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Assessment of Households' Access to Domestic Water Supply in Keffi Urban Area, Nasarawa State

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ABSTRACT

This study assessed household water accessibility in Keffi, Nigeria, with emphasis on sources, service conditions, consumption, and socioeconomic determinants. A cross-sectional survey of 382 households was conducted using structured questionnaires, and data were analysed using descriptive and inferential statistics. Results showed that boreholes were the dominant water source (42.9%), followed by private piped connections (18.3%) and vendor/sachet water (16.2%), while government supply accounted for only 14.1%. Although 57.1% of households accessed water within 500 m and 59.6% spent ≤10 minutes reaching sources, only 20.9% had daily supply, indicating poor service reliability. Average water consumption was approximately 85 L/person/day, below the recommended 120 L standard, with 56.6% of households consuming less than 100 L/day. Water affordability was a major concern, as households spent about 10% of income on water, exceeding the 5% benchmark. Access to improved water sources increased significantly with income, from 47.0% among low-income households to 86.5% among high-income groups. Statistical analysis confirmed a significant relationship between income and water accessibility ($\chi^2 = 102.38$, $p < 0.001$), with income emerging as the strongest predictor ($\beta = 0.383$, $p < 0.001$; $R^2 = 0.233$). Perception analysis revealed general dissatisfaction with water reliability, affordability, and government performance (overall mean = 2.95), alongside strong demand for improved planning (mean = 4.74). The study concludes that water accessibility in Keffi is constrained primarily by service inefficiencies and socioeconomic inequality rather than physical distance, highlighting the need for improved infrastructure and equitable water policies.

Keywords: Water accessibility; Domestic water supply; Improved water sources; Water affordability; Service reliability; Nigeria.

INTRODUCTION

Access to safe and reliable domestic water remains one of the most critical determinants of public health, environmental sustainability, and socioeconomic development. Adequate water supply supports hygiene, sanitation, food security, and economic productivity, while inadequate access increases vulnerability to waterborne diseases and constrains human well-being (Gleick, 2019; Hrudey & Hrudey, 2020; Prüss-Ustün et al., 2019). Despite global commitments under Sustainable Development Goal 6 (SDG 6) to ensure universal access to safe water and sanitation, progress remains uneven, particularly across developing countries where rapid urbanization, population growth, climate variability, and inadequate infrastructure continue to undermine water security (United Nations, 2015; Sustainable Development Goals, 2023).

Nigeria exemplifies these challenges. Although the country possesses substantial surface and groundwater resources, access to safe and reliable domestic water remains inadequate for a large proportion of the population. Recent evidence indicates that only about 42% of Nigerians have access to both improved water sources and sanitation facilities (Edefo, 2025). Increasing urban expansion has been associated with declining groundwater quality and heightened contamination risks (Ojo et al., 2024), while governance constraints, inadequate funding, and fragmented institutional arrangements continue to hinder effective water resource management (Adamu, 2024). Consequently, many households rely on multiple water sources, including boreholes, wells, rainwater

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harvesting systems, and water vendors, to cope with unreliable public water supply (Agbonaye & Eboi, 2024; Soladoye & Adepoju, 2025).

The challenge is particularly evident in Nasarawa State, where disparities in water quality and accessibility persist across communities. Studies have reported contamination of surface and well water sources, inadequate piped water supply, and household water consumption levels below recommended standards (Chunwate et al., 2021; Sodangi et al., 2023). Although recent government interventions, including the provision of solar-powered boreholes, aim to improve water access, concerns remain regarding the adequacy, affordability, reliability, and safety of domestic water supply, especially in rapidly growing urban centres such as Keffi.

Existing studies in Nigeria and Nasarawa State have largely concentrated on water quality assessment, groundwater potential, and general community-level water supply conditions (Aikowe & Mazancová, 2021; Balogun et al., 2019; Sodangi et al., 2023). However, there remains limited empirical evidence on household-level access to domestic water supply in Keffi, particularly regarding the combined influence of water source dependence, accessibility, affordability, reliability, and household coping strategies. This knowledge gap restricts a comprehensive understanding of how residents obtain and manage domestic water and constrains the development of evidence-based interventions tailored to local needs.

Against this backdrop, the present study investigates household access to domestic water supply in Keffi, Nasarawa State, Nigeria. Specifically, it examines the sources, accessibility, affordability, reliability, and challenges associated with household water supply in order to provide empirical evidence that can support sustainable water resource management, improved service delivery, and enhanced water security in the study area.

