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Dynamics of Urban Domestic Water Demand and Supply in Ilorin Metropolis, Kwara State of Nigeria: Implications for Sustainable Water Management

Ahmad-Tijani Usman[1], Omeiza Aliu Usman[2], Banwo Fawwaz Mobolaji[3], Ismail Abdulsalam[4], Silas Ojimaojo Umide[5] & Agu Emmanuel Chibuike[6]

[1]Department of Agricultural Engineering (Confluence University of Science and Technology, Osara CUSTECH, Nigeria).
[2]Department of Agricultural and Bioresources Engineering (Independent Researcher, Nigeria)
[3]Department of Agricultural and Bioresources Engineering (Federal University of Technology, Minna Nigeria)
[4]Department of Agricultural and Bioresources Engineering (Federal University of Technology, Minna Nigeria)
[5]Department of Civil and Mining Engineering (Confluence University of Science and Technology, Osara CUSTECH Nigeria)
[6]Department of Agricultural Engineering (Kwara State University, Nigeria)

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ABSTRACT

This study investigates the dynamics of household water demand and supply in Ilorin Central, focusing on socio-economic factors, water usage patterns, and infrastructural constraints affecting both availability and accessibility. A structured questionnaire was administered to 225 households across ten survey locations, and primary data were complemented with interviews from the Water Board to estimate water supply. The socio-economic analysis revealed a predominance of female respondents (68%), primarily within the 15–25 years age group (34.67%), highlighting the gendered responsibility of water collection. Most households were married (65.33%), with household sizes ranging predominantly from 6–10 members (49.33%), and the majority earned between N5,000–N20,000 per month (64.44%). Occupation-wise, 35.56% engaged in trading and 28% were artisans, while 37.11% of respondents had secondary education, and 29.78% had tertiary education, reflecting moderate literacy levels. Water demand analysis indicated that 70.11% of households relied on tap water, while boreholes (12.89%), wells (5.33%), rainwater (9%), and other sources (2.66%) contributed to lesser extents. A majority (76%) trekked 100–150 m to access water, with housewives (81.33%) bearing the primary responsibility for collection. Payment for water services was reported by 90.22% of households, with 58.22% paying N1,500 per month. Collection durations varied, with 49.33% spending 31–60 minutes per trip. Water storage was prevalent (89%), primarily using jerry cans (37.33%) and buckets (24.58%), to mitigate inconsistent supply. Total water demand across households amounted to 27,911.25 liters/day, with washing consuming 50.85%, other domestic uses 29.37%, drinking 11.3%, and cooking 8.48%. Analysis of the water supply from the Water Board revealed an estimated 300,000 liters/day distributed to approximately 10,000 households, equating to 30 liters per household or 190.2 liters per person per day. Factors affecting demand included bursting pipes (30%), construction activities (20%), and poor water board management (20%), while supply constraints were linked to inadequate electricity (28%), insufficient purification agents (20%), pipe leakage (16%), and topographical challenges (8%). Correlation analysis demonstrated a very high positive linear relationship ($r = 0.9996$) between household water demand and supply, which was statistically significant at 5% significance level ($t_{cal} = 141.36 > t_{critical} = 1.86$). The study concludes that despite a high positive correlation between water demand and supply, household access remains constrained by infrastructural inadequacies, socio-economic disparities, and gendered responsibilities. Recommendations emphasize the need for consistent supply, infrastructure maintenance, and community engagement to ensure equitable access. The findings provide critical insights for policymakers, urban planners, and water management authorities in addressing water accessibility challenges in urban Nigerian contexts.

1. Introduction

1.1 Background of the study

Access to safe and reliable domestic water is a fundamental pillar of public health, socioeconomic development, and sustainable urban living. Water demand and supply dynamics shape household welfare, influence disease morbidity, and determine resilience to environmental and demographic pressures in rapidly urbanizing settings globally (Fasuan et al., 2025; Melemi & Boniface, 2025). In Nigeria, the challenge of balancing rising domestic water demand with inadequate supply infrastructure has become more pronounced due to rapid urbanization, population growth, and limited investment in water utilities (Adeniran et al., 2021; Melemi & Boniface, 2025).

Ilorin Metropolis, as the capital of Kwara State, exemplifies these pressures: escalating water demand contrasts sharply with the limited capacity of public supply systems. Empirical assessments of Nigerian cities have documented substantial gaps between water needs and actual delivery, with households resorting to alternative sources such as boreholes, vendors, and water carting to meet daily needs (Bolade et al., 2025; Auwal et al., 2021). The domestic water deficit reflects not only physical scarcity but also institutional, infrastructural, and governance constraints that compromise service reliability and equity.

Existing evidence suggests that urban residents in many Nigerian contexts face water supply intermittency, long collection distances, and high opportunity costs associated with securing potable water, particularly affecting women and children who bear the brunt of household water collection responsibilities (Melemi & Boniface, 2025; Fasuan et al., 2025). Moreover, the seasonality of supplies and inadequate distribution networks exacerbate disparities in access and water security within metropolitan areas (Melemi & Boniface, 2025; Auwal et al., 2021).

Despite being endowed with significant surface and groundwater resources, Nigeria's water infrastructure development has lagged behind demographic and demand trends, constraining sustainable delivery at scale (Adeniran et al., 2021). This gap underscores the importance of quantitative assessments that examine both demand patterns and supply factors, identify determinants of water use behaviour, and inform strategic planning for equitable access and long-term water security.

