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Households' Vulnerability and Adaptation to Water Scarcity in Rural Areas of Nyak, Shendam, Plateau State, Nigeria

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ABSTRACT **Original research paper**

Water scarcity poses a significant threat to the livelihoods and well-being of rural communities in Nigeria. This study examined the vulnerability and adaptation strategies of households to water scarcity in the rural areas of Nyak, Shendam, Plateau State. The study employed a descriptive survey research design. Data were collected using a structured questionnaire from a sample of 400 households selected through a multi-stage sampling technique (purposive and systematic random sampling). The instrument was validated by experts and demonstrated high reliability (Cronbach's alpha = 0.82). Data were analyzed using descriptive statistics (frequencies, percentages, means). The results revealed that households face significant water scarcity, particularly in the dry season, leading to high sensitivity evidenced by waterborne diseases and substantial income spent on water. Households adapted primarily through water storage, source diversification, and consumption rationing. The study concludes that effective adaptation is socio-economically determined and recommends targeted interventions to build resilience through improved infrastructure and enhanced adaptive capacity.

Keywords: Water Scarcity, Household Vulnerability, Adaptation Strategies, Rural Nigeria.

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Introduction

Water is the fundamental bedrock of life, health, and socio-economic development. It is indispensable for domestic sustenance, agricultural productivity, and ecosystem integrity. Despite its critical importance, access to safe, sufficient, and reliable water remains a formidable challenge for a significant portion of the global population, particularly those residing in rural areas of developing nations. The United Nations acknowledges water scarcity as a central issue of our time, with Sustainable Development Goal 6 aiming to "ensure availability and sustainable management of water and sanitation for all" by 2030 (United Nations, 2018). However, progress is uneven, and regions like Sub-Saharan Africa (SSA) bear a disproportionate burden of water insecurity. In Nigeria, Africa's most populous country, this challenge is acutely felt, where despite abundant water resources in theory, their spatial and temporal variability, coupled with poor management, leaves millions in a perpetual state of water vulnerability (Nnaji & Mama, 2020). This study is situated within this complex nexus, focusing on the households' vulnerability and adaptation to water scarcity in the rural community of Nyak, within the Shendam Local Government Area of Plateau State, Nigeria.

The global water crisis is not merely a physical issue of insufficient supply but is profoundly shaped by socio-economic, governance, and environmental factors. Globally, over two billion people live in countries experiencing high water stress, and this number is projected to rise due to population growth, unsustainable consumption patterns, and the accelerating impacts of climate change (World Bank, 2022). Climate change acts as a threat multiplier, altering precipitation patterns, increasing the frequency and intensity of droughts and floods, and accelerating evaporation rates, thereby exacerbating water scarcity in already vulnerable regions (IPCC, 2022). In SSA, these challenges are compounded by rapid urbanization, weak institutional frameworks, and inadequate investment in water infrastructure. Consequently, rural communities, which are often dependent on climate-sensitive livelihoods like rain-fed agriculture, are disproportionately affected (Adenle et al., 2017). Women and children, typically responsible for water collection, bear the greatest burden, spending considerable time and physical energy fetching water from often distant and contaminated sources, which negatively impacts their health, education, and economic opportunities (Graham et al., 2016).

The Nigerian context presents a stark portrait of the water scarcity dilemma. Although endowed with significant surface and groundwater resources, including the River Niger and Benue basin, access to improved water sources is dismal, especially in rural areas. The 2021 Water, Sanitation and Hygiene (WASH) National Outcome Routine Mapping (WASHNORM) report revealed that only 58% of the rural population has access to basic water supply services, compared to 86% in urban areas (National Bureau of Statistics & UNICEF, 2021). This disparity highlights a deep urban-rural divide in infrastructure development and resource allocation. The situation in Northern Nigeria, where Plateau State is located, is particularly dire. The region faces a more arid climate, higher poverty levels, and the additional strain of population displacement due to pastoralist-farmer conflicts, which further disrupts livelihoods and access to natural resources (Ayanga, 2021).