Materials and Methods

Study Area and Population

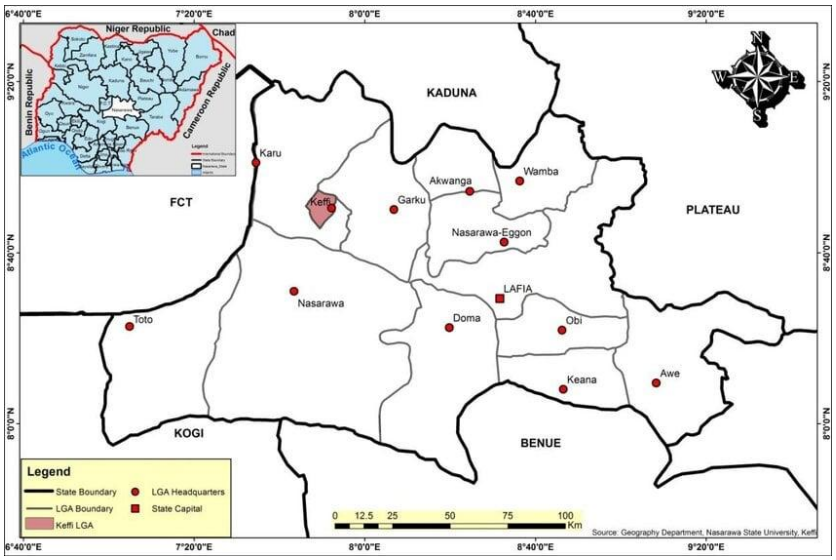


Figure 1: Map of Nasarawa State Showing Keffi Lga

The study was conducted in Keffi Urban Area, Nasarawa State, Nigeria. The base population of 92,664 recorded in the 2006 national census was projected to 2025 using an annual growth rate of 2.8%, yielding an estimated population of 156,593. Adopting an average household size of five persons, the total number of households was estimated at 31,319.

The base population of the study area as at the 2006 population census conducted by the Federal Government of Nigeria was 92,664. This population is therefore projected to the research period which is 2025 (19 years projection at 2.8% growth rate) using the Exponential Model

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$PT = P_o (1 + r)^n$

Where:

PT = Projected population

P_o = Base population = 92,664

r = Growth Rate = 2.8%

n = Number of years for which projection is made = 19 years

Thus:

$PT = P_o (1 + r/100)^n$

$PT = P_o (1+2.8/100)^n$

$PT = 92,664 (1+0.028)^{19}$

$PT = 92,664 (1.028)^{19}$

PT = 92,664 x 1.6899

PT = 156,593

Therefore, the total sample frame for this study is 156,593 people.

However, the average household size in Nigeria according to the 2013 Nigeria Demographic and Health Survey (NDHS) was 4.6 persons per household. Therefore, for this study we are adopting 5 persons per household. Thus, the total number of households in Keffi urban area is:

$$\frac{156,593}{5} = 31,319$$

Sample Size and Sampling Procedure

The sample size was determined using the Taro Yamane (1967) formula at a 5% margin of error, resulting in 399 respondents. The sample was proportionally distributed across eight neighborhoods (Yara, Tudun Kofa, Gangaren Tudu, Kofar Goriya, Angwan Rimi, Kofar Hausa, Liman Abaji, and Sabon Layi) based on their population sizes.

This refers to the population size that was used to represent the overall population in the study area. Yaro Yamane (1967) model for calculating sample size was adopted for the purpose of this study

Formula:

$$n = \frac{N}{1+N\,(e)^2}$$

Where:

n = sample size

N = total population

e = exponential/margin of error = 0.05

1 = constant value

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$$n = \frac{156{,}593}{1 + 156{,}593\ (0.05)^2}$$

$$n = \frac{156{,}593}{1 + 156{,}593\ (0.0025)}$$

$$n = \frac{156{,}593}{1 + 391.4825}$$

$$n = \frac{156{,}593}{392.4825}$$

n = 399.98

n ≈ 399 respondents.

A multi-stage sampling technique was employed. First, the study area was stratified into neighbourhoods (clusters). Second, households within each cluster were selected using systematic random sampling at a fixed interval. Additionally, purposive sampling was used to select key informants, including water vendors, community leaders, and relevant officials.

