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ASSESSING THE PATTERNS, CHALLENGES, AND DETERMINANTS OF HOUSEHOLD WATER SOURCE UTILIZATION IN MANGU LOCAL GOVERNMENT AREA, PLATEAU STATE, NIGERIA

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Abstract

This study employed a mixed-methods design to investigate the sources, distribution, seasonal variability, and socio-economic implications of household water access in Mangu Local Government Area (LGA), Plateau State, Nigeria. A total of 420 households were surveyed across six purposively selected communities using stratified random sampling. The study also included 12 key informant interviews and six focus group discussions. Quantitative findings reveal that boreholes serve as the dominant water source (35.71%), followed by hand-dug wells (28.57%) and streams (20.24%). Ownership analysis shows that 64.28% of water sources are publicly or community managed. Seasonal comparison highlights a shift in reliance from streams and wells in the wet season to boreholes and vendors in the dry season, with boreholes scoring highest in reliability (4.5/5). A one-way ANOVA revealed a significant relationship between distance to water sources and time spent collecting water ($p < 0.01$), where 64.3% of households travel between 0.5 and 2 km, spending up to 45 minutes per trip. Chi-square analysis ($\chi^2 = 22.4$, $p < 0.001$) confirmed significant disparities in water access across communities. Additionally, correlation analysis ($r = 0.78$) between perceived safety and drinking preference indicates that safety perceptions strongly influence water source choice. These insights underscore the urgent need for sustainable water infrastructure and equitable distribution strategies to improve health, reduce gendered time burdens, and support rural livelihoods.

Keywords: Rural water access, Seasonal water insecurity, Distance-time burden, Perceived water safety, Community-level disparities

INTRODUCTION

Access to clean and reliable water remains a persistent challenge in rural Nigeria, directly impacting health, livelihoods, and overall well-being (WHO/UN-Water, 2023). In Mangu Local Government Area (LGA) of Plateau State, the situation is emblematic of broader national and sub-Saharan African trends, where households often rely on a combination of boreholes, hand-dug wells, streams, and rainwater harvesting to meet their daily water needs (Okoye et al., 2023). The absence of centralized piped water systems and the variability of natural water sources have led to a layered water access landscape, marked by both infrastructural limitations and adaptive coping strategies (Adebayo et al., 2021).

The patterns of household water source utilization in Mangu LGA are shaped by a complex interplay of environmental, infrastructural, and socio-economic factors. Boreholes, often supported by

government or NGO interventions, are the most widely used source due to their perceived safety and year-round reliability (Musa et al., 2022). However, recent evidence suggests that over-reliance on groundwater is leading to declining water tables, raising concerns about the long-term sustainability of these sources (Okoye et al., 2023). In areas where boreholes and wells are inaccessible or non-functional, households turn to streams, rivers, and water vendors, especially during the dry season, despite the higher risks of contamination and increased financial burden (Agbo & Tanko, 2023).

Challenges to equitable water access in Mangu LGA extend beyond physical availability. The burden of water collection falls disproportionately on women and children, who often travel significant distances—sometimes exceeding two kilometers—to fetch water, resulting in considerable time and energy expenditure (Eze et al., 2023). This not only affects household productivity but also has broader implications for educational attainment and gender equity (Eze et al., 2023). Furthermore, the monetization of water through vendors, particularly in periods of scarcity, exacerbates inequalities by placing additional financial strain on low-income households (Agbo & Tanko, 2023).

Determinants of water source selection among households are influenced by a range of factors, including distance to source, perceived water quality, cost, seasonality, and socio-demographic characteristics such as income, education, and household size (Ajayi & Ibrahim, 2023). Perceptions of water safety and taste play a critical role in shaping preferences, with borehole water being the most trusted and preferred for drinking, while streams are least favored due to visible contamination risks (Ajayi & Ibrahim, 2023). Recent statistical analyses confirm that these perceptions, alongside logistical considerations, are significant predictors of household water source choices (Eze et al., 2023).

In response to these complex challenges, government and development partners have implemented various interventions, including borehole rehabilitation, promotion of rainwater harvesting, and community-based water management schemes (Okoye et al., 2023). However, the effectiveness and sustainability of these efforts are often undermined by policy gaps, inadequate maintenance, and limited community engagement (Okoye et al., 2023). A comprehensive assessment of the patterns, challenges, and determinants of household water source utilization in Mangu LGA is therefore essential for informing more effective, context-specific interventions and ensuring sustainable water security for all residents.