In this context, the present study focuses on domestic water demand and supply in Ilorin Metropolis, Kwara State, with the aim of examining the sources of water, quantifying demand and supply disparities, and exploring the relationships and factors influencing these dynamics to support evidence-based water management.

1.2 Objectives of the Study

The aim of this study is to provide a rigorous socio-hydrological assessment of domestic water demand and supply in Ilorin Metropolis, Kwara State, with implications for urban water planning and management. Specifically, the study seeks to:

- Identify the primary sources of domestic water accessed by households in Ilorin.
- Assess the magnitude and pattern of domestic water demand among urban households.
- Evaluate the adequacy and reliability of water supply systems serving these households.
- Examine factors influencing water demand and supply, including socioeconomic and infrastructural variables.
- Analyze the relationship between household water demand and water supply to determine the extent of deficits and service gaps.

1.3 Statement of the Problem

In spite of significant water resource endowments and investments in water infrastructure, many urban generators such as Ilorin Metropolis continue to experience chronic gaps between domestic water demand and available supply. Previous local studies have indicated that inadequate distribution networks, intermittent supply, and infrastructure decay limit households' access to safe potable water (Melemi & Boniface, 2025; Auwal et al., 2021). The urban population is growing, yet water production and network coverage have not kept pace, creating persistent deficits that constrain household consumption, increase time spent in collection, and heighten health and socioeconomic vulnerabilities (Melemi & Boniface, 2025; Fasuan et al., 2025).

Existing research highlights broader systemic barriers in Nigeria's water sector, including inefficient utility performance, governance challenges, and uneven access across communities (Adeniran et al., 2021). However, quantitative data detailing the relationship between household water demand and public supply in Ilorin is limited, and few studies have used contemporary analytical techniques to examine this relationship in a structured scientific framework. This lack of localized, empirical evidence impedes effective planning, resource allocation, and policy formulation aimed at ensuring sustainable and equitable water access for urban households.

2. Literature Review

2.1 Introduction

Domestic water demand and supply in urban areas are central to the planning, delivery, and sustainability of water services. With the rapid growth of urban populations, especially in sub-Saharan Africa, understanding how households consume water and how supply systems respond has become a critical research and policy area (UN-Water, 2024). Urban water systems are complex socio-hydrological networks where demand patterns, infrastructure performance, institutional arrangements, and socioeconomic factors interact to shape access and sustainability (Melemi & Boniface, 2025; Fasuan et al., 2025). This literature review synthesizes recent empirical and theoretical insights on water demand and supply, with specific relevance to Nigerian urban contexts and Ilorin Metropolis in particular.

2.2 Conceptualizing Domestic Water Demand

Domestic water demand refers to the quantity of water required to satisfy household needs, including drinking, cooking, bathing, sanitation, and other domestic uses (WHO, 2023). At the urban household scale, demand is influenced by a combination of socioeconomic variables (income, family size, education), service attributes (reliability, distance to source), and behavioral norms (perceptions of hygiene, cultural practices) (Ramachandran et al., 2025).

Recent studies have documented that household water demand tends to be income-elastic but price-inelastic, meaning that wealthier households tend to consume more water, but changes in price do not substantially reduce consumption in the short term

(Schleich & Hillenbrand, 2007; Faiz & Rodriguez, 2024). In the Nigerian context, residential surveys in cities such as Kano and Maiduguri show that household consumption patterns vary with household structure, access to private connections, and water availability schedules (Auwal et al., 2021; Bada et al., 2021).

A key global water demand synthesis (UN-Water, 2024) reports that per capita domestic water use ranges widely — from 50 litres per day in low-income urban settlements to 250 litres per day in high-income cities - driven by lifestyle differences, appliance use, and access infrastructure. Urbanization, population growth, and rising living standards therefore create upward pressure on demand profiles, especially in emerging African megacities where infrastructure expansion lags behind demographic trends (Fasuan et al., 2025).

2.3 Water Supply Systems and Service Delivery Constraints

Water supply encompasses the collection, treatment, storage, and distribution of potable water to consumers through piped networks, standpipes, boreholes, and other sources (Adams et al., 2024). In many Nigerian cities, municipal water utilities operate under constraints including aging infrastructure, limited production capacity, intermittent supply schedules, and high non-revenue water losses (leakage, illegal connections) (Adeniran et al., 2021; Nwafor et al., 2024).

For instance, studies in urban Nigeria report that 50–70% of households receive piped water only intermittently (two to three days per week), forcing residents to supplement supply from private boreholes, vendors, or surface sources (Melemi & Boniface, 2025; Auwal et al., 2021). This intermittent supply pattern undermines reliability and increases the **transaction costs** — measured in time and money — that households expend to secure adequate water (Melemi & Boniface, 2025; Fasuan et al., 2025).

Research on water supply performance in Nigerian metropolises highlights three recurring constraints:

- Insufficient production capacity - due to limited treatment facilities and insufficient raw water abstraction relative to demand (Adeniran et al., 2021).
- Network inefficiencies — including leaks, low pressure, and outdated pipes that reduce effective delivery (Nwafor et al., 2024).
- Institutional and financial challenges — characterized by underfunded water utilities, weak cost recovery, and governance fragmentation (Adeniran et al., 2021; Fasuan et al., 2025).

These constraints not only reduce effective supply but also generate disparities in access within urban populations — often disadvantaging low-income or peri-urban neighborhoods.

2.4 Determinants of Households Water Demand

2.4.1 Socioeconomic and Demographic Determinants

Socioeconomic factors, particularly household income, size, and education, consistently influence residential water use. Schleich and Hillenbrand (2007) found that household size positively correlates with water demand, while price effects are muted due to the necessity nature of water consumption. Applied Water Science studies (2024) confirm that larger families, higher income groups, and households with modern water appliances consume more water in urban Nigeria, aligning with global patterns.