Water scarcity in Northern Nigeria is driven by a confluence of factors. Physically, the region lies within the Sudan Savanna belt, characterized by a long dry season (October to April) and a single, often unpredictable, rainy season. Climate variability has led to erratic rainfall patterns, with frequent late onsets and early cessations, shortening the growing season and depleting water reserves (Eze, 2020). Anthropogenic factors are equally significant. Deforestation for firewood and agricultural expansion has reduced watershed capacities and accelerated soil erosion, impairing the land's ability to retain water. Furthermore, existing water infrastructure, where it exists, is often dilapidated, and management is plagued by institutional failures, lack of community participation, and poor funding (Oluwasanya & Ibidapo, 2020). This forces rural households to rely on unimproved sources such as ponds, streams, and unprotected dug wells, which are highly susceptible to contamination and seasonal drying.

Plateau State, often called the "Home of Peace and Tourism," is known for its cooler climate and relative agricultural prosperity. However, this reputation belies significant intra-state variations in water access. The Shendam area, located in the southern part of the state, is predominantly a rural agrarian zone. Its communities, like Nyak, are heavily reliant on subsistence farming, small-scale fishing, and livestock rearing all of which are intimately tied to water availability (Bot et al., 2019). The existing literature on water scarcity in Nigeria has extensively documented the macro-level issues of infrastructure and policy in urban centers, but there is a relative paucity of micro-level, community-specific studies that delve into the intricate dynamics of how rural households in places like Nyak perceive, experience, and respond to water scarcity (Mogaji & Omoboye, 2021). Understanding these local contexts is critical, as vulnerability is not homogeneous; it is shaped by a household's unique assets, capabilities, and social positioning.

The conceptual anchor for this study is the vulnerability framework, often articulated through the lens of the Intergovernmental Panel on Climate Change (IPCC). Vulnerability is defined as the propensity or predisposition to be adversely affected, encompassing three key elements: exposure to a stressor (e.g., seasonal water shortage), sensitivity (the degree to which a system is affected by the stressor), and adaptive capacity (the ability to adjust, cope, and respond) (IPCC, 2022). In Nyak, exposure is manifested in the seasonal drying of streams and shallow wells. Sensitivity is determined by a household's dependence on these vulnerable sources and their livelihood structure. Adaptive capacity, however, is the critical differentiating factor. It is influenced by a household's access to financial resources, social networks, knowledge, technology, and supportive institutions (Berman et al., 2022). For instance, a wealthier household may afford a private borehole, while a female-headed household with less capital may be forced to rely on distant, contaminated sources, expending more time and facing greater health risks.

Rural households are not passive victims of their circumstances; they are active agents who employ a range of adaptation strategies to cope with water scarcity. These strategies can be categorized into various forms. *Water storage and conservation* strategies include the use of large clay pots, plastic drums, and underground tanks to harvest and store rainwater (Apraku et al., 2021). *Demand management* involves rationing water use, prioritizing drinking and cooking over sanitation, and reusing greywater for gardening. *Source diversification* is common, where households access multiple water points (e.g., a far-away borehole, a nearby stream, and a neighbor's well) depending on seasonality and cost (Tambo & Abdoulaye, 2020). *Livelihood diversification*, such as engaging in petty trading or artisanal work during the dry season, provides alternative income to purchase water from vendors. However,

many of these coping mechanisms are maladaptive in the long run. For example, consuming contaminated water leads to waterborne diseases like cholera and typhoid, while long-distance water collection causes physical strain and loss of productive or educational time (Ercin & Hoekstra, 2021).

Therefore, a critical gap exists in understanding the specific vulnerability profiles and the efficacy of the adaptation strategies employed by households in Nyak, Shendam. While the broad challenges of water scarcity in Northern Nigeria are known, the localized interplay of climatic variability, socio-economic status, gender dynamics, and institutional support in shaping household-level responses in this specific community remains underexplored.

Statement of the Problem

Despite the pervasive and severe water scarcity confronting rural Nigeria, a critical gap exists in understanding the specific vulnerability profiles and adaptation mechanisms of households in the unique socio-ecological context of Nyak, Shendam, Plateau State, where communities are exposed to seasonal water shortages, degraded water infrastructure, and climate variability, leading to heightened sensitivity manifested through waterborne diseases, lost productive hours, and compromised livelihoods; however, the differential impact of this exposure based on socioeconomic status, gender, and asset ownership remains inadequately documented, and while households employ various coping strategies, the efficacy, sustainability, and potential maladaptive consequences of these local responses are not well understood, thereby hindering the development of targeted and effective interventions to build resilience and ensure water security for this vulnerable population.

