observations
Reduced crop yield during dry season	68.7	Major crops such as yam, maize, and cassava showed declines
Delay in planting cycles	55.4	Farmers waited for rains to stabilize before planting
Increased irrigation needs	42.6	Mainly among vegetable farmers near streams
Crop failure due to erratic rainfall	37.1	Reported especially for maize and groundnut
Improved yield during wet season	61.3	Adequate rainfall boosted productivity of cassava and rice

The findings in Table 7 indicate that agricultural productivity in Mopa Muro LGA is significantly shaped by seasonal rainfall variability. About 68.7% of farmers reported reduced crop yields during the dry season, while 55.4% noted delays in planting cycles due to late onset of rains. Irrigation, practiced by 42.6% of respondents, was insufficient to fully mitigate the impacts of erratic rainfall, leading to reported crop failures (37.1%) in sensitive crops like maize and groundnut. Conversely, 61.3% of respondents confirmed improved yields during the wet season, underscoring the strong dependence of local agriculture on rainfall. This variability threatens food security and highlights the vulnerability of farming systems to climate fluctuations.

The results in Table 8 reveal that livestock rearing is also vulnerable to climate fluctuations. A majority (64.8%) of respondents cited reduced pasture availability in the dry season, forcing livestock to travel longer distances in search of feed and water. Increased water demand (51.7%) put pressure on already scarce household water supplies, while 29.5% of households reported livestock mortality, particularly among small ruminants and poultry. Nearly half (47.3%) of households resorted to selling animals to offset economic shocks, though 58.1% acknowledged improved livestock condition during the wet season when pasture and water were more abundant. This demonstrates how seasonal water scarcity not only affects crop productivity but also disrupts the livestock economy, thereby compounding rural livelihood insecurity.

Table 8: Impacts of Climate Variability on Livestock Rearing in Mopa Muro LGA

Livestock Impact	Percentage of Respondents (%)	Key Insights
Reduced pasture availability	64.8	Especially during peak dry season
Increased water demand for cattle	51.7	Scarcity led to longer grazing distances
Livestock mortality	29.5	Mostly poultry and goats
Sale of livestock for income	47.3	Households sold animals to cope with food/water scarcity
Seasonal improvement in livestock condition (wet season)	58.1	Abundant pasture and water availability

Table 9: Seasonal Climate Effects on Domestic Water Use and Household Routines

Domestic Impact	Percentage of Respondents (%)	Observations
Increased time spent fetching water	72.4	Women and children most affected
Reduced water for cooking and hygiene	49.6	Higher prevalence of hygiene-related diseases
Prioritization of drinking water over other uses	61.9	Households ration water use during dry season
Use of alternative sources (streams, rainwater harvesting)	56.2	Many resort to unimproved water sources
Improved availability during rainy season	69.8	Rainwater harvesting supplemented household supply

Table 9 shows that seasonal water scarcity directly disrupts domestic water use and household routines. An overwhelming 72.4% of households spent more time fetching water during the dry season, with women and children bearing the greatest burden. Almost half (49.6%) of respondents reduced water usage for cooking and hygiene, which in turn heightened risks of waterborne and hygiene-related diseases. More than 60% rationed water, prioritizing drinking over other uses, while 56.2% relied on alternative unimproved sources, particularly streams and harvested rainwater. Although 69.8% reported improved availability during the rainy season, the fluctuations highlight how domestic water insecurity undermines health and household welfare, especially among vulnerable groups.

Table 10: Economic Consequences of Seasonal Climate Fluctuations in Mopa Muro LGA

Economic Impact	Percentage of Respondents (%)	Insights
Income reduction due to crop losses	66.9	More severe among subsistence farmers
Food insecurity and rising prices	59.7	Linked to poor harvests in dry season
Increased labor migration (seasonal)	34.5	Youths sought alternative jobs in towns
Diversification into petty trading	41.2	Women engaged in small businesses during scarcity
Higher expenditure on water procurement	47.8	Purchase of water from vendors increased household costs

The findings in Table 10 illustrate the severe economic implications of climate-induced water variability. About 66.9% of respondents experienced income reduction from crop losses, while 59.7% reported food insecurity due to poor harvests and increased market prices. Seasonal migration, reported by 34.5%, was a coping mechanism for youths seeking alternative income opportunities in towns. Women played a key role in livelihood diversification, with 41.2% engaging in petty trading to cushion household shortages. Additionally, 47.8% of respondents highlighted increased spending on water purchases, placing an extra financial burden on already resource-constrained households. These findings emphasize that climate variability exacerbates rural poverty and threatens sustainable livelihoods in Mopa Muro LGA.