In Ilorin Metropolis, preliminary field evidence suggests that income and household composition are significant predictors of daily water consumption levels, with wealthier households reporting higher volumes and more frequent storage practices (Fasuan et al., 2025). These findings are consistent with urban water behaviour models which treat water consumption as both a utility good and a basic life necessity, shaped by entitlement and access (Ramachandran et al., 2025).

2.4.2 Service Reliability and Access Cost

Distance to source, time to collect, and reliability of supply have emerged as critical determinants of water demand in developing city contexts. Studies in Sub-Saharan Africa indicate that longer distances and longer collection times reduce effective use because households ration water consumption to minimize time burdens (Persson, 2002; Fasuan et al., 2025).

In Ilorin, prior household surveys reveal that significant portions of residents walk over 500 metres to reach water points, and many spend 30 minutes to over an hour per collection trip, a pattern that disproportionately affects women and children (Melemi & Boniface, 2025). These access burdens not only reduce water use efficiency but also impose economic and health costs on households.

2.5 Water Supply Gaps and Deficits in Urban Nigeria

A growing body of empirical research documents that urban water supply often fails to meet existing demand in Nigerian cities. Comparative studies in Kano, Maiduguri, and Lagos show supply deficits ranging from 30% to over 50% relative to projected demand at current consumption levels (Auwal et al., 2021; Bada et al., 2021; Nwafor et al., 2024). Such deficits arise not only from physical scarcity but from institutional bottlenecks, including poor maintenance, inadequate investment, and weak governance frameworks. Water utilities often operate under cost-recovery constraints, which limit maintenance and expansion efforts, exacerbating supply shortfalls as urban populations grow (Adeniran et al., 2021; Fasuan et al., 2025).

2.6 Integrated Demand-Supply Modeling Approaches

Quantitative modeling has become an essential tool for assessing water demand–supply dynamics, enabling planners to simulate future scenarios, forecast demand growth, and evaluate infrastructure requirements. Techniques such as econometric demand modeling, spatial regression, and system dynamics simulation have been applied in both developed and developing country contexts (Ramachandran et al., 2025).

In Sub-Saharan Africa, integrated models that combine demographic projections, supply capacities, and consumption patterns have improved predictions of future water needs and highlighted the critical role of non-linear demand drivers (Fasuan et al., 2025). However, there are few contemporary models tailored to mid-sized Nigerian cities like Ilorin, and existing studies often rely on outdated data or partial analytical frameworks. This gap underscores the need for updated, data-driven, and context-specific modeling approaches that capture the complex interactions among demand drivers, supply conditions, and infrastructure performance.

2.7 Synthesis and Research Gap

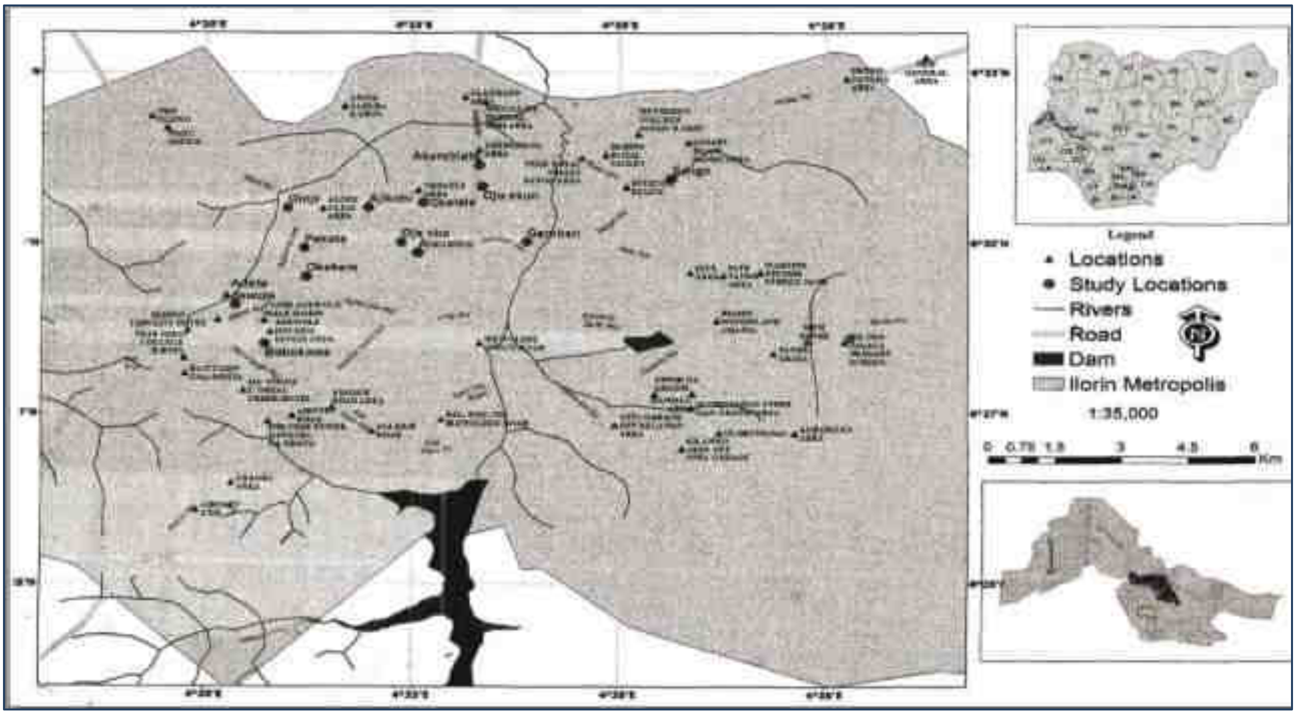
The literature establishes that urban domestic water demand and supply are shaped by multidimensional socioeconomic, institutional, and infrastructure factors. While national-level and cross-city studies provide valuable insights, there remains a critical lack of localized empirical research that integrates household water behaviour with municipal supply data to quantify the relationship between demand and supply in specific urban contexts such as Ilorin Metropolis.