Table 1: Sample Size for Cluster Areas or Neighbourhoods

S/N	Sample Cluster Area	Population	Percentage	Allocated Sample Size
1	Yara	28,187	18	72
2	Tudun Kofa	23,489	15	60
3	Gangaren Tudu	18,791	12	48
4	Kofar Goriya	15,659	10	40
5	Angwan Rimi	17,225	11	44
6	Kofar Hausa	14,093	9	36
7	Liman Abaji	18,791	12	48
8	Sabon Layi	20,357	13	51
	TOTAL	156,593	100	399

Data Collection

A mixed-methods approach combining quantitative and qualitative techniques was adopted. Primary data were collected through structured questionnaires administered to household heads. Supplementary information was obtained through field observation and key informant interviews to capture insights on water supply systems and challenges.

Data Analysis

Data were analysed using both descriptive and inferential statistical methods. Descriptive statistics (frequencies, percentages, and means) were used to summarize household characteristics and water access indicators. Inferential statistics, including chi-square tests, Spearman correlation, and multiple regression analysis, were used to examine relationships between socioeconomic factors and water accessibility. Results were presented using tables and charts for clarity.

RESULTS

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Socioeconomic Characteristics of Respondents

The socioeconomic characteristics of respondents are presented in Table 2. Males constituted 51.8% of respondents, while females represented 48.2%. The largest age group was 31–40 years (37.2%). Most respondents possessed secondary education (38.7%), while civil servants accounted for the largest occupational category (31.4%).

Table 2. Socioeconomic Characteristics of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	198	51.8
	Female	184	48.2
Age	Below 20	28	7.3
	21–30	88	23.0
	31–40	142	37.2
	41–50	78	20.4
	Above 50	46	12.1
Education	No formal education	34	8.9
	Primary	66	17.3
	Secondary	148	38.7
	Tertiary	134	35.1
Occupation	Civil servant	120	31.4
	Trader	98	25.6
	Artisan	72	18.8
	Student	48	12.6
	Unemployed/Others	44	11.5
Income (₦)	<20,000	86	22.5
	20,000–49,999	144	37.7
	50,000–99,999	104	27.2
	≥100,000	48	12.6
Household size	1–3	58	15.2
	4–6	176	46.1
	7–9	112	29.3
	≥10	36	9.4

Sources of Domestic Water Supply

Table 3 presents the major sources of domestic water supply among households in Keffi. Boreholes constituted the dominant source, accounting for 42.9% of household water supply. Private piped connections accounted for

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18.3%, while vendor, sachet, and bottled water sources contributed 16.2%. Wells supplied 11.0% of households, public standpipes accounted for 10.5%, and stream/rainwater sources represented only 1.1%.

Table 3. Sources of Domestic Water Supply

Source	Frequency	Percentage (%)
Borehole	164	42.9
Private tap (piped)	70	18.3
Public standpipe	40	10.5
Vendor/Sachet/Bottled	62	16.2
Well	42	11.0
Stream/Rainwater	4	1.1
Total	382	100

Distance and Time to Water Source

The distribution of respondents according to distance and travel time to water sources is presented in Table 4. Approximately 31.4% of respondents accessed water sources located between 100 and 500 m from their residence, while 26.8% travelled less than 100 m. Regarding travel time, 31.9% spent between 5 and 10 minutes reaching their water source.

Table 4. Distance and Time to Water Source

Distance	Frequency	Percentage (%)	Time to Source	Frequency	Percentage (%)
Within compound	98	25.7	< 5 min	106	27.7
< 100 m	102	26.8	5–10 min	122	31.9
100–500 m	120	31.4	11–20 min	82	21.4
500–1000 m	42	11.0	21–30 min	46	12.0
> 1 km	20	5.1	> 30 min	26	7.0
Total	382	100	Total	382	100

Regularity and Cost of Water Supply

Table 5 shows the frequency of water supply and daily expenditure on water. Only 20.9% of households reported receiving water daily, while 30.1% obtained water three to five times weekly. In terms of expenditure, 28.8% spent between ₦200 and ₦500 daily on water, whereas 21.2% incurred no direct costs because they relied on self-supplied sources.

Table 5. Regularity and Cost of Water Supply

Frequency of Supply	Percentage (%)	Daily Cost (₦)	Percentage (%)
Daily	20.9	None (own source)	21.2
3–5 times/week	30.1	< 200	20.1

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1–2 times/week	22.0	200–500	28.8
Occasionally	17.0	501–1000	18.1
Rarely	10.0	> 1000	11.8
Total	100	Total	100

Daily Water Consumption

Table 6 shows household daily water consumption. The majority of respondents (39.8%) consumed between 50 and 100 litres per person per day, while 16.8% consumed less than 50 litres per person per day. Only 3.1% consumed more than 200 litres daily.