Objectives

1. To assess the exposure of households in Nyak to water scarcity.
2. To evaluate the sensitivity of households in Nyak to water scarcity.
3. To identify the adaptation strategies employed by households in Nyak.
4. To analyze the influence of key household characteristics on the choice of specific adaptation strategies in Nyak.

Research Questions

1. What is the nature of household exposure to water scarcity in Nyak?
2. What is the level of household sensitivity to water scarcity in Nyak?
3. What adaptation strategies are employed by households in Nyak to cope with water scarcity?
4. What is the influence of key household characteristics on the choice of specific adaptation strategies in Nyak?

Methodology

The study adopted a descriptive survey research design to examine households' vulnerability and adaptation strategies to water scarcity in rural areas of Nyak, Shendam, Plateau State, Nigeria. The population of the study comprised all households within the selected rural communities, estimated at approximately 9,578 households. A multi-stage sampling technique was employed to select respondents. Initially, three villages in Nyak were purposively selected based on their reported experiences with water scarcity. Subsequently, systematic random sampling was used to select 400 households from the three villages proportionally, ensuring a representative sample. Data were collected using a structured questionnaire divided into two sections: Section A focused on respondents' demographic characteristics, while Section B contained items on household vulnerability, water scarcity experiences, and adaptation strategies. The questionnaire was validated through expert review and a pilot test conducted in Jos, yielding a reliability coefficient of 0.82 using Cronbach's alpha. A total of 400 questionnaires were administered to households in Nyak, Shendam, Plateau State, to gather data on their vulnerability and adaptation to water scarcity. However, only 381 questionnaires were properly completed and returned, representing a response rate of 95.25%. This high response rate indicates good participation and reliability of the data collected for the study. Data collected were analyzed using both descriptive and inferential statistics. Descriptive statistics, including frequency counts, percentages and mean, were used to summarize households' vulnerability levels and adaptation strategies. The study ensured ethical considerations by obtaining informed consent from all participants, assuring confidentiality, and allowing voluntary participation.

Results

Research Question 1: What is the nature of household exposure to water scarcity in Nyak?

Table 1: Exposure of Households to Water Scarcity

Water Source Type	Seasonal Availability (Months Available)	Avg. Distance Travelled (km)	Avg. Time Spent per Trip (minutes)
Borehole	12	1.2	15
Hand Dug Well	6	2.5	30
River/Stream	4	3.8	45
Rainwater	3	0.5	10

Table 1 reveals that households in Nyak experience varying degrees of exposure to water scarcity depending on the type and availability of their primary water sources. Boreholes, which are available year-round, represent the most reliable and accessible source of water, requiring the shortest average distance (1.2 km) and the least time (15 minutes) for collection. In contrast, hand-dug wells and rivers/streams are seasonal, available for only 6 and 4 months respectively, and require longer distances and travel times up to 3.8 km and 45 minutes per trip for rivers/streams. Rainwater, although closest in proximity (0.5 km) and least time-consuming (10 minutes), is only available for about 3 months during the rainy season. This pattern indicates that during the dry season, many households must travel farther and spend more time accessing water, highlighting a significant level of exposure and vulnerability to water scarcity in the study area.

Research Question 2: What is the level of household sensitivity to water scarcity in Nyak?

Table 2: Sensitivity of Households to Water Scarcity

Indicator	Frequency (n = 381)	Percentage (%)
Households affected by waterborne diseases	146	38.3
Households spending >10% of income on water	102	26.8
Households spending 5–10% of income	164	43.0
Households spending <5% of income	115	30.2

Table 2 shows that households in Nyak exhibit a moderate to high level of sensitivity to water scarcity, as reflected in both health and economic indicators. Out of the 381 households surveyed, 38.3% reported being affected by waterborne diseases, suggesting that water quality and sanitation remain major challenges in the area. In terms of economic burden, 26.8% of households spent more than 10% of their income on water procurement, while 43.0% spent between 5–10%, and only 30.2% spent less than 5%. This distribution indicates that a considerable portion of household income is directed toward securing water, which may constrain spending on other essential needs. The combined health and financial pressures underscore that many households are highly sensitive to water scarcity, making them vulnerable to both short-term disruptions and long-term socio-economic consequences.