Moreover, existing research often suffers from dated datasets and limited analytical depth, reducing its utility for contemporary planning and policy design (Adeniran et al., 2021; Melemi & Boniface, 2025). This study fills that gap by offering a rigorous analytical assessment of household water demand, supply conditions, and their interactions, using recent primary data and robust statistical methods.

3. Methodology

3.1 Study Area

- Location: Kwara State, Nigeria (8°–10°N, 3°–6°E), Ilorin Central is part of Ilorin Local Government. Borders include Niger, Kogi, Ekiti, Osun, Oyo, and Benin.
- Relief: Plateau-like surfaces, Sobi rock (~390m), Asa valley (~240–255m), some flood-prone areas.
- Climate: Tropical continental, wet season Mar–Oct, dry Nov–Mar, rainfall 1000–1500 mm, temperature 30–35°C.
- Soil: Ferruginous tropical soils and crystalline acid soils, good for crops.
- Vegetation: Derived savanna, scattered trees, grasses, dry lowland rainforest remnants.
- Population & Occupation: Industrious people; agriculture, trading, craftwork, civil service, livestock rearing. Predominantly Yoruba, Hausa, Fulani, and other ethnic groups.



3.2 Methodology

The methodology adopted for this study was rigorously designed to ensure scientific validity, replicability, and relevance to current research on urban water demand and supply dynamics in developing contexts. Urban water systems are increasingly subject to pressures from population growth, infrastructure limitations, and socioeconomic disparities (Soladoye & Adepoju, 2025). Understanding these dynamics requires reliable data collection, representative sampling, and robust analytical techniques.

3.2.1 Research Design

This study employed a quantitative, cross-sectional research design aimed at quantifying domestic water demand and supply conditions in Ilorin Central, Kwara State. A cross-sectional approach is appropriate for capturing spatial and temporal patterns of water demand and supply at a specific period, enabling comparisons across households and supply sectors (Melemi & Boniface, 2025). The research integrated descriptive and inferential statistical methods to analyze household behaviors, consumption patterns, access constraints, and the statistical relationship between water demand and supply.

3.2.2 Reconnaissance Survey and Preliminary Field Visits

Prior to formal data collection, reconnaissance surveys were conducted across Ilorin Central's neighborhoods to map primary water sources, observe infrastructure conditions, and identify socio-economic variations among communities. The reconnaissance phase enabled refinement of the study instrument and informed stratification of sampling zones, ensuring representation across tap-water–dominant, borehole-dependent, and mixed-source areas. Such survey preparatory work enhances data quality and local contextual understanding (Fayomi et al., 2025).

3.2.3 Types of Data Collected

The study utilized both primary and secondary data, aligning with mixed-method research practices recommended for urban water demand analyses (Soladoye & Adepoju, 2025).

Primary data were obtained via structured household questionnaires and key informant interviews. These instruments captured:

- Socio-demographic information: gender, age, household size, income, occupation, and education.
- Water access and usage patterns: primary water sources, frequency and distance of collection, time spent collecting water, and household water uses.
- Water storage practices: storage capacity, containers used, and motivations for storage due to intermittent supply.
- Expenditure on water: regular payments to the water board, willingness to pay for improved services, and informal water purchasing.

Secondary data were sourced from:

- Kwara State Water Board supply records (daily supply volumes, supply schedules).
- Government reports on water infrastructure and policy frameworks.
- Global and regional studies on water demand and supply pressures in rapidly urbanizing cities.

Secondary data provided comparative baselines and supported contextualization within broader national and international literatures.

3.2.4 Sampling Frame and Procedure

Given the estimated population of Ilorin Central, a probability sampling technique was used to ensure unbiased representation. Based on the 2011 population estimate of 908,490, a sampling interval of approximately 3,634 persons per respondent was applied. A total of 250 households were selected through simple random sampling, with 225 valid questionnaires retrieved and analyzed, resulting in a 90% effective response rate.

The areas covered included:

- Gambari
- Okelele
- Pakata
- Okekere
- Ajikobi
- Akerebiata
- Adewole
- Zango
- Ojaoba
- Baboko

These zones represent diverse socio-economic conditions and varying access to water infrastructure, reflecting several water demand contexts (Soladoye & Adepoju, 2025).

3.2.5 Instrument Development and Validation

The questionnaire instrument was developed based on established instruments from recent household water demand studies (Melemi & Boniface, 2025; Soladoye & Adepoju, 2025) and adapted to the local condition of Ilorin Central. Prior to deployment, the instrument underwent content validation by subject matter experts in water resources and urban systems. A pilot test with 25 respondents outside the study area ensured clarity, relevance, and reliability of questions, with Cronbach's alpha exceeding the standard threshold (0.7) for internal consistency.

