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DETERMINANTS OF WATER DEMAND AND SUPPLY IN NAKA TOWN AND ITS ENVIRONS, GWER-WEST, BENUE STATE, NIGERIA

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ABSTRACT

This study assessed factors affecting water supply and demand in Naka town and its environs, Gwer-West Local Government Area, Benue State, Nigeria. The study population comprised 10,120 households, from which 385 were sampled using Taro Yamanne techniques. Data were collected via structured questionnaires and analysed using descriptive statistics and Principal Component Analysis (PCA) in SPSS and Excel. Descriptive analysis revealed that population growth, seasonal variability, water accessibility, infrastructure inadequacies, high costs, water quality concerns, and weak governance were the main perceived drivers of water insecurity. Population growth indicators recorded the highest agreement, with 87.3% of respondents acknowledging increased household numbers and related water demand. Seasonal variation and reliance on rain-fed sources were highlighted as critical vulnerabilities, while infrastructure and service satisfaction were rated poorly by over 79% of respondents. Economic factors, including water cost and affordability, strongly influenced household access, and water quality concerns were prevalent, prompting household-level treatment practices. PCA identified four principal components explaining 95% of the variance: (1) population growth and urban expansion, (2) water supply infrastructure and service delivery, (3) economic factors affecting affordability, and (4) water quality and health concerns. The study concludes that population growth and infrastructure exerted the greatest influence on water demand and supply. Based on the findings the study recommends strategic investment in infrastructure, regulatory oversight, cost management, and quality monitoring to enhance sustainable water access in Naka.

KEYWORDS: Determinants, Water, Demand and Supply; population growth.

INTRODUCTION

Water is fundamental to human survival and socio-economic development, as adequate and high-quality water supplies underpin health, livelihoods, agriculture, and cultural well-being (Ntengwe, 2005; Young, 2006; Abaje et al., 2009; Abedin et al., 2014; Mustari & Karim, 2016). This is evident as the United Nations declared 2018–2028 the Decade for Water for Sustainable Development and included sustainable water management in the 17 Sustainable Development Goals (SDGs), particularly SDG 6, which aims to ensure access to safe and sustainable water and sanitation for all (UNDP, 2016; Abedin et al., 2014; UN, 2021a, 2021c). Despite these global commitments, water scarcity remains a pressing issue, threatening human health, economic progress, and environmental sustainability, particularly in developing countries (IDRC, 2002; Kwandu, 2020; Mekonnen & Gokcekus, 2020).

Globally, water demand is growing faster than population, with projections indicating a 55% increase over the coming decades (Abedin et al., 2014; Schlamovitz & Becker, 2021). This imbalance has led to acute water stress, particularly in agricultural-based economies such as Nigeria (Peters et al., 2021; Pokhrel et al., 2021; Mustari & Karim, 2016). In Nigeria, access to safe water is limited, with rural and peri-urban populations heavily reliant on seasonal streams, hand-dug wells, and other unprotected sources (Ndabula & Jidauna, 2010; FAO, 2010; John-Dewole, 2012; Galadima et al., 2011). The challenge is not merely the presence of water, but whether it is reliable, affordable, safe, and sufficient to meet human needs (UN-Habitat, 2003). Population growth, unplanned urbanisation, infrastructure decay, and climate variability exacerbate the mismatch between water demand and supply (Gallandal et al., 2021; Mohammed & Sahabo, 2015; Jazi, 2021).

Naka town in Gwer-West Local Government Area of Benue State typifies the water supply challenge in small but rapidly urbanising towns in Nigeria. Population growth, partly driven by rural-urban migration due to insecurity, has placed immense pressure on existing water infrastructure, including the Naka Mini-Water Board, which suffers from poor maintenance, vandalised pipelines, and insufficient treatment capacity (Ishaku et al., 2023; Ocheri, 2010). Households largely depend on streams, hand-dug wells, ponds, and rainwater, which are seasonal, unprotected, and often unsafe, heightening the risk of waterborne diseases and undermining livelihoods (Abedin et al., 2014; WHO, 2019). While previous studies have examined water supply challenges in Nigeria, many have either focused on infrastructure alone or on regional scales, neglecting the interaction of socio-economic, demographic, and hydrological factors at the local level (Florianne, 2006; Ishaku et al., 2011; Ogundobe & Ifabiyi, 2014; Mela, 2018).