MATERIALS AND METHODS

Mangu Local Government Area (LGA) is located in Plateau State, situated in the central region of Nigeria. It lies approximately 70 kilometers southeast of Jos, the state capital, and is part of the North Central geopolitical zone. Mangu serves as both the administrative headquarters and the main town within the LGA. The area is well-positioned on the Jos–Shendam road, making it a key transit point between various towns and rural communities in Plateau State. The location provides strategic access for agricultural trade and regional communication.

In terms of size, Mangu LGA spans an estimated area of about 1,653 square kilometers. This relatively expansive landmass supports a mix of urban and rural settlements, with numerous villages spread throughout the area. The LGA has a substantial population, with tens of thousands of residents engaged primarily in farming, trading, and local crafts. The size of the region contributes significantly

to its agricultural productivity, especially in the cultivation of crops like maize, potatoes, and vegetables, which are vital to both local consumption and the state's economy.

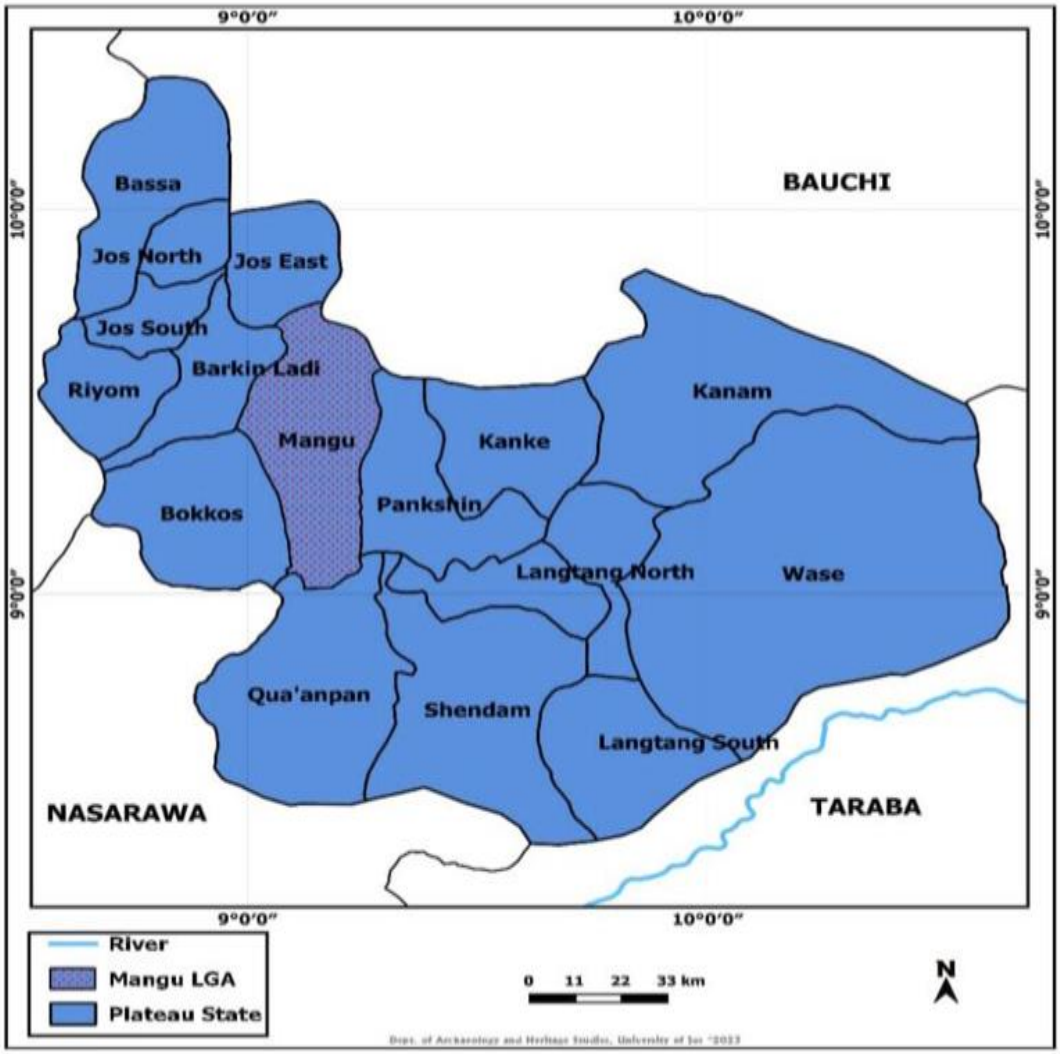

Figure 1: Plateau State showing the study area
Source: Plateau State Geographic Information Service 2013