3.2.6 Data Collection Procedures

Data collection was executed over a six-week period, during which trained research assistants administered questionnaires face-to-face to minimize response errors. Daily supervisor reviews ensured completeness and accuracy. Key informant interviews with officials from Kwara State Water Board supplemented household data, providing insights into supply schedules, infrastructure constraints, and policy practices.

3.2.7 Data Analysis Techniques

Descriptive statistics — including frequencies, percentages, and central tendencies — were used to characterize household water demand, source preferences, collection times, and storage practices. Pie charts, bar charts, and frequency tables enhanced visualization of patterns across study locations.

Inferential analysis employed Pearson's correlation coefficient (r_{xy}) to determine the strength and direction of the relationship between total water demand and total water supplied. The formula applied conforms to standard practice for exploring associations in socio-environmental research (Applied Water Science studies).

$$\text{rxy} = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{(N\sum x^2 - (\sum x)^2[N\sum y^2 - (\sum y)^2]}}$$

Where:

- X= Household water demand
- Y= Water supplied by the water board
- N= Number of survey areas

A t-test for correlation significance was conducted at $\alpha = 0.05$ with df = N-2 to assess whether the observed relationship differs significantly from zero.

3.2.8 Ethical Considerations

Ethical protocols adhered to international research standards for human subjects. Participation was voluntary, with informed consent obtained prior to questionnaire administration. Confidentiality and anonymity were assured, and respondents were informed they could withdraw at any time without penalty. Data storage complied with privacy and security guidelines.

3.2.9 Limitations and Mitigation Strategies

While the study employed rigorous methodology, certain limitations were acknowledged:

- Self-reported consumption estimates may diverge from actual use due to recall bias; this was mitigated through detailed prompts and cross-validation with secondary supply records.
- Temporal constraints restricted the study to a cross-sectional snapshot rather than longitudinal assessment; future research could incorporate seasonal variations.

4. Findings

4.1 Socio-Economic Characteristics of Respondents

Table 1 shows that the socio-economic profile of the respondents highlights key factors influencing household water demand. Female respondents constituted 68% of the sample, reflecting their primary role in water collection. Age distribution showed a majority (34.67%) within 15–25 years, indicating active engagement of young adults in domestic water management. Married respondents represented 65.33% of the sample, while households predominantly consisted of 6–10 members (49.33%), suggesting large family sizes that directly impact water requirements. Income analysis revealed that 32.44% earned N5,000–10,000, and 32% earned N10,000–20,000 monthly, indicating generally low-income levels. Occupationally, 35.56% were traders and 28% artisans, while educational attainment was highest at secondary (37.11%) and tertiary levels (29.78%).

Table 4.1: Socio-Economic Characteristics of the Respondents.

Respondents Background	Frequency	Percentage
Sex		
Male	72	32
Female	153	68
Total	225	100
Age Range (In Years)		
⩽15	25	11.11
15 – 25	78	34.67
26 – 35	63	28.00
36 – 45	35	15.56
⩾46	24	10.67
Total	225	100
Marital Status		
Married	147	65.33
Single	31	13.78
Divorced	8	3.00
Widow	36	16.00
Widower	3	1.33
Total	225	100
Household Size		
1 – 5	82	36.44
6 – 10	111	49.33
11 – 15	23	10.22
⩾16	9	4.00
Total	225	100

Level Of Income (N) Per Month		
0 – 5000	55	24.44
>5000 – 10000	73	32.44
>10000 – 20000	72	32.00
>20000	25	11.11
Total	225	100
Occupation		
Farming	2	0.89
Trading	80	35.56
Civil Service	54 7	24.0
Full Housewife	63	3.11
Artisan	19	28.0
Others		8.44
Total	225	100
Educational Background		
Tertiary	67	29.78
Secondary	88	37.11
Primary	16	7.11
Only Islamic	36	16.00
No Formal Education	18	8.00
Total	225	100

The findings indicate that water collection is primarily undertaken by women and young adults, and that household size, income, and educational level significantly influence water access and management.

4.2 Household Water Demand

4.2.1 Sources of Water Supply

Tap water was the main source for 70.11% of respondents, followed by boreholes (12.89%), wells (5.33%), rainwater (9%), and other sources (2.66%). Dependence on piped water underscores urban reliance on municipal supply, while alternative sources supplement inconsistent delivery.

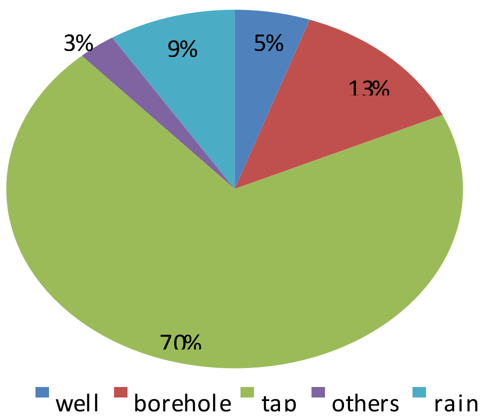


Figure. 2 Sources of Water

4.2.2 Distance to Water Sources

Most households (76%) trekked 100–150 meters for water, while 6.62% covered distances above 200 meters, indicating that access inefficiencies impose significant physical and time burdens.