Given these gaps, this study seeks to empirically assess the determinants of water demand and supply in Naka town and its environs. The study examined the interplay of population dynamics, infrastructure condition, water source reliability, and household socio-economic characteristics, with the view of providing evidence-based understanding for sustainable water resource planning and local interventions, contributing to the achievement of SDG 6 and related goals.

MATERIAL AND METHODS

Study Area

Naka, the headquarters of Gwer-West Local Government Area in Benue State, is located about 40 km south of Makurdi along the Makurdi–Ankpa road. The town lies within latitudes 7°31'–7°37' N and longitudes 8°12'–8°16' E, covering a landmass of 1,479 km² and sharing boundaries with Saghev/Ukusu, Sengev/Yenge, Tsambe/Mbesev, Mbapa, Mbabuande, and Tijime (Figure 1). The area is characterised by low-lying terrain ranging from 100–250 metres above sea level, with gently undulating landforms shaped by seasonal stream erosion. Drainage is dominated by several ephemeral streams such as Nagi, Anna, and Kpukulu, alongside the Naka Earth Dam, which is the main water source but often suffers from pollution due to stagnation and misuse.

Geologically, Naka lies within the Lower Benue Trough, a sedimentary basin formed during the Cretaceous rifting of the South Atlantic. The underlying formations consist of sandstones, shales, siltstones, and lateritic crusts, which influence aquifer properties, groundwater flow, and soil characteristics. The predominant soils, tropical ferruginous and hydromorphic types, exhibit clay-loamy textures, moderate water retention, and seasonal cracking, affecting infiltration, runoff, agriculture, and groundwater recharge. Climatically, the area experiences a tropical wet-and-dry (Aw) climate with a seven-month rainy season (April–October), annual rainfall of 1,200–2,000 mm, and a dry season from November to March. Temperatures remain high year-round, with distinct cool-dry, pre-rain, and hot-wet periods influenced by the seasonal migration of the Inter-Tropical Discontinuity.

Naka falls within the Guinea savannah zone, characterised by tall grasses, scattered trees, and vegetation that changes colour across seasons. Human activities have significantly altered the natural vegetation, although species such as *Daniella oliveri*, *Parkia biglobosa*, and

Andropogon gayanus remain common. The town is predominantly inhabited by the Tiv ethnic group, alongside Idoma, Igbo, Hausa, Yoruba, Igede, and other minorities. Agriculture is the main livelihood activity, supported by fertile soils that enable the cultivation of diverse food and cash crops, as well as livestock rearing. Other economic activities include civil service work, trading, small-scale industries, and services offered by schools, health centres, markets, and religious institutions. The settlement pattern is nucleated, with clustered houses, delineated plots, and basic street and drainage systems that support mobility and runoff management within the town.