The study employed a mixed-methods design integrating quantitative surveys and qualitative interviews to comprehensively examine water access and its impact on rural livelihoods. Data were collected from 420 households across six purposively selected communities using stratified random sampling, complemented by 12 key informant interviews and six focus group discussions. Primary data on water sources, consumption patterns, livelihood activities, and barriers to water access were gathered through structured questionnaires, interviews, focus groups, and field observations, while secondary data were drawn from government and NGO reports. Rigorous validation processes ensured reliability and ethical standards were maintained throughout. Quantitative data were analyzed statistically with SPSS and R, and qualitative data underwent thematic content analysis using NVivo, with findings triangulated to enhance validity. This approach enabled a nuanced

understanding of seasonal water availability, usage behaviors, socio-economic impacts, and community-driven solutions, providing a robust basis for policy recommendations on sustainable water management and rural development.

RESULT

Water Sources in Mangu Local Government Area

Access to clean and reliable water sources remains a significant challenge in many rural communities in Mangu Local Government Area (LGA). It is found that the primary sources of household water are boreholes, hand-dug wells, and natural surface water bodies such as streams and rivers. According to the data presented in Figure 2, boreholes are the most frequently used source of water, serving 35.71% of the households surveyed.

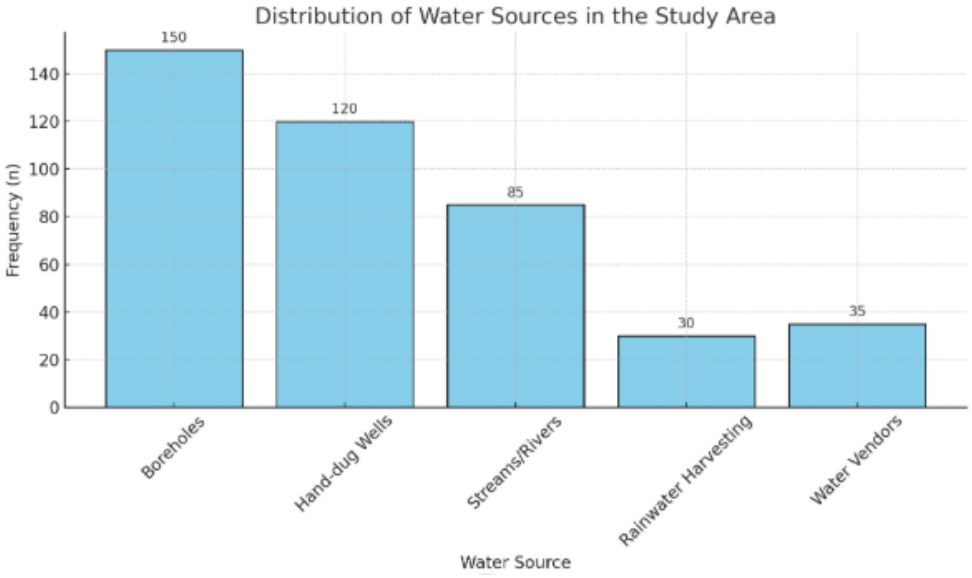

Figure 2: Distribution of Water Sources in the study area
Source: Authors Field Work 2024

This is followed closely by hand-dug wells, which account for 28.57% of household water use. Streams and rivers also play a critical role, providing water to 20.24% of the population. In contrast, rainwater harvesting (7.14%) and water vendors (8.33%) are used to supplement these primary sources, particularly during periods of scarcity or in areas where groundwater access is limited.

These findings are consistent with previous studies, including UNICEF's 2021 report, which emphasized that groundwater sources—primarily boreholes and wells—remain the most relied-upon water sources in rural Nigerian communities. This reliance on groundwater is often due to its relative availability, lower contamination risk compared to surface water, and the absence of centralized piped water systems in many rural settings.