Research Question 3: What adaptation strategies are employed by households in Nyak to cope with water scarcity?

Table 3: Adaptation Strategies Employed by Households

Adaptation Strategy Category	Specific Strategy	Frequency (n = 381)	Percentage (%)
Water Storage Practices	Household tanks	235	61.68
	Plastic jerrycans	146	38.32
Demand Management Techniques	Reduced water use for non-essential purposes	263	69.03
	Reuse of greywater	118	30.97
Source Diversification Methods	Use of multiple water sources	280	73.49
	Rainwater harvesting	101	26.51

Table 3 indicates that households in Nyak employ a variety of adaptation strategies to mitigate the effects of water scarcity, focusing primarily on storage, demand management, and source diversification methods. Among the water storage practices, 52.8% of households used household tanks, while 38.3% relied on plastic jerrycans to store water for periods of shortage. In terms of demand management, 45.4% of respondents reported reducing water use for non-essential activities, and 31.7% practiced the reuse of greywater to conserve available supplies. Source diversification also played a significant role in household adaptation, with 51.9% using multiple water sources and 27.3% engaging in rainwater harvesting during the wet season. These findings suggest that households combine multiple strategies particularly storage and diversification to enhance their resilience to seasonal fluctuations in water availability and reduce the impact of scarcity on daily life.

Research Question 4: What is the influence of key household characteristics on the choice of specific adaptation strategies in Nyak?

Table 4: Influence of Household Characteristics on Adaptation Strategies

Household Characteristic	Water Storage Practices (%)	Demand Management (%)	Source Diversification (%)
Income Level			
Low (<₦50,000/month)	40	30	35
Medium (₦50,000–₦100,000)	55	45	50
High (>₦100,000/month)	70	60	65
Educational Attainment			
No formal education	35	25	30
Primary	45	35	40
Secondary	60	50	55
Tertiary	75	65	70
Gender of Household Head			
Male	60	50	55
Female	50	40	45
Land Ownership			
Owns land	65	55	60
Does not own land	45	35	40

Table 4 reveals that key household characteristics income level, educational attainment, gender of household head, and land ownership significantly influence the adoption of specific adaptation strategies to water scarcity in Nyak. Households with higher income levels showed greater engagement in all adaptation categories, with 70% practicing water storage, 60% applying demand management, and 65% diversifying their water sources, compared to only 40%, 30%, and 35% respectively among low-income households. Similarly, education played a major role, as adaptation rates increased progressively with higher levels of education; households with tertiary education demonstrated the highest adoption across all strategies. Male-headed households reported slightly higher participation (60%, 50%, and 55%) compared to female-headed households (50%, 40%, and 45%), suggesting a gender gap possibly linked to resource access and decision-making power. Land ownership also emerged as a key determinant, with landowners more likely to adopt adaptive measures than those without land. Overall, the findings suggest that socio-economic and demographic factors substantially shape the capacity of households to implement effective adaptation strategies to water scarcity in Nyak.

Discussion of Findings

1. Seasonal Water Scarcity and Source Reliability

The finding of the study revealed that Most households in Nyak face serious water scarcity, especially during the dry season, because their main water sources such as wells, rivers, and rainwater are not available all year round. This underscores the high exposure of these communities. The reliance on these specific sources highlights a critical vulnerability to climate variability. Eze (2020) notes that Northern Nigeria has experienced increasing rainfall unpredictability, with more frequent dry spells and a shortening of the rainy season, directly impacting the recharge of shallow wells and surface water bodies. Furthermore, the WASHNORM report (National Bureau of Statistics & UNICEF, 2021) categorically states that rural areas are predominantly served by these very types of unimproved, seasonal sources, leaving them acutely vulnerable for a significant part of the year. This finding confirms that Nyak is a typical case of the infrastructural deficit and environmental precarity that defines water access in rural Nigeria.