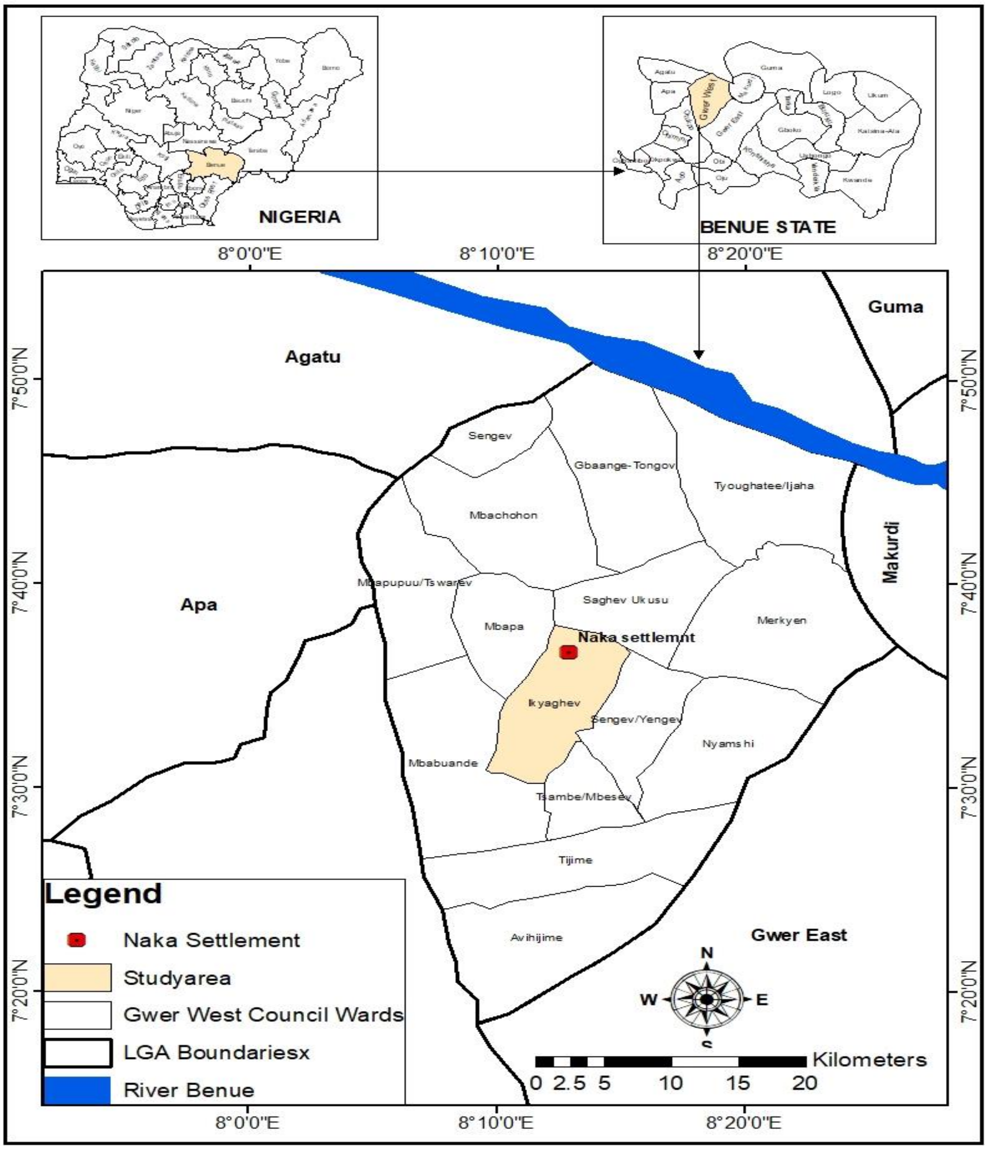

Figure 1: Gwer West Local Government Area Showing Naka Town.

Source: GIS Lab. Department of Geography, Rev. Fr. Moses Orshio Adasu University, Makurdi, (2025)

Methods

The study population comprised 10,120 households, identified through a reconnaissance survey, forming the sampling frame. Using the Taro Yamane (1967) formula at a 5% precision level, a final sample size of 385 households was determined. A stratified random sampling technique was applied to ensure that the fifteen residential zones in Naka were proportionately represented. Each zone received a sample allocation based on its household population size, resulting in a balanced and representative distribution of questionnaires across diverse neighbourhoods.

Data for the study were collected through questionnaires. A total of 385 questionnaires were distributed, focusing on household-level determinant of water supply and demand. For data analysis, the study adopted both descriptive and inferential statistical approaches. Descriptive statistics, including tables, percentages, means, skewness, and kurtosis. To identify underlying factors affecting water supply and demand, Principal Component Analysis (PCA) was employed. PCA helped reduce large sets of interrelated variables into meaningful components, revealing statistical patterns that could not be detected through descriptive measures alone. All analyses were conducted using Excel and SPSS (version 22), ensuring accurate interpretation and visual presentation of the data.

RESULTS AND DISCUSSION

Seveeral factors affect water supply and demand in Naka town and its Environs, the factors identified and analysed for this reasearch include; population growth and density factors, climate change and seasonal variability factors, water source availability and accessibility factors, infrastructure and water supply systems factors, socio-economic and affordability factors, quality and health concerns factors, government policies and management factors.

Result of Descriptive Analysis of Factors Affecting Water Supply and Demand

1. Population Growth and Density Factors

Table 1 shows that respondents strongly perceived population growth as a driver of water demand. The highest mean was for perceived increase in households (M = 4.23, SD = 1.01, skew = -1.65, kurt = 2.37), with 87.3% agreeing/strongly agreeing. Increase in household size (M = 3.87, SD = 1.27) and perceived impact on water demand (M = 3.96, SD = 1.24) also showed strong agreement (72.2% and 78.4%, respectively). In contrast, frequency of new housing developments was rated lower (M = 2.82, SD = 1.39), reflecting uneven urban expansion. Negative skewness in the first three indicators confirms concentration at higher agreement levels.

Table 1: Population Growth and Density Factors.