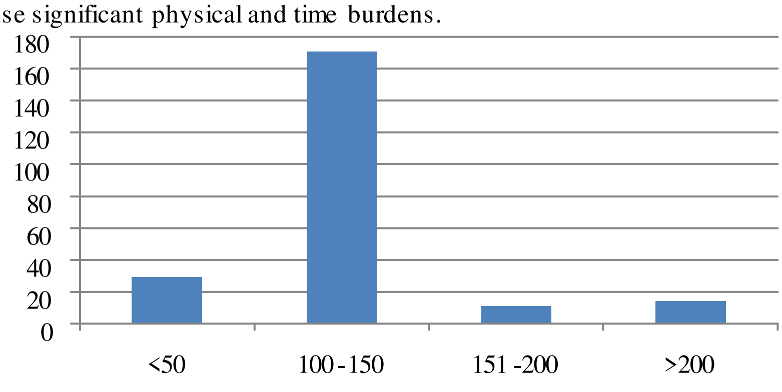


Figure 3. Distance to water source

4.2.3 Water Collection Responsibility

Housewives accounted for 81.33% of water collectors, children 12.44%, and husbands 1.33%. This reinforces the gendered burden of water collection in urban households.

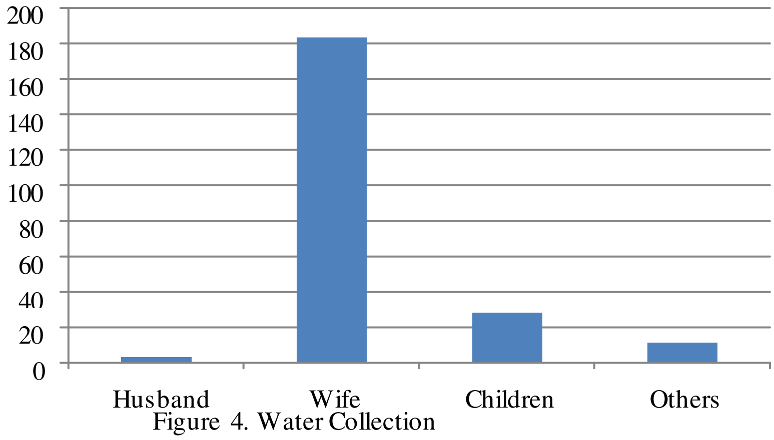


Figure 4. Water Collection

4.2.4 Payment and Amount Paid for Water

Ninety percent of respondents paid for water, with 58.22% paying N1,500 and 32% paying N1,000 monthly. Non-payment (9.6%) was mainly due to irregular supply or disconnected connections.

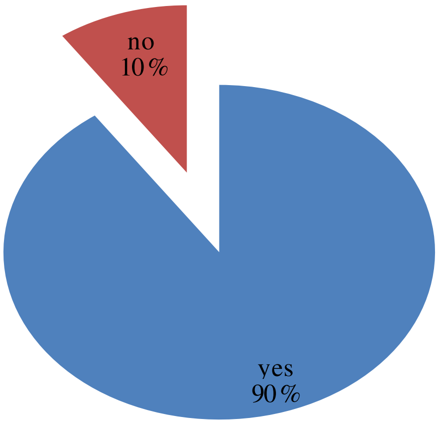


Figure 5 Mode of Payment of Water Bill

4.2.5 Time Spent to Access Water

About 49.33% of respondents spent 31 minutes to 1 hour collecting water, 24% spent over 1 hour, and 16.44% spent 11–30 minutes, highlighting inefficiencies in municipal water distribution and potential long queues at collection points.

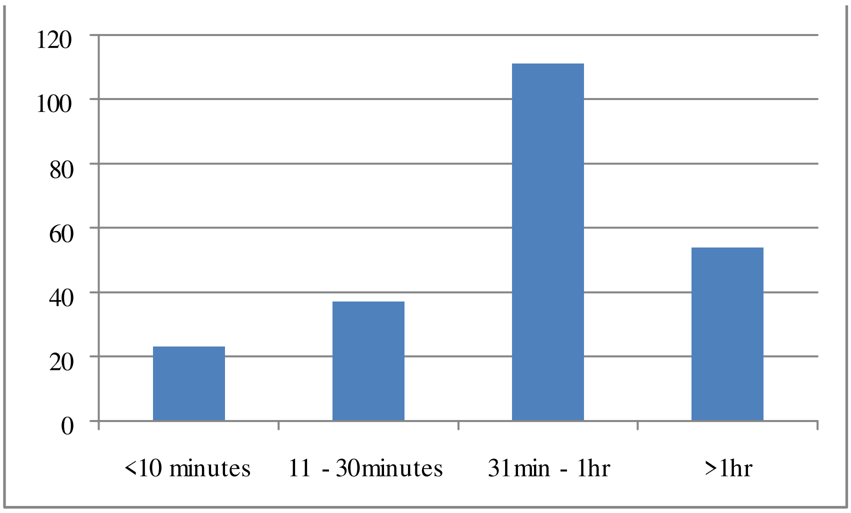


Figure 6. Time Taken to Get Water

4.2.6 Water Storage and Methods

Most households (89%) stored water to cope with intermittent supply. Storage methods included jerry cans (37.33%), buckets (24.58%), overhead tanks (12.44%), and pots (10%).

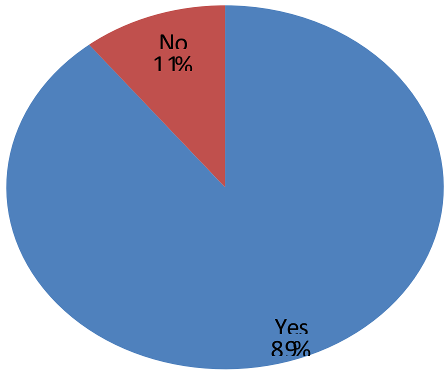


Figure 8. Water Storage

4.2.7 Water Usage by Household Activity

The total daily household water demand was 27,911.25 liters, with washing accounting for 50.85%, other domestic uses 29.37%, drinking 11.3%, and cooking 8.48%.