Table 6: Daily Water Consumption

Daily Use (L/person/day)	Frequency	Percentage (%)	Evaluation
< 50	64	16.8	Low access
50–100	152	39.8	Low access
101–150	104	27.2	Adequate
151–200	50	13.1	Good
> 200	12	3.1	High
Total	382	100	

Collection Time and Number of Water Collection Trips

Table 7 presents collection time and number of trips made daily to obtain water. About 33.0% of respondents spent 10–20 minutes collecting water, while 31.4% reported making three trips per day.

Table 7: Collection Time and Number of Trips

Collection Time	Frequency	Percentage (%)	Trips/Day	Frequency	Percentage (%)
<10 min	86	22.5	1	50	13.1
10–20 min	126	33.0	2	100	26.2
21–30 min	84	22.0	3	120	31.4
31–60 min	56	14.7	4	74	19.3
>1 hr	30	7.8	≥5	38	9.9
Total	382	100	Total	382	100

Water Service Providers

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Table 8 shows the major water service providers. Private vendors constituted the largest provider category (43.5%), followed by self-supply systems (26.2%). Government agencies accounted for only 14.1% of household water supply.

Table 8: Water Service Providers

Provider	Frequency	Percentage (%)
Government	54	14.1
Private/Vendor	166	43.5
Community	44	11.5
NGO	18	4.7
Self-supply	100	26.2
Total	382	100

Household Income and Access to Improved Water Sources

Table 9 presents the relationship between income level and access to improved water sources. Access to improved sources increased progressively with income level, ranging from 47.0% among households earning less than ₦20,000 monthly to 86.5% among households earning at least ₦100,000 monthly.

Table 9: Household Income and Access to Improved Water Sources

Income (₦/month)	Improved Sources (%)	Unimproved Sources (%)
<20,000	47.0	53.0
20,000–49,999	63.9	36.1
50,000–99,999	74.0	26.0
≥100,000	86.5	13.5

Perception of Water Accessibility

Respondents' perceptions of water accessibility are summarized in Table 9. The highest mean score was recorded for the need for better planning and management (Mean = 4.74), while government performance received the lowest rating (Mean = 2.20).

Table 10. Perception of Water Accessibility

Statement	Mean	Interpretation
Water supply is regular and reliable	2.36	Disagree
Distance to source is convenient	3.68	Agree
Time spent fetching water is reasonable	2.80	Neutral
Daily quantity is adequate	2.54	Disagree
Cost is affordable	2.40	Disagree

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Water quality is good	3.09	Neutral
Meets planning/health standards	2.28	Disagree
Satisfaction with provider	2.42	Disagree
Government performing well	2.20	Disagree
Need for better planning and management	4.74	Strongly Agree

Overall Mean = 2.95

Comparison of Water Accessibility Indicators with Standards

Table 11 compares observed water accessibility indicators with WHO and Nigerian standards.

Table 11. Comparison with Standards

Indicator	Standard	Keffi Average	Evaluation
Distance to source	≤1 km	0.5 km	Meets
Quantity/person/day	120 L	85 L	Below
Supply frequency	Daily	3–4 times/week	Below
Safe source coverage	≥80%	70%	Below
Cost affordability	≤5% income	~10% income	Below

Relationship Between Household Characteristics and Water Accessibility

Table 12: Cross-tabulation of Income and Water Accessibility

Income Category (₦/month)	High Access	Medium Access	Low Access	Total
<20,000	10	30	46	86
20,000–49,999	40	70	34	144
50,000–99,999	60	34	10	104
≥100,000	36	8	4	48
Total	146	142	94	382

Chi-square test results indicated a significant association between household income and water accessibility ($\chi^2 = 102.38$, df = 6, $p < 0.001$).

Table 12. Spearman Rank Correlation Between Income and Accessibility

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Variable	Spearman's ρ	p-value
Income and Accessibility	0.481	<0.001

Table 13. OLS Regression Results for Predictors of Water Accessibility

Predictor	B	SE	t	P
Constant	0.951	0.184	5.158	<0.001
Income	0.383	0.037	10.313	<0.001
Household Size	0.026	0.042	0.625	0.532
Distance	0.040	0.031	1.296	0.196
Cost	0.049	0.027	1.794	0.074
Regularity	0.004	0.028	0.126	0.900

Model Summary: $R^2 = 0.233$; N = 382.