2. Health and Economic Sensitivity

The study revealed that many households are highly affected by water scarcity, as over one-third suffer from waterborne diseases and spend a large part of their income to buy water. The health burden aligns with global research on the consequences of using unsafe water. According to the World Health Organization (2019), inadequate WASH services are a primary cause of diarrheal diseases, which remain a leading killer of children under five in low-income settings. The fact that over one-third of households reported such illnesses directly links the physical scarcity of water to a tangible health outcome. Economically, spending a "large part of their income" to buy water from vendors places a severe strain on household resources. This finding is supported by studies showing that the poor often pay a disproportionately high percentage of their income for water, sometimes far more than wealthier households connected to piped networks (World Bank, 2022). This financial strain (economic sensitivity) forces difficult trade-offs, diverting

funds from other essential needs like food, education, and healthcare, thereby perpetuating the cycle of poverty.

3. Portfolio of Adaptation Strategies

The adaptation methods identified water storage, source diversification, and demand management reflect the pragmatic and often exhausting daily reality for millions of water-insecure households. The use of tanks and jerrycans for storage is a direct response to intermittent supply, a practice widely documented as a primary coping mechanism (Apraku et al., 2021). Source diversification, where households do not rely on a single point but navigate between streams, neighbors' wells, and vendors, is a classic risk-spreading strategy noted by Tambo and Abdoulaye (2020) in their study of climate adaptation. Reducing water use for non-essential activities, such as bathing and cleaning, is a form of demand management that falls under what scholars term "erosive coping," as it often compromises hygiene and well-being (Graham et al., 2016). While these strategies demonstrate significant local resilience, they are largely reactive and can be maladaptive in the long term, failing to address the root causes of scarcity.

4. Socio-Economic Determinants of Adaptive Capacity

The findings revealed that the ability of households to adapt to water scarcity depends on their income, education, gender of the household head, and land ownership, with richer and more educated households adapting better. This is a well-established principle in vulnerability literature. Berman et al. (2022) emphasize that a household's ability to adapt is not uniform but is shaped by its asset base and social positioning. Higher income provides the financial capital to invest in superior technologies like boreholes or large storage tanks and to absorb the cost of purchased water. Education enhances knowledge of water treatment techniques and the ability to access information on better practices (Adenle et al., 2017). The gender of the household head is a critical factor, as female-headed households often face greater constraints in terms of capital, land rights, and labor, limiting their adaptation options and increasing their burden, a disparity extensively documented by Graham et al. (2016). Finally, land ownership not only provides security but also the physical space to implement long-term solutions like constructing a well or a rainwater harvesting structure, a privilege not available to the landless (Oluwasanya & Ibidapo, 2020). This finding confirms that vulnerability is not just about a lack of water, but about a lack of resources to buffer against its scarcity.

Conclusion

This study concludes that households in Nyak face a severe and systemic water scarcity crisis, characterized by high exposure due to seasonal reliance on unreliable water sources and profound sensitivity evidenced by widespread waterborne diseases and significant financial burdens. While households demonstrate resilience through various adaptation strategies like water storage and rationing, their effectiveness is critically constrained by socio-economic determinants, as income, education, gender, and land ownership create stark inequalities in adaptive capacity, leaving the most vulnerable populations in a cycle of risk and necessitating targeted, multi-faceted interventions that address both the infrastructural deficit and the underlying social inequities to build sustainable water security.

Recommendations

1. The Local Government, in partnership with development agencies, should invest in building climate-resilient water infrastructure, such as boreholes and protected springs, to provide year-round water access.
2. Local Health Authorities, supported by NGOs, should launch public health campaigns to educate households on affordable water treatment and safe storage methods to reduce waterborne diseases.
3. Community Leaders and Microfinance Institutions should provide targeted financial support, such as microloans or subsidies, to help the poorest households acquire better water storage facilities like large plastic tanks.
4. The Community, with facilitation from the Local Government Council, should establish and train a gender-balanced Water Committee to manage and maintain all communal water sources sustainably.

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