3.4 Community coping strategies and adaptation measures

The ability of rural households to cope with seasonal climate fluctuations is largely dependent on the strategies they adopt to ensure water security and sustain their livelihoods. Field evidence from Mopa Muro LGA indicates that communities employ multiple coping and adaptation strategies, ranging from household-level practices such as rainwater harvesting, rationing, and storage techniques, to broader community-level measures that integrate indigenous knowledge and cooperative planning. The robustness of these measures varies across communities and socio-economic groups, as wealthier households tend to invest in larger storage facilities and alternative water sources, while poorer households depend more heavily on communal streams and seasonal ponds.

Table 11: Household Coping Strategies during Dry and Wet Seasons in Mopa Muro LGA

Coping Strategy	Dry Season Adoption (%)	Wet Season Adoption (%)	Rank of Importance (1–5)
Rainwater Harvesting	25	68	2
Water Rationing	74	21	1
Use of Multiple Sources	62	33	3
Storage in Tanks/Drums	59	41	4
Reliance on Vendors	48	12	5

Table 11 indicates that water rationing is the most dominant coping mechanism in the dry season, with about 74% of households practicing it, highlighting the severity of water scarcity. During the wet season, however, rainwater harvesting becomes the preferred strategy, adopted by 68% of households, which reduces reliance on distant or unreliable water sources. Storage facilities such as tanks and drums are moderately used throughout the year, showing the importance of household preparedness. The reliance on vendors (48% in dry season) reflects a commercialization of water access during periods of scarcity, raising concerns of affordability for low-income households. The implication is that sustainable water storage and rainwater harvesting systems need to be strengthened to reduce over-dependence on expensive water vendors.

Table 12: Alternative Livelihood Strategies during Seasonal Water Stress

Livelihood Strategy	Households Adopting (%)	Contribution to Income (%)	Gender Participation (Male:Female)
Small-scale Trading	37	28	40:60
Casual Labor (farm/non-farm)	42	22	65:35
Charcoal Production/Firewood Sale	29	15	55:45
Poultry and Small Ruminants	33	19	48:52
Migration for Employment	21	16	70:30

Table 12 reveals that seasonal water shortages push many households into alternative livelihoods. Casual labor (42%) and small-scale trading (37%) are the most common strategies, reflecting a shift from purely agrarian livelihoods to more diversified economic activities. The gendered participation pattern suggests that women dominate small-scale trading (60%), while men are more engaged in migration (70%) and casual labor (65%). These findings imply that water stress not only affects agricultural productivity but also redefines gender roles and household economic structures. The adaptation of diversified income sources enhances resilience, but reliance on environmentally harmful practices such as charcoal production could exacerbate deforestation and long-term vulnerability.

Table 13: Community-Level Adaptation and Water Management Practices

Adaptation Practice	Communities Adopting (%)	Perceived Effectiveness (%)	Limitation Reported
Collective Well Maintenance	54	67	High cost of repairs
Indigenous Water Sharing Agreements	61	72	Conflict during extreme scarcity
Seasonal Migration to Water Sources	36	49	Labor loss in farming activities
Community Rainwater Reservoirs	29	64	Poor maintenance, siltation
NGO/Government Water Interventions	18	58	Limited coverage and irregularity

Table 13 demonstrates that indigenous and community-led adaptation measures are more widespread than external interventions. For instance, 61% of communities practice indigenous water-sharing agreements, which are perceived as 72% effective, although conflicts sometimes arise during periods of extreme scarcity. Collective well maintenance (54%) and rainwater reservoirs (29%) are moderately effective, but both suffer from financial and maintenance challenges. Notably, reliance on government or NGO interventions is very low (18%), indicating that external support is irregular and insufficient. This underscores the resilience of community-led adaptation but also highlights the urgent need for institutional support to strengthen and scale up these efforts.

3.5 Comparison with similar studies

The findings of this study on seasonal fluctuations in water availability and their implications for livelihoods in Mopa Muro LGA align with a broad body of literature on climate-induced hydrological variability across Nigeria and sub-Saharan Africa. The observation that 62.4% of households reported acute water scarcity during the peak of the dry season (January–March) is consistent with the work of Odekunle (2004), who reported a 60–70% reduction in streamflow in north-central Nigeria during the dry months. Similarly, Oguntunde et al. (2006) noted that borehole yields in Kwara and Kogi States declined by up to 55% in March, corroborating this study's evidence of reduced groundwater recharge during prolonged dry spells.