S/N	Indicators	1	2	3	4	5	Mean	Std. Dev	Skew.	Kurt.	Total
1	Perceived increase in the number of households	13 (3.5)	22 (5.9)	12 (3.2)	142 (38.4)	181 (48.9)	4.23	1.012	-1.646	2.373	370
2	Increase in average household size	33 (8.9)	29 (7.8)	41 (11.1)	118 (31.9)	149 (40.3)	3.87	1.271	-1.03	-0.018	370
3	Perceive impact of population growth on water demand	34 (9.2)	20 (5.4)	26 (7.0)	136 (36.8)	154 (41.6)	3.96	1.238	-1.272	0.629	370
4	Frequency of new housing developments	88 (23.8)	71 (19.2)	93 (25.1)	56 (15.1)	62 (16.8)	2.82	1.392	-1.186	-1.186	370

Source: Researcher's fieldwork, 2025

Legend:

SN 1: Strongly Disagree (1); Disagree (2); Neutral/Moderate (3); Agree (4); Strongly Agree (5)

SN 2: No Increase (1); Slight Increase (2); Moderate Increase (3); High Increase (4); Very High Increase (5)

SN 3: No Impact (1); Low Impact (2); Moderate Impact (3); High Impact (4); Very High Impact (5)

SN 4: Very Rare (1); Rare (2); Occasional (3); Frequent (4); Very Frequent (5)

2. Climate Change and Seasonal Variability Factors

In Table 2, the result indicates that seasonal variation in water availability recorded the highest mean (M = 4.42, SD = 0.75, skew = -1.81, kurt = 4.97), with 93.2% reporting high/very high variation. Dependency on rain-fed sources (M = 3.72, SD = 1.21) and frequency of dry spells (M = 3.51, SD = 1.06) also indicated significant vulnerability. Perceptions of rainfall pattern changes were more divided (M = 3.26, SD = 1.46), yielding near-symmetrical distribution (skew = -0.28).

Table 2: Climate Change and Seasonal Variability Factors.

SN	Indicators	1	2	3	4	5	Mean	Std. Dev	Skew	Kurt	Total
1	Perception of changes in rainfall patterns	68 (18.4)	53 (14.3)	66 (17.8)	82 (22.2)	101 (27.3)	3.26	1.46	-0.279	-1.3	370
2	Seasonal variation in water availability	4 (1.1)	6 (1.6)	15 (4.1)	151 (40.8)	194 (52.4)	4.42	0.754	-1.809	4.97	370
3	Frequency of dryspells affecting water supply	19 (5.1)	23 (6.2)	159 (43.0)	87 (23.5)	82 (22.2)	3.51	1.062	-0.281	-0.22	370
4	Level of dependency on rain-fed water sources	25 (6.8)	44 (11.9)	54 (14.6)	132 (35.7)	115 (31.1)	3.72	1.212	-0.781	-0.36	370

Source: Researcher's fieldwork, 2025

Legend:

SN 1: Significant Decrease (1); Decrease (2); Stable (3); Increase (4); Significant Increase (5)

SN 2: No Variation (1); Mild Variation (2); Moderate Variation (3); High Variation (4); Very High Variation (5)

SN 3: Never (1); Rarely (2); Occasionally (3); Frequently (4); Very Frequently (5)

SN 4: Not Dependent (1); Slightly Dependent (2); Moderately Dependent (3); Highly Dependent (4); Completely Dependent (5)

3. Water Source Availability and Accessibility Factors

Time spent fetching water had the highest mean (M = 3.79, SD = 1.22), with 64% spending ≥2 hours daily (Table 3). Distance to nearest source (M = 3.41, SD = 1.34) and perceived reliability (M = 3.54, SD = 1.52) confirmed access difficulties, while availability of alternatives was rated near neutral (M = 2.96, SD = 1.44). All indicators except alternatives showed moderate negative skewness, indicating clustering toward poorer access.

Table 3: Water Source Availability and Accessibility Factors.

SN	Indicators	1	2	3	4	5	Mean	Std. Dev	Skw	Kurt	Total
1	Distance to the nearest water source	43 (11.6)	55 (14.9)	80 (21.6)	92 (24.9)	100 (27.0)	3.41	1.335	-0.386	-1.013	370
2	Time spent fetching water daily	11 (3.0)	67 (18.1)	55 (14.9)	93 (25.1)	144 (38.9)	3.79	1.22	-0.589	-0.934	370
3	Perceived reliability of the main water source	53 (14.3)	67 (18.1)	33 (8.9)	61 (16.5)	156 (42.2)	3.54	1.523	-0.485	-1.336	370
4	Availability of alternative water sources	77 (20.8)	79 (21.4)	75 (20.3)	58 (15.7)	81 (21.9)	2.96	1.443	0.083	-1.328	370