However, recent research has brought attention to several nuances and emerging challenges. For instance, a 2023 study by Okoye and colleagues published in the *Journal of Water, Sanitation & Hygiene for Development* noted a growing concern over the sustainability of groundwater extraction in parts of North-Central Nigeria, including Plateau State. The study highlighted declining water tables in

areas heavily reliant on boreholes, suggesting a need for better regulation and monitoring of groundwater use. Conversely, a 2022 study by Musa et al. found that while boreholes remain dominant, community-based rainwater harvesting systems have gained popularity in some rural areas due to increased awareness and the promotion of low-cost storage technologies by NGOs.

The result from Mangu LGA also reflects broader patterns of water access disparities, where households often rely on a mix of sources to meet their daily needs. The relatively high usage of hand-dug wells and streams points to gaps in infrastructure development and the limitations of groundwater access for all. The use of vendors—although minimal—indicates a monetization of water access, which may place financial strain on poorer households, especially during dry seasons.

Categorization of Water Sources by Ownership

To further understand the patterns of water access in Mangu Local Government Area (LGA), water sources were categorized based on their typical ownership and management structures. This categorization is consistent with water governance literature in rural sub-Saharan Africa, which emphasizes a mix of public provision, community-led systems, and informal private sector involvement (UNICEF, 2021; WHO/UN-Water, 2023).

Boreholes and **hand-dug wells**, together account for 64.28% of water access in the study area, are primarily government- or community-based systems. (Table 1)

Table 1: Categorization of Water Sources by Ownership

Water Source	Percentage (%)	Ownership Category
Boreholes	35.71	Government/Community-Based
Hand-dug Wells	28.57	Government/Community-Based
Streams/Rivers	20.24	Private/Unregulated
Rainwater Harvesting	7.14	Mixed (Govt/NGO & Private)
Water Vendors	8.33	Private/Commercial

Source: Authors Field Work 2024

Boreholes, often constructed through state or NGO programs, are favored for their ability to tap into relatively safe groundwater. This aligns with UNICEF's (2021) findings, which identify boreholes as the cornerstone of rural water access in Nigeria due to their safety and relative resilience to seasonal variation.

Similarly, **hand-dug wells**, though sometimes constructed by individual households, are frequently part of community-managed water systems or are legacy projects of earlier government schemes. According to Olanrewaju et al. (2022), the communal management of wells remains prevalent in many rural Nigerian settings where state infrastructure is limited.

However, some recent studies caution that government and community systems, particularly boreholes, face long-term sustainability challenges. **Okoye et al. (2023)**, in their assessment of groundwater use in Plateau State, highlight significant declines in water tables in heavily borehole-dependent areas. They argue for the need to establish groundwater management frameworks and to integrate hydrogeological data into rural water planning—a strategy largely absent in current government interventions.

Streams and rivers (20.24%) fall under the **private/unregulated** category. These are natural water bodies accessed freely by households, typically without any formal control, regulation, or treatment. Their widespread use reflects significant infrastructure gaps, particularly in more remote or underserved communities. A study by **Adebayo et al. (2021)** found that reliance on surface water is often highest in communities with limited or no functioning groundwater infrastructure, and is associated with higher risks of waterborne diseases.

Rainwater harvesting (7.14%) presents a more complex ownership structure, involving both **private and public actors**. While some systems are installed by households independently, NGOs and donor agencies have increasingly promoted low-cost rainwater harvesting systems as climate-resilient alternatives in rural areas. For example, **Musa et al. (2022)** report growing acceptance of rainwater harvesting in parts of northern Nigeria, following public awareness campaigns and technical support from international NGOs. However, uptake remains modest in areas like Mangu LGA, where erratic rainfall and poor storage facilities limit widespread adoption.

Water vendors, representing 8.33% of access, are categorized as **private/commercial** sources. These vendors often source water from boreholes or wells and sell it at a cost, particularly during dry seasons. This dynamic introduces a monetized aspect to water access and raises concerns over equity. **Agbo and Tanko (2023)** found that water vending is expanding in peri-urban and rural Nigerian communities as a response to unreliable public supply, but note that this model disproportionately affects low-income households.

The data reflect a layered and hybrid water access system, where households rely on a combination of publicly supported infrastructure, community-managed resources, and informal or commercial alternatives. While government and NGO efforts have expanded access to relatively safer water sources (e.g., boreholes), the continued use of unregulated and private water sources—especially streams, vendors, and home-based harvesting systems—points to both infrastructure deficits and adaptive coping strategies.