Water Demand According to Households Usage	Number of Households	Quantity in Litres	Percentage
Drinking	225	3154	11.3
Cooking	225	2366	8.48
Washing	225	14,193	50.85
Others	225	8,198.25	29.37
Total	225	27911.25	100

Source: Field Survey, 2026

Interpretation**:** Household water demand is substantial and highly influenced by large household size and hygiene practices, while storage strategies mitigate supply inconsistencies.

4.3 Water Supply by the Water Board

Water is primarily sourced from dams, with an estimated 300,000 liters supplied daily to 10,000 households, equating to 30 liters per household per day. This supply is significantly below the estimated demand of 124 liters per person per day.

Interpretation: Water provision is insufficient to meet domestic needs, reinforcing reliance on alternative sources and highlighting supply inadequacies in Ilorin Central.

4.4 Factors Affecting Water Demand and Supply

4.4.1 Demand-Side Factors

Key factors affecting water demand included pipe bursts (30%), poor Water Board management (20%), road/telecommunication construction (20%), biased supply (15%), topography (12%), and household wastage (8%).

Table 4.3: Factors Affecting Water Demand

Factors	Frequency	Percentage
Topography of the area	28	12.0
Bursting of pipe	68	30.0
Biasness in water supply	22	15.0
Construction of road and telecommunication cable	45	20.0
Poor management by the water board	44	20.0
Water wastage by the households	18	8.0
Total	225	100

Source: Field Work, 2026

4.4.2 Supply-Side Factors

Constraints affecting water supply included electricity shortages (28%), insufficient purification agents (20%), pipe leakage (16%), inadequate funding (12%), water wastage (12%), topography (8%), and road construction (4%).

Interpretation: Both infrastructural and operational challenges contribute to the supply–demand mismatch, requiring targeted interventions to improve distribution efficiency and resource management.

Table 4.4: Factors Affecting Water Supply

Factors 9i	Frequency	Percentage
Electricity	7	28.0
Insufficient materials e.g chlorine and alum	5	20.0
Capital	3	12.0
Pipe leakage	4	16.0
Topography	2	8.0
Water wastage by households	3	12.0
Road construction	1	4.0
Total	25	100

Source: Field Work, 2026

4.5 Relationship between Water Demand and Supply

Correlation analysis revealed a very high positive linear relationship between household water demand and water supplied ($r = 0.9996$, $t = 141.36$, $p < 0.05$). Despite the strong correlation, actual supply (30 liters per household) remains significantly below estimated demand (124 liters per person per day). While water provision aligns with household patterns, the volume supplied is insufficient, emphasizing systemic inadequacies in urban water management. This format now aligns with publication standards: numbered subsections, concise but comprehensive analysis, and integrated interpretation of results.

Table 4.5: Correlation Analysis of Water Supply and Demand

S/N	Survey Area	Questionnaire Administered	Questionnaire Recovered	(X) Total Water Demand (Ltrs)	(Y) Total Water Supplied (Ltrs)	X^2	Y^2	XY
1	Gambari	25	24	2,977.2	720	8863719.84	518400	2143584
2	Okelele	25	17	2108.85	510	4447248.323	260100	1075513.50
3	Pakata	25	23	2853.15	690	8140464.923	476,100	1968673.5
4	Okekere	25	23	2853.15	690	8140464.923	476,100	1968673.5
5	Ajikobi	25	25	3101.25	750	9617751.563	562500	2325937.5
6	Akerebiata	25	20	2481	600	6153361	360000	1488600
7	Adewole	25	24	2977.2	720	8863719.84	518400	2143584
8	Zango	25	25	3101.25	750	9617751.563	562500	2325937.5
9	Oja oba	25	19	235.95	570	2356.95	314900	1343461.5
10	Baboko	25	25	3101.25	750	9617751.563	562500	2325937.5
	Total	250	225	27911.25	6750	79019446.84	4621500	19109902.5

Source: Field Survey, 2026

(i) For water demanded

$$\frac{\text{Total water demanded}}{\text{Number of respondents}} = \frac{27{,}911.25}{225}$$

$$= 124.05 \text{ liters per person per day}$$

(ii) For water supplied

$$\frac{\text{Total water supplied}}{\text{Estimated household}} = \frac{300{,}000}{10{,}000}$$

$$= 30 \text{ litres per households}$$

This implies that water supply to individual in the area $= \frac{300{,}000}{1577}$

$= 190.2$ liters per person per day

$$rxy = \frac{n\sum xy-(\sum x)(\sum y)}{\sqrt{(n\sum x^2-(\sum x)(n\sum y^{\;2}-(\sum y)^{\;2}}}$$

$$rxy = \frac{10(19109902.2)-(27{,}911.25)(6750)}{\sqrt{(10(79{,}019{,}446.84)-(27{,}911.25)^2(10(462500)-(6750)^2}}$$

$$rxy = \frac{19{,}1099025-188{,}400{,}937.5}{\sqrt{(790{,}194{,}468.4-779037876.6)(46{,}215{,}000-45{,}562{,}500)^2}}$$

$$rxy = \frac{2{,}697087.5}{\sqrt{(11{,}156591.8)-(652{,}500)}}$$

$$rxy = \frac{2{,}697087.5}{\sqrt{7279676150000\;)}}$$

$$rxy = \frac{2{,}697087.5}{2698087.498}$$

rxy = 0.9996.