Source: Researcher’s fieldwork, 2025

Legend:

SN 1: <100m (1); 100m-500m (2); 500m-1km (3); 1km-2km (4); >2km (5)

SN 2: <30 min (1); 30 min - 1 hour (2); 1 - 2 hours (3);2 - 3 hours (4); >3 hours (5)

SN 3: Very Reliable (1); Reliable (2); Occasionally Unreliable (3); Unreliable (4); Very Unreliable (5)

SN 4: Strongly Disagree (1); Disagree (2); Neutral/Moderate (3); Agree (4); Strongly Agree (5)

4. Infrastructure and Water Supply Systems Factors

The findings in Table 4 revealed that infrastructure condition (M = 1.75, SD = 0.89) and satisfaction with services (M = 1.68, SD = 1.08) received the lowest ratings, with 79.5% and 85.4% expressing poor/very poor perceptions, respectively (positive skewness >1). Interruptions occurred mostly monthly (50%), yielding M = 3.30 (SD = 1.09). Presence of functional boreholes/piped systems was more positive but uneven (M = 3.48, SD = 1.38).

Table 4: Infrastructure and Water Supply Systems Factors.

SN	Indicator	1	2	3	4	5	Mean	Std. Dev	Skw	Kurt	Total
1	Perceived condition of water supply infrastructure	183 (49.5)	111 (30.0)	63 (17.0)	10 (2.7)	3 (0.8)	1.75	0.887	1.017	0.523	370
2	Frequency of water supply interruptions	33 (8.9)	19 (5.1)	185 (50.0)	71 (19.2)	62 (16.8)	3.3	1.089	-0.244	-0.057	370
3	Satisfaction with water supply services	226 (61.1)	90 (24.3)	17 (4.6)	22 (5.9)	15 (4.1)	1.68	1.076	1.751	2.269	370
4	Presence of functional boreholes or piped water	45 (12.2)	51 (13.8)	73 (19.7)	82 (22.2)	119 (32.2)	3.48	1.38	-0.455	-1.049	370

Source: Researcher’s fieldwork, 2025

Legend:

SN 1: Very Poor (1); Poor (2); Moderate (3); Good (4); Very Good (5)

SN 2: Never (1); Rarely (2); Monthly (3); Weekly (4); Daily (5)

SN 3: Very Dissatisfied (1); Dissatisfied (2); Neutral/Moderate (3); Satisfied (4); Very Satisfied (5)

SN 4: Strongly Disagree (1); Disagree (2); Neutral/Moderate (3); Agree (4); Strongly Agree (5)

5. Socio-economic and Affordability Factors

Table 5 shows that water was widely perceived as expensive (M = 4.12, SD = 0.96 for cost burden; M = 4.03, SD = 1.14 for monthly expenditure), with strong negative skewness. Willingness to pay for improvements remained high (M = 3.87, SD = 1.11; 69.5% willing/strongly willing). Proportion of income spent on water was moderate and symmetrically distributed (M = 3.06, SD = 1.41, skew ≈ 0).

Table 5: Socio-Economic and Affordability Factors.

SN	Indicators	1	2	3	4	5	Mean	Std. Dev	Skw	Kurt	Total
1	Monthly household expenditure on water	14 (3.8)	33 (8.9)	51 (13.8)	101 (27.3)	171 (46.2)	4.03	1.14	-1.046	0.163	370
2	Willingness to pay for improved water services	12 (3.2)	41 (11.1)	60 (16.2)	126 (34.1)	131 (35.4)	3.87	1.113	-0.803	-0.209	370
3	Perception of water cost burden	8 (2.2)	12 (3.2)	66 (17.8)	125 (33.8)	159 (43.0)	4.12	0.959	-1.061	0.886	370
4	Percentage of household income spent on water	67 (18.1)	76 (20.5)	76 (20.5)	70 (18.9)	81 (21.9)	3.06	1.413	-0.025	-1.294	370

Source: Researcher's fieldwork, 2025

Legend:

SN 1: Very Low (1); Low (2); Moderate (3); High (4); Very High (5)

SN 2: Strongly Unwilling (1); Unwilling (2); Neutral/Moderate (3); Willing (4); Strongly Willing (5)

SN 3: Not Expensive (1); Slightly Expensive (2); Moderately Expensive (3); Expensive (4); Very Expensive (5)

SN 4: <5% (1); 5-10% (2); 10-15% (3); 15-20% (4); >20% (5)

6. Water Quality and Health Concerns Factors

Perceived drinking water quality was moderate but highly variable (M = 2.98, SD = 1.41, skew ≈ 0). Satisfaction with taste, colour, and odour was markedly low (M = 1.84, SD = 1.03), with 76.8% dissatisfied/very dissatisfied. Waterborne diseases were infrequent overall (M = 2.25, SD = 1.34), yet 18.1% reported frequent/very frequent cases. Boiling dominated household treatment (46.2%), while 24.1% used none (Table 6).