Seasonality

In rural areas of Mangu Local Government Area (LGA), water access is deeply affected by seasonal fluctuations, which influence both the availability and the perceived reliability of different water sources. The result presented in Table 2 shows how household dependence on various sources shifts between the wet and dry seasons, revealing significant insights into the region's water security dynamics.

Table 2: Seasonality

Water Source	*Wet Season Usage (%)*	*Dry Season Usage (%)*	*Reliability Rating (1–5)*
Boreholes	38	44	4.5
Wells	32	22	3.2
Streams	18	10	2.8
Rainwater Harvesting	8	0	1.0
Water Vendors	4	24	4.0
Total	**100**	**100**	—

Source: Authors Field Work 2024

Table 2 indicates that boreholes emerge as the most consistently reliable water source throughout the year. During the wet season, 38% of households rely on boreholes, and this figure increases to 44% during the dry season. This slight increase suggests that when other sources diminish or disappear due to the dry climate, more households fall back on boreholes. Correspondingly, boreholes receive the highest reliability rating of 4.5 out of 5, reflecting users' trust in their consistent performance, especially in times of scarcity.

Wells serve as an important supplementary source, particularly in the wet season, when 32% of households use them. However, the usage of wells drops significantly to 22% in the dry season, likely due to falling water tables and reduced recharge rates. This seasonal variability affects their perceived reliability, which is rated at a moderate 3.2. Similarly, streams are more accessible in the wet season (18%) than in the dry season (10%), and they score a lower reliability rating of 2.8, indicating susceptibility to drying up and contamination.

Rainwater harvesting, while briefly useful during the rainy months (used by 8% of households), is entirely absent as a water source in the dry season (0%). This makes it the least reliable option overall, with a reliability rating of just 1.0. This underscores a common limitation in relying solely on rain-fed systems in the absence of sufficient storage capacity or integrated planning for off-season use.

Interestingly, water vendors represent a stable source of water during the dry season, used by 24% of households compared to just 4% in the wet season. Their relatively high reliability rating of 4.0 reflects their availability when natural sources diminish. However, this option often comes with significant cost implications, raising concerns about affordability and equitable access, particularly for low-income households.

These patterns reinforce the critical issue of seasonal water insecurity in rural Nigerian settings. The correlation between usage rates and perceived reliability highlights the structural dependence on boreholes, while simultaneously exposing vulnerabilities associated with other sources. Recent studies support these observations. A 2023 report by the Nigeria Integrated Water Resources Commission found that while boreholes offer year-round functionality, maintenance challenges and declining aquifer levels in over-exploited zones are rising concerns. Meanwhile, initiatives promoting improved rainwater harvesting have yet to overcome barriers related to infrastructure and seasonal limitations.

Distance and Time Spent to Access Water

Access to water in rural communities is not only a matter of availability but also of physical accessibility. In Mangu Local Government Area (LGA), the burden of collecting water falls heavily on households, particularly on women and children, who are often responsible for this daily task. Results from Table 3 reveals that a significant proportion of households—specifically, 64.3%—travel between 0.5 and 2 kilometers to reach their water sources. Of this group, 38.1% walk between 0.5 and 1 kilometer, while 21.4% travel between 1 and 2 kilometers. A smaller yet notable segment, 14.3%, must cover distances exceeding 2 kilometers. In contrast, only 26.2% of households have relatively close access, walking less than 0.5 kilometers to fetch water.

Table 3: Distance to Water Source and Time Spent per Trip

Distance Category (km)	Households (n)	Percentage (%)	Avg. Time (mins)
<0.5	110	26.2	10
0.5–1	160	38.1	20
1–2	90	21.4	30
>2	60	14.3	45

Source: Authors Field Work 2024

These distances translate directly into time spent per trip. Households located less than 0.5 km from a water source report an average round-trip time of just 10 minutes. However, those walking between 0.5 and 1 km spend about 20 minutes, and this increases to 30 minutes for the 1–2 km category. Households traveling more than 2 kilometers spend approximately 45 minutes on each trip. This time expenditure is not trivial. It has significant implications for household productivity, educational attendance—particularly for school-aged girls—and overall well-being. These findings are consistent with broader global research, such as the World Bank's 2022 report on rural water access, which identifies time poverty due to water collection as a critical barrier to economic and educational advancement for women and girls in sub-Saharan Africa.