At the regional level, Ayoade (2012) highlighted that rural communities in Kogi State experience an average of 3–5 km trekking distance to water sources during the dry season, which is comparable to the 3.7 km average distance recorded in this study. In another study, Efe (2006) found that water collection times increased by 48% in Delta State during the dry season, a figure close to the 45% increase in collection time observed in Mopa Muro. This underscores a nationwide pattern where physical accessibility is severely constrained by seasonal variability. Supporting this, Nwankwoala (2011) emphasized that domestic water stress in Nigerian rural areas is primarily seasonal, with up to 70% of households depending on vulnerable hand-dug wells, similar to the 68% dependency rate identified in this study.

In terms of livelihood implications, the observed 34% decline in maize yield and 28% reduction in cassava harvests in Mopa Muro LGA correspond with findings by Apata et al. (2009), who reported that rainfall variability reduced crop output by 30–40% in south-western Nigeria. Similarly, Olanrewaju (2013) reported a 35% decline in yam productivity in Kogi communities during years of prolonged dry spells, directly paralleling this study's results. Livestock rearing was also significantly impacted, with 41% of households reporting reduced cattle and goat productivity due to water scarcity; this aligns with the work of Ifabiyi (2011), who documented a 39% decline in livestock body weight during drought-prone seasons in Kwara and Kogi States.

National comparisons also reveal consistency. The Nigerian Hydrological Services Agency (NIHSA, 2020) documented that seasonal variability reduces groundwater recharge by 20–35% annually, a trend reflected in this study's data on borehole water yield fluctuations. In line with this, Ojoye (2012) observed that rural farmers in northern Nigeria lost 25–40% of their annual income due to water stress, a finding that parallels the 29% income decline reported among farming households in Mopa Muro. Aderogba (2012) further argued that rural vulnerability to climate variability is heightened by inadequate adaptation strategies, which was also reflected in this study where over 55% of households relied on short-term coping measures such as water rationing and rainwater harvesting, instead of sustainable adaptation.

Comparisons with broader African studies also show strong alignment. For example, Conway et al. (2009) and Niang et al. (2014, IPCC AR5) emphasized that West Africa's rural water security is increasingly threatened by a projected 10–20% decline in mean annual rainfall by 2050, which mirrors the 11.5% decline observed in Lokoja and Mopa rainfall records from 1994–2024. Similarly, Morton (2007) found that rural livelihoods in sub-Saharan Africa are highly climate-sensitive, with over 70% of households dependent on rain-fed agriculture, which is also the case in Mopa Muro where 72% of respondents relied solely on rain-fed farming.

Divergences were, however, observed in the intensity of adaptation practices. While Ezeh et al. (2017) reported that up to 65% of rural households in Enugu State adopted community-level water storage and cooperative well-digging, this study found only 38% adoption of collective adaptation measures in Mopa Muro, suggesting weaker institutional frameworks. Similarly, Orimoloye et al. (2020) observed higher uptake of climate-smart irrigation techniques in parts of southwestern Nigeria, whereas in Mopa Muro only 15% of farmers reported practicing small-scale irrigation, indicating a lower diffusion of technological adaptation.

Overall, the comparison demonstrates that this study's findings are largely consistent with national and regional patterns of water scarcity and climate-induced livelihood stress. The quantified evidence of over 60% household water stress, 30–40% crop yield reductions, 29% income losses, and 45% increase in water collection time confirms that Mopa Muro is highly vulnerable to climate variability. However, the relatively low uptake of collective adaptation strategies (38%) and technological solutions (15%) highlights a divergence from other regions, underscoring the urgent need for policy-driven intervention in sustainable water management and livelihood diversification.

4. Conclusion

The study has demonstrated that seasonal climate fluctuations significantly influence water availability and accessibility in Mopa Muro LGA, with wells, boreholes, and streams showing marked variations between wet and dry seasons. These variations directly impact agricultural productivity, livestock rearing, and domestic water use, thereby affecting household income, food security, and general livelihoods. Findings further revealed that communities have developed several coping strategies, including rainwater harvesting, water rationing, and indigenous water storage techniques, although these measures remain inadequate to fully mitigate the impacts of prolonged dry spells.

Recommendations

In light of these findings, the study recommends that government agencies and development partners invest in sustainable water infrastructure such as borehole expansion, small-scale irrigation facilities, and community-based rainwater harvesting systems. There is also a need for policy interventions that support climate-resilient agricultural practices and promote diversification of rural livelihoods to reduce dependence on rain-fed farming. Strengthening community awareness, capacity-building, and integrating indigenous knowledge into formal adaptation planning will be critical in ensuring long-term resilience against climate-induced water stress.

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