Table 6: Water Quality and Health Concerns.

SN	Indicators	1	2	3	4	5	Mean	Std. Dev	Skw	Kurt	Total
1	Perceived quality of drinking water	73 (19.7)	81 (21.9)	70 (18.9)	74 (20.0)	72 (19.5)	2.98	1.411	0.037	-1.304	370
2	Frequency of reported water borne diseases	143 (38.6)	101 (27.3)	59 (15.9)	23 (6.2)	44 (11.9)	2.25	1.344	0.87	-0.415	370
3	Use of water treatment methods at home	89 (24.1)	171 (46.2)	67 (18.1)	35 (9.5)	8 (2.2)	2.19	0.979	0.767	0.199	370
4	Satisfaction with taste, colour, and odour of drinking water	183 (49.5)	101 (27.3)	55 (14.9)	23 (6.2)	8 (2.2)	1.84	1.032	1.136	0.579	370

Source: Researcher's fieldwork, 2025

Legend:

SN 1: Very Poor (1); Poor (2); Moderate (3); Good (4); Very Good (5)

SN 2: Never (1); Rarely (2); Occasionally (3); Frequently (4); Very Frequently (5)

SN 3: None (1); Boiling (2); Filtering (3); Chemical Treatment (4); Multiple Methods Combined (5)

SN 4: Very Dissatisfied (1); Dissatisfied (2); Neutral/Moderate (3); Satisfied (4); Very Satisfied (5)

7. Government Policies and Management Factors (Table 19)

Table 7 indicates that awareness of water policies (M = 1.56, SD = 0.88) and perceived existence/enforcement of regulations (M = 1.68, SD = 0.95) were very low, with >88% reporting little/no awareness or enforcement (strong positive skewness and high kurtosis). Government support was rated poorly (M = 2.47, SD = 1.11), and community involvement moderate but limited (M = 2.68, SD = 1.16).

Table 7: Government Policies and Management Indicators.

SN	Indicators	1	2	3	4	5	Mean	Std. Dev	Skw	Kurt	Total
1	Awareness of water management policies	224 (60.5)	111 (30.0)	15 (4.1)	13 (3.5)	7 (1.9)	1.56	0.876	1.974	4.125	370
2	Perception of government support in water supply	91 (24.6)	95 (25.7)	111 (30.0)	64 (17.3)	9 (2.4)	2.47	1.112	0.175	-0.94	370
3	Community involvement in water management decisions	67 (18.1)	88 (23.8)	146 (39.5)	34 (9.2)	35 (9.5)	2.68	1.155	0.306	-0.44	370

4	Existence of water regulations and enforcement	197 (53.2)	131 (35.4)	20 (5.4)	9 (2.4)	13 (3.5)	1.68	0.947	1.862	3.662	370

Source: Researcher's fieldwork, 2025

Legend:
SN 1:Not Aware (1); Slightly Aware (2); Moderately Aware (3); Aware (4); Very Aware (5)
SN 2: Very Poor (1); Poor (2); Moderate (3); Good (4); Very Good (5)
SN 3: None (1); Low (2); Moderate (3); High (4); Very High (5)
SN 4: Strongly Disagree (1); Disagree (2); Neutral/Moderate (3); Agree (4); Strongly Agree (5)

Population growth, seasonal variability, poor infrastructure, high costs, and weak governance emerged as the strongest drivers of water insecurity in Naka. Access constraints (distance/time), unreliable sources, and dissatisfaction with quality and services compound demand pressures. Despite high willingness to pay and some functional boreholes, systemic deficits in infrastructure, regulation, and year-round supply remain critical barriers requiring urgent policy and investment attention.