DISCUSSION

The findings reveal that water accessibility in Keffi is shaped by both socioeconomic and service-related factors. The near-equal gender distribution and dominance of the economically active age group (31–40 years) suggest that water collection and management are shared responsibilities among households, consistent with patterns reported in urbanizing African communities (WHO/UNICEF, 2021). The predominance of respondents with secondary and tertiary education implies a relatively informed population; however, this did not translate into optimal water access, indicating structural supply constraints rather than knowledge gaps.

Boreholes emerged as the primary water source, reflecting the widespread reliance on self-supply systems in areas with inadequate public infrastructure. Similar trends have been documented in Nigeria and other developing regions, where households compensate for unreliable municipal systems through private sources (Adelana et al., 2011). The limited contribution of government supply (14.1%) further underscores institutional inefficiencies and the growing role of informal providers.

Although most households accessed water within 500 m and spent less than 10 minutes reaching sources, the frequency and reliability of supply were inadequate. Only 20.9% reported daily access, falling below WHO standards for continuous supply (WHO, 2017). This inconsistency contributes to coping strategies such as multiple daily trips and dependence on vendors, which increase both time burden and financial cost.

Water consumption levels were generally low, with over half of respondents using less than 100 L/person/day, below the recommended 120 L threshold. This shortfall has implications for hygiene and public health, supporting previous findings that insufficient water quantity increases vulnerability to disease (Howard & Bartram, 2003). Additionally, the average cost of water (~10% of household income) exceeds the affordability benchmark of 5%, placing disproportionate pressure on low-income households.

Income was the strongest predictor of water accessibility, as demonstrated by significant chi-square and regression results ($p < 0.001$). Higher-income households had greater access to improved sources and higher accessibility levels, confirming socioeconomic disparities in water provision (UNDP, 2020). The moderate

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positive correlation ($\rho = 0.481$) further indicates that improvements in household income are likely to enhance water access outcomes.

Perception data reinforce these objective findings, with respondents expressing dissatisfaction with reliability, affordability, and government performance, while strongly advocating for improved planning. The overall mean score (2.95) reflects moderate dissatisfaction, suggesting that current services fall short of user expectations.

Despite meeting distance standards, Keffi falls below national and international benchmarks in supply frequency, water quantity, and affordability. These gaps highlight the need for targeted interventions, including strengthening public water infrastructure, regulating private vendors, and implementing pro-poor pricing policies.

In summary, this study demonstrates that water accessibility in Keffi is constrained more by service delivery inefficiencies and economic inequalities than by physical proximity. Addressing these challenges requires integrated policy approaches that prioritize reliability, affordability, and equitable distribution.

LIMITATION OF THE STUDY

The study is limited by its cross-sectional design, restricted geographic scope and omission of factors such as seasonal variation and water quality, which may affect the generalizability and explanatory power of the findings.

CONCLUSION

This study assessed household water accessibility in Keffi and revealed significant gaps in adequacy, reliability, and affordability of water supply. Although a substantial proportion of households accessed water within acceptable distance limits, service delivery remains inconsistent, with most households receiving water less than daily. Boreholes and private vendors dominate as primary sources, highlighting the limited role of public water infrastructure.

Water consumption levels were generally below recommended standards, suggesting constrained access and potential implications for hygiene and health. Additionally, the cost of water exceeded affordability benchmarks for many households, particularly among low-income groups, indicating economic barriers to safe water access.

The analysis further established that household income is a critical determinant of water accessibility. Higher-income households were significantly more likely to access improved sources and achieve better water access levels, confirming the presence of socioeconomic inequalities. In contrast, variables such as household size, distance, and supply regularity showed weaker influence in predicting accessibility.

Perception results reinforced these findings, with respondents expressing dissatisfaction with water reliability, affordability, and government performance, while strongly advocating for improved planning and management.

Overall, the study concludes that water accessibility in Keffi is constrained more by systemic service delivery inefficiencies and economic disparities than by physical proximity to sources. Addressing these challenges requires strengthening public water infrastructure, improving supply reliability, regulating informal providers, and implementing equitable pricing policies to ensure sustainable and inclusive access to safe water.

Future studies should include objective water quality testing, climate variability indicators, and infrastructure assessments to provide a more comprehensive understanding of water access challenges. Expanding the study to multiple urban and rural locations would enhance external validity and facilitate comparative analysis. The authors may also explore advanced statistical models to examine interactions among socioeconomic, environmental, and institutional factors. Additional policy discussion on financing mechanisms, public-private partnerships, and sustainable water governance would further increase the practical contribution of the research.

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