To further examine the relationship between distance and time burden, a one-way Analysis of Variance (ANOVA) was conducted. The results indicate a statistically significant difference in the time spent collecting water across distance categories ($p < 0.01$). This confirms that travel distance is a strong predictor of time burden, supporting the argument that physical access remains a critical dimension of water insecurity. It also underscores the need for more localized water infrastructure to reduce travel distances, thereby alleviating the socio-economic costs borne by rural households.

Recent literature corroborates these findings. A 2023 study by Eze et al. found that communities with decentralized water access points within 500 meters of homes showed marked improvements in school attendance and maternal income-generating activities. Conversely, areas requiring long treks to water sources reported higher incidences of fatigue, absenteeism from school, and time lost from farming or household duties.

Perceived Water Quality and User Preferences

Perception plays a critical role in shaping water usage behaviors, especially in rural communities where access to multiple water sources exists but varies significantly in quality. In Mangu Local Government Area (LGA), borehole water is not only the most frequently used source but also the most trusted and preferred for drinking. As shown in Figure 3, 35% of respondents perceive borehole water as the safest, and 40% prefer it for drinking. This preference is also supported by the highest average taste quality rating of 4.3 out of 5. These findings reinforce the dominant role boreholes play in the water security landscape of the region, not just in terms of physical access but also in terms of user confidence in water safety and palatability.

Conversely, stream water is the least preferred and least trusted source for drinking, with only 10% of respondents perceiving it as safe and a mere 5% preferring it for consumption. Its low taste quality rating of 2.2 further underscores this negative perception. These views likely stem from the visible exposure of stream water to contaminants, runoff, and human or animal activity, which heightens concerns about microbial and chemical contamination. The negative perception of stream water

aligns with broader findings in rural water research, such as those reported by WHO (2022), which identified unprotected surface water as the riskiest source in terms of waterborne diseases, especially in low-income settings.

Rainwater harvesting and water from vendors occupy a middle ground. Both are perceived as safe by 15% of respondents, yet vendor water enjoys a slightly higher preference for drinking (20%) compared to rainwater (15%), likely due to the latter's seasonal limitations and storage concerns. Interestingly, vendor-supplied water has a high taste rating of 4.1, closely following boreholes, suggesting that commercial suppliers often draw from treated or relatively clean sources. Hand-dug wells fall in between, with moderate ratings for safety (25%), preference (20%), and taste (3.5).

A correlation analysis between safety perception and drinking preference revealed a strong positive relationship ($r = 0.78$), indicating that the safer a water source is perceived to be, the more likely it is to be chosen for drinking. This statistically significant correlation underscores the importance of trust in determining household behavior around water use. When households believe a source is safe, they are more likely to prioritize it for drinking purposes, which has direct implications for health and sanitation interventions.

Recent studies support this behavioral insight. For instance, a 2023 study by Ajayi and Ibrahim in the *Journal of Environmental Health Research* found that households in rural Plateau State showed a clear preference for water sources they perceived as safer, even when alternative sources were physically closer. Their study concluded that risk perception, especially regarding waterborne diseases like cholera and typhoid, strongly influences water source selection in rural Nigerian contexts.

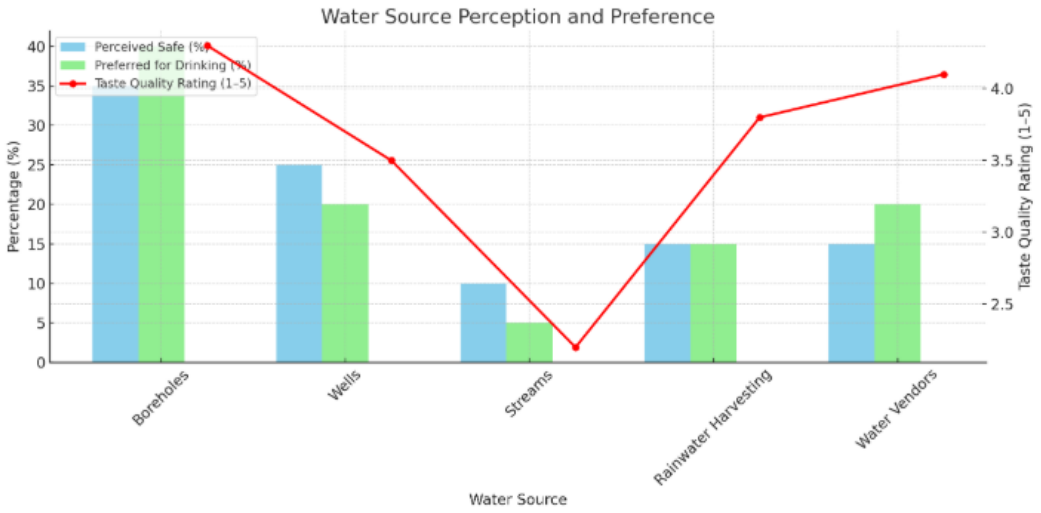

Figure 3: Perceptions of Water Safety, Taste, and Usage Preference
Source: Authors Field Work 2024