Result of Principal Component Analysis (PCA)

The Principal Component Analysis (PCA) result of the factors affecting water supply and demand in Naka and its Environs is presented in Table 8. The result identified four (4) components based on the sums of squares loadings. The technique of PCA is further strengthened by the application of orthogonal (Varimax) rotation of the original components without changing the position of the original variables. This enables further determination of distinctive loading of the variables so that each variable has the highest load on and only one component. Explanations are given with reference to structure of the variable loadings on the components together with their separate and joint contribution to the variance of loading pattern.

Extraction of the Components

Significant loadings are considered from the threshold of + 0.60 which is statistically significant at 95% confidence level. This cut off value is based on the size of the components loading. According to Johnston (1991) this cut off value is an arbitrary decision and represents 36% (that is 0.60 = 3.36). It is thus chosen to ease interpretation. Each squared component loading indicates the degree to which the new variables replace the original variables. The sum of these squared loadings known as the eigenvalue therefore shows the total variance explained by the component. Hence, the eigenvalue is employed in accounting for the total explained variance in the data matrix. The solution to the question of the number of components to be extracted in this work is provided by Kings (1969) rule. The rule is that only those components whose eigen value account for over 5% of the total variance should be extracted. However, additional component (Fourth component) with eigenvalue of 0.452 (approximately, 0.5) with % variance explanation of 1.614 was extracted to boost the cumulative % explanation to 96% (Tables 18 and 19).

Table 8: Rotated Component Matrix.^{a}

Variable	**Component**			
	1	**2**	**3**	**4**
Perceived increase in the number of households	.903	.262	-.052	.246
Increase in average household size	.919	.337	.097	-.068
Perceived impact of population growth on water demand	.928	.302	.028	-.046
Frequency of new housing developments	.648	.643	.367	.000
Perception of changes in rainfall patterns	.773	.508	.339	.036
Seasonal variation in water availability	.818	.297	.030	.426
Frequency of dry spells affecting water supply	.724	.563	.112	.222
Level of dependency on rain-fed water sources	.861	.392	.218	-.051
Distance to the nearest water source	.800	.486	.278	.083
Time spent fetching water daily	.853	.421	.231	-.032
Perceived reliability of the main water source	.835	.416	.285	.020
Availability of alternative water sources	.684	.611	.360	.019
Perceived condition of water supply infrastructure	.402	.823	.267	.235
Frequency of water supply interruptions	.708	.578	.066	.010
Satisfaction with water supply services	.253	.946	.026	-.035
Presence of functional boreholes or piped water	.824	.455	.275	.032
Monthly household expenditure on water	.922	.324	.084	.083
Willingness to pay for improved water services	.879	.390	.150	-.040
Perception of water cost burden	.891	.369	.053	.086
Percentage of household income spent on water	.715	.588	.331	.014
Perceived quality of drinking water	.694	.614	.334	.016
Frequency of reported waterborne diseases	.446	.800	.318	.011
Use of water treatment methods at home	.533	.766	.179	-.124
Satisfaction with taste, colour, and odour of drinking water	.374	.865	.220	.183
Awareness of water management policies	.283	.941	-.060	-.038
Perception of government support in water supply	.642	.666	.297	.094
Community involvement in water management decisions	.616	.685	.257	-.001
Existence of water regulations and enforcement	.311	.925	-.029	.089
Total Eigenvalues	***14.413***	***10.320***	***1.411***	***.452***
% of Variance	***51.474***	***36.857***	***5.040***	***1.614***
Cumulative %	***51.474***	***88.331***	***93.371***	***94.985***

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 9 iterations.

Component 1: Population Growth and Urban Expansion

The first extracted component is associated with population growth and urban expansion and its effect on water demand. Variables loading highly on this component include a perceived increase in the number of households (.903), an increase in average household size (.919), and a perceived impact of population growth on water demand (.928). These variables indicate that the rapid population growth in Naka, Gwer-West LGA, has significantly influenced water demand. A growing number of households lead to increased water consumption, placing pressure on existing water sources. Moreover, the frequency of new housing developments (.648) suggests urban expansion, further escalating water demand. The high eigenvalue of this component (14.413) with 51.474% explanation indicates its dominant role in explaining the variance in water supply and demand.

Component 2: Infrastructure and Water Supply Systems

The second component relates to the state of water supply infrastructure and servicedelivery. The most relevant variables under this factor include the perceived condition of water supply infrastructure (.823), frequency of water supply interruptions (.578), satisfaction with water supply services (.946), and presence of functional boreholes or piped water (.824). These loadings suggest that water supply infrastructure plays a critical role in accessibility and reliability. Poor infrastructure resulted in frequent interruptions and dissatisfaction with water services. The high loading of satisfaction with water services (.946) implies that public perception strongly depends on infrastructure effectiveness. This component has a high eigenvalue of 10.320, and a percentage explanation of 36.857 indicates its substantial influence on water access.

Component 3: Economic factors (Water Cost and Affordability)

The third component encompasses economic factors affecting water affordability and financial burden. Key variables include monthly household expenditure on water (.922), willingness to pay for improved services (.879), perception of water cost burden (.891), and percentage of household income spent on water (.715). These loadings demonstrate that the cost of water significantly affects household access. High water prices limited accessibility, particularly for low-income families. Willingness to pay for improved services (.879) suggests that residents are open to paying higher fees if service quality improves. The component's eigenvalue of 1.411 and variance contribution of 5.04% indicate its relevance, albeit lower than the first two factors.

Component 4: Water Quality and Health Concerns

Water quality and health-related issues form the fourth component, with high loadings on perceived drinking water quality (.694), frequency of reported water-borne diseases (.800), use of water treatment methods at home (.766), and satisfaction with taste, colour, and odour of drinking water (.865). These variables suggest that concerns over water contamination and safety are prevalent. The high loading of the frequency of waterborne diseases (.800) implies that poor water quality has direct health implications. The adoption of household water treatment methods (.766) suggests that many residents take proactive steps to improve water safety. The eigenvalue (.452) and variance contribution (1.614%) suggest that while important, this factor has less impact than the first three.

Overall, the PCA analysis reveals that water supply and demand in Naka town and its Environs are influenced by four main factors: (1) population growth and urban expansion, (2) infrastructure and water supply systems, (3) water cost and affordability, and (4) water quality and health concerns. Population growth exerts the most significant impact, followed by infrastructure and water systems, water cost and affordability, water quality and health concerns play supporting roles in shaping the water supply landscape. These findings indicate the need for infrastructure investment, cost regulation, quality monitoring, and strong governance to enhance water accessibility and sustainability in the study area

DISCUSSION

Recent studies on water supply and demand in Nigeria have reported that population growth as a primary driver of increased water pressure, which is consistent with the findings of the current study where descriptive analysis showed high mean scores (4.23 for perceived household increases) and PCA identified it as the dominant component explaining 51.474% of variance. For instance, Ayeni (2017) examined urbanization and population dynamics in Lagos State, revealing a 525.9% population increase from 1963 to 2006, leading to a supply-demand gap similar to Naka's observed household expansion and its impact on demand (mean 3.96). Likewise, Olabode and Comte (2024) noted rapid demographics exacerbating scarcity in Lagos, echoing Naka's concerns with new housing developments (mean 2.82) and urban expansion. Climate change and seasonal variability, another key factor in Naka (mean 4.42 for seasonal variation), are corroborated by Irene et al. (2025), who discussed Nigeria's freshwater crisis amid fluctuating rainfall, paralleling Naka’s high dependency on rain-fed sources (mean 3.72) and frequent dry spells (mean 3.51).

Infrastructure deficiencies and accessibility issues in Naka, with means like 3.41 for distance to sources and 1.75 for infrastructure condition, resonate with broader Nigerian challenges. Balogun et al. (2017) reviewed Lagos’ public supply, citing poor operational efficiency and low reticulation coverage as causes of shortages, much like Naka’s unreliable sources (mean 3.54) and frequent interruptions (mean 3.3). Adeoti et al. (2023) synthesized failures due to technical and institutional factors, supporting Naka’s PCA component on infrastructure (36.857% variance). Socio-economic and affordability factors in Naka (mean 4.03 for expenditure) mirror Akoteyon (2019), who found income and cost as key barriers in Lagos residential areas, where low-income households face similar burdens (mean 4.12 for cost perception in Naka).

Water quality and health concerns, forming Naka's fourth PCA component, are evident in studies like Shuaibu et al. (2025), which advocate integrating self-supply for governance in Yola North to address contamination risks, akin to Naka’s moderate quality perception (mean 2.98) and waterborne disease frequency (mean 2.25). Ogunbode et al. (2024) analyzed variability in Iwo, noting sub-WHO consumption levels due to supply gaps, paralleling Naka’s dissatisfaction with taste and odor (mean 1.84). Policy and management shortcomings in Naka (low awareness mean 1.56) align with these studies’ calls for sustainable solutions, emphasizing the need for integrated strategies to mitigate vulnerabilities.

CONCLUSION

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