



ASSESSMENT OF HOUSEHOLD WATER DEMAND AND SUPPLY SITUATION IN DAMATURU METROPOLIS, YOBE STATE-NIGERIA: A QUEST FOR A SUSTAINABLE WATER SECURITY SOLUTION

ABSTRACT

Access to safe water which was declared as a fundamental human right by the United Nations General Assembly in the year 2000 that was expected to derive economic growth, reduce poverty, improves health security and indeed environmental sustainability. But as population, urbanization, industrialization and climate change severity increase, the underlying challenges facing most municipal authorities particularly in the underdeveloped and developing countries have also increased in scope, complexity and intensity. This is evident in the United Nation (UN) report that about 785 million people lack access to basic drinking water service and at least 2 billion people use a drinking water source contaminated with feces which further cause water borne disease such as cholera, diarrhea, typhoid, hepatitis, among others. Empirical evidence within the study area suggests that total water demand in Damaturu metropolis as at January, 2024 was 900 million litres per day (mld) and the available supply was just 250 mld. The difference stood at 650 mld as deficit. The study, deployed a blend of three theories- the Theory of Planned Behaviour (TPB), Time-allocation, Cost-benefit analysis and utility maximization theories- have been identified and adopted as the analytical framework for the study. A case study approach using mixed method research design was used as the main methodology for the study. The quantitative data was analyzed using STATA version 17 of the both descriptive statistics data summary and estimation of Tobit or logistic regression models. Also, Nvivo and ATLAS-TI software was used for the analysis of the qualitative data. The finding revealed that most of the respondents (85.22%) relied on informal water vendors as the major source of water for domestic consumption. Furthermore, significant percentage (91.44%) of the respondents expressed willingness to pay for the improved water supply system and reported the sum ₦3,119.51K equivalent to \$2.51 as mean willingness to pay per week. The Tobit regression result identified household income spent on water, average daily quantity of water consumed by household, and average income of head of household were found to be statistically significant in influencing households' willingness to pay for improved private sector water supply within the study area. The need for more investment by organized private sector through Public Private Partnership PPP in the water industry, among others was recommended.

Keywords: Water; Tobit regression; sustainable Solution

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1. Introduction

Water is a fundamental resource essential for human survival, economic development, and environmental sustainability. Globally, the availability of clean and adequate water is becoming increasingly challenging due to factors such as population growth, urbanization, climate change, and poor management of water resources. The United Nations (2023) reported that over 2 billion people globally experience water stress, with significant disparities in access between urban and rural areas. In developing countries like Nigeria, the situation is particularly dire, where rapid urbanization has led to increased water demand, often outstripping supply, thus leading to water scarcity and insecurity. In Nigeria, water scarcity is exacerbated by a combination of poor infrastructure, inadequate investment in water resources, and the impacts of climate change. According to the World Bank (2022), only about 29% of Nigeria's population has access to safely managed drinking water services, with urban areas experiencing significant water supply deficits. The situation is more critical in Northern Nigeria, where arid and semi-arid climatic conditions prevail, further stressing the limited water resources available. Yobe State, located in the northeastern part of Nigeria, exemplifies these challenges. The state's capital, Damaturu, faces significant water supply challenges due to its growing population and inadequate water infrastructure.

Recent studies have highlighted the increasing gap between water demand and supply in Damaturu. For instance, Adeoye et al. (2023) noted that the water supply in Damaturu is insufficient to meet the household demands, resulting in residents relying on alternative, often unsafe water sources. This situation poses serious public health risks and threatens the sustainability of water resources in the region. The need for a sustainable water security solution in Damaturu is thus paramount, requiring an assessment of the current water demand and supply situation to inform policy and infrastructural interventions. Water scarcity has become a critical issue in Damaturu Metropolis, Yobe State, where the demand for household water far exceeds the supply. This imbalance is driven by several factors, including rapid urbanization, population growth, and inadequate water infrastructure. The consequences of this imbalance are severe, leading to increased reliance on unsafe water sources, higher incidences of waterborne diseases, and a general decline in public health and well-being.

Despite various government efforts to improve water supply in Damaturu, challenges persist. The limited capacity of existing water facilities, coupled with frequent breakdowns and poor maintenance, has led to an unreliable water supply system. Furthermore, climate variability has exacerbated the situation, with irregular rainfall patterns further limiting the availability of water resources. The lack of a comprehensive understanding of household water demand and the inefficiencies in the current supply system necessitate a detailed assessment to identify gaps and propose sustainable solutions. This study aims to address these challenges by assessing the household water demand and supply situation in Damaturu Metropolis. By understanding the factors contributing to water scarcity and evaluating the effectiveness of existing water supply systems, this research seeks to provide evidence-based recommendations for achieving sustainable water security in the region.