Distribution of Water Sources across Communities

Water access in rural settings often varies not just between households but across entire communities, depending on infrastructure availability, geography, and local governance. In Mangu Local Government Area (LGA), such spatial disparities are clearly illustrated in the differing access levels among its constituent communities. Table 4 presents access scores for six communities based

on their primary water source, revealing significant inequalities in the quality and reliability of water access.

Table 4: Primary Water Sources and Access by Community

Community	Primary Source	Access Score (1–5)
Pushit	Borehole	4.2
Kerang	Wells	3.0
Ampang-West	Stream	2.5
Langai	Borehole	4.0
Fwangroi	Vendors	2.8
Jipal	Wells	3.1

Source: Authors Field Work 2024

Pushit and Langai report the highest access scores of 4.2 and 4.0, respectively. These communities benefit primarily from functional boreholes, which are widely regarded as the most reliable year-round water source in the region. The high scores in these areas reflect not only the presence of boreholes but also their operational status and proximity to users. In contrast, Ampang-West and Fwangroi score substantially lower, at 2.5 and 2.8, respectively. Ampang-West relies predominantly on stream water, which is seasonal and susceptible to contamination, while Fwangroi depends on water vendors—a source that, although consistent, imposes a financial burden on residents. These communities experience greater water insecurity, both in terms of reliability and affordability.

Kerang and Jipal, which primarily rely on hand-dug wells, fall in the middle of the spectrum with access scores of 3.0 and 3.1. While these sources are more stable than streams, they are less dependable than boreholes, especially during the dry season when groundwater levels drop. The variation in these scores reflects the broader reality that access is not uniform, even within a single local government area.

To quantify these differences statistically, a Chi-square test of independence was conducted to examine the variation in access scores across communities. The test produced a chi-square value of 22.4 with 5 degrees of freedom, which was statistically significant at $p < 0.001$. This result confirms that water access is not evenly distributed and that the disparities observed across communities are unlikely to be due to chance. Instead, they point to systemic differences in infrastructure, investment, and perhaps local management of water systems.

CONCLUSION

This study highlights the complex and complex nature of household water source utilization in Mangu Local Government Area, Plateau State. Households rely on a combination of boreholes, hand-dug wells, streams, and rainwater harvesting to meet their water needs, with significant seasonal variation influencing source preference and reliability. Despite the predominance of boreholes as a relatively safe and reliable source, challenges such as groundwater depletion, infrastructure deficits, and inequitable access persist. The physical burden of water collection, especially on women and children, alongside disparities in water quality and affordability, underscores the socio-economic implications of water insecurity in the region. Addressing these challenges requires integrated water resource management approaches that consider both technical

and social dimensions to ensure sustainable and equitable water access for all communities within Mangu LGA.

RECOMMENDATIONS

- Expand and Sustain Borehole Infrastructure: Government and development agencies should prioritize the expansion of borehole networks and ensure their regular maintenance to provide consistent and safe water supply, particularly in underserved communities.
- Promote Community-Based Water Management: Strengthening community participation in water source management can enhance ownership, sustainability, and timely maintenance of water infrastructure.
- Improve Water Quality Monitoring and Treatment: Regular monitoring of both groundwater and surface water sources is essential to safeguard public health, coupled with interventions to treat contaminated water where necessary.
- Reduce Physical Burden of Water Collection: Decentralizing water points to reduce travel distances can alleviate the time and labor burden on women and children, improving their well-being and socio-economic opportunities.
- Integrate Water Access with Livelihood Support: Water supply initiatives should be linked with programs aimed at improving agricultural productivity and income generation to enhance overall rural livelihoods.
- Raise Awareness and Promote Water Conservation: Educational campaigns on water conservation and hygiene practices should be intensified to optimize water use and reduce wastage, especially during dry seasons.

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