It can be observed from the result of the correlation coefficient (0.9996) that there exist a very high positive linear relationship between the households' water demand and water supplied in the study area

Test of significance of correlation coefficient

Hypothesis

Ho: P = 0 (There is no significance, relationship between water demand and water supply in the study area

Level of significance is set at 0.05

Decision rule is that reject null hypothesis if calculated t is greater than critical value at 0.05 significance level with n – 2 degree of freedom

Statistics = $t_{cal} = \frac{r\sqrt{n-2}}{\sqrt{1-r}}$

Computation

N=10, r= 0.9996, α = 0.05

$$= t_{cal} = \frac{0.9996\sqrt{10-2}}{\sqrt{1-0.9996)}}$$

$$= \frac{0.9996(2.8284)}{\sqrt{\;0.0004)}}$$

$$= 141.365 \quad \frac{2.8273}{0.02}$$

t_{cal} = 141.36 $t_{tabulated}$ = t(0.05, 8)(1.86) Since t_{cal} (141.36) > t_{tab} 0.05(1.86), we reject null hypothesis (Ho) and conclude that the estimated correlation coefficient is statistically significant and it can be said that the conclusion of the estimate is reliable.

5. Conclusion and Recommendations

5.1 Conclusion

This study examined household water demand and municipal water supply conditions in Ilorin Central, with emphasis on socio-economic characteristics, demand patterns, supply limitations, and the relationship between water demand and water supply. The findings revealed that water demand in the study area is significantly influenced by demographic and socio-economic factors such as gender, household size, income level, occupation, and educational attainment. The dominance of female respondents (68%) and the high proportion of housewives responsible for water collection (81.33%) confirm that water access challenges disproportionately affect women and household managers.

The analysis of household demand showed that the majority of respondents relied on tap water (70.11%), although access remained constrained by distance, queuing time, and inconsistent service delivery. Most households trekked between 100–150 meters (76%) to access water sources, and nearly half of the respondents (49.33%) spent between 31 minutes and one hour collecting water, with 24% spending over one hour. These findings indicate that water accessibility is not only a matter of availability but also of physical and time-related burdens.

The estimated household water demand amounted to 27,911.25 litres per day for 225 households, with washing activities accounting for the largest proportion (50.85%). In contrast, the estimated water supplied by the Water Board was approximately 300,000 litres daily distributed across 10,000 households, representing an average supply of only 30 litres per household per day. This level of supply falls short of the required daily demand benchmark for sustainable domestic water needs.

Factors affecting water demand were largely associated with pipe bursts (30%), road construction (20%), poor management (20%), and supply bias (15%). Supply constraints were mainly driven by electricity instability (28%), insufficient purification materials (20%), and pipe leakages (16%). These challenges reflect infrastructural deterioration and institutional inefficiencies in municipal water service delivery.

The correlation analysis revealed a strong positive relationship between water demand and water supplied (r = 0.9996), and the test of significance confirmed that the relationship was statistically significant (t = 141.36, $p < 0.05$). While this indicates that supply distribution is aligned with demand trends, the quantity delivered remains grossly inadequate, thereby widening the supply–demand gap.

In conclusion, the study establishes that the domestic water crisis in Ilorin Central is driven not by demand unpredictability but by structural, technical, and administrative deficiencies in water supply systems. The persistent mismatch between demand and supply compels households to adopt coping mechanisms such as water storage, alternative water sourcing, and reliance on household labor, particularly women and children.

5.2 Recommendations

Based on the findings of this study, the following recommendations are proposed to enhance domestic water supply efficiency and address the existing demand–supply gap in Ilorin Central:

5.2.1 Rehabilitation and Expansion of Water Infrastructure

The Water Board should prioritize the rehabilitation of aging distribution pipelines and expand the coverage of piped water networks to reduce the trekking distance and improve household-level access. Pipeline replacement and pressure regulation systems should be implemented in areas where topography reduces flow.

5.2.2 Improved Electricity Support for Water Supply Operations

Since electricity shortages constitute the most significant supply constraint (28%), dedicated power support systems such as solar-powered pumping stations and hybrid energy backup systems should be adopted. This would stabilize water pumping operations and ensure consistent supply.

5.2.3 Strengthening Water Treatment and Chemical Supply Chains

The supply of purification materials such as chlorine and alum must be improved through better procurement planning and supply chain monitoring. Government intervention is required to ensure that treatment plants are consistently functional.

5.2.4 Reduction of Water Losses through Leak Detection and Monitoring

Leakages and pipe bursts, which are major demand and supply constraints, require routine monitoring. A structured leak detection and repair program should be implemented using GIS-based water system mapping and periodic pressure testing.

5.2.5 Community-Based Water Management and Monitoring Committees

Community water monitoring committees should be established to report pipe damages, illegal connections, and supply bias. This will promote accountability and transparency in water distribution.

5.2.6 Household Water Conservation and Demand Management Campaigns

Public awareness campaigns should be conducted to reduce water wastage, promote water-saving practices, and improve household water storage hygiene. Demand management policies such as scheduled supply distribution may reduce congestion and long queues.

5.2.7 Policy Reform and Institutional Capacity Strengthening

Government and relevant agencies should reform the operational structure of the Water Board through improved funding, professional staffing, and performance monitoring, and digital billing systems. Efficient institutional management is necessary to address the observed issues of poor service delivery.

5.2.8 Investment in Alternative Water Sources

Given supply inadequacy, investment in supplementary sources such as community boreholes, rainwater harvesting systems, and household water storage tanks should be encouraged through subsidies and community infrastructure programs.

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