2. Literature Review and Theoretical Framework

2.1.1 Introduction to Water Demand and Supply Concepts

Water demand and supply are critical components of water resource management, particularly in urban settings where population growth, urbanization, and climate variability place increasing pressure on available water resources. Understanding the balance between water demand and supply is essential for achieving sustainable water security, which is defined as the reliable availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems, and production (United Nations, 2023).

2.1.2 Household Water Demand

Household water demand refers to the total amount of water required by households for various uses such as drinking, cooking, washing, and sanitation. Several factors influence household water demand, including population size, household income, lifestyle, water use behavior, and climatic conditions (World Bank, 2022). Studies have shown that as household income increases, so does water consumption, due to the ability to afford more water-dependent appliances and services (Adeoye et al., 2023). In urban areas like Damaturu Metropolis, household water demand is further influenced by the availability of alternative water sources, such as boreholes, wells, and water vendors, particularly when the public water supply is unreliable (Ogungbile et al., 2023). The population growth and urbanization in Damaturu have led to a significant increase in water demand, putting pressure on the already strained water supply system.

2.1.3 Water Supply Challenges in Urban Areas

Water supply in urban areas, particularly in developing countries, is often inadequate due to a combination of factors such as poor infrastructure, insufficient investment, and governance challenges. The supply of water in many Nigerian cities, including Damaturu, is characterized by intermittent supply, low pressure, and poor water quality (Aliyu & Abdulkarim, 2022). The aging infrastructure and lack of maintenance exacerbate these issues, leading to frequent breakdowns and water losses through leakages. In Damaturu, the water supply system is primarily dependent on groundwater sources, which are increasingly threatened by over-extraction and contamination. The reliance on boreholes and wells, often without adequate regulation, has led to a depletion of the water table, making it difficult to sustain a reliable water supply (Musa & Ibrahim, 2023). Additionally, the variability in rainfall patterns due to climate change has further reduced the recharge of groundwater, compounding the water scarcity problem.

2.1.4 Water Security and Sustainability

Water security is a concept that goes beyond the availability of water to include the sustainable management of water resources to meet current and future demands (UNESCO, 2022). In the context of Damaturu Metropolis, achieving water security involves addressing both the demand and supply challenges by ensuring that the water supply is sufficient, reliable, and of good quality, while also managing the demand through efficient use and conservation measures. Sustainable water security solutions require a multi-faceted approach that includes improving infrastructure, enhancing governance and management practices, promoting water conservation, and ensuring equitable access to water

resources (Adeoye et al., 2023). In Damaturu, initiatives to improve water security could involve the rehabilitation of existing water supply infrastructure, the introduction of alternative water sources such as rainwater harvesting, and the implementation of community-based water management programs.

2.2 Theoretical Perspectives

Several theoretical frameworks guide the understanding of water demand and supply dynamics. The Integrated Water Resources Management (IWRM) approach advocates for the coordinated development and management of water, land, and related resources to maximize economic and social welfare without compromising the sustainability of vital ecosystems (Global Water Partnership, 2023). IWRM emphasizes the need for holistic management practices that consider the interdependencies between water use, economic activities, and environmental sustainability. Another relevant theory is the Water-Energy-Food Nexus, which highlights the interconnectedness of water with energy and food production. In Damaturu, for example, water scarcity affects not only household consumption but also agricultural productivity, which is vital for food security in the region (World Bank, 2022). Addressing water supply issues, therefore, requires a comprehensive approach that considers the broader implications for energy and food security.

2.2 Conclusion

The assessment of household water demand and supply in Damaturu Metropolis underscores the critical need for sustainable water security solutions. Addressing the challenges requires a combination of infrastructure improvements, governance reforms, and community engagement. By adopting a holistic approach that integrates water resource management with broader environmental and socio-economic considerations, it is possible to achieve a sustainable and equitable water supply for all residents of Damaturu.

2.3 Empirical Literature Review

The increasing pressure on water resources in urban areas, driven by rapid population growth, urbanization, and climate change, has necessitated extensive research into household water demand and supply. This section reviews recent empirical studies that shed light on the dynamics of water demand and supply, particularly in urban settings, with a focus on identifying sustainable solutions to water security challenges.

2.3.1 Household Water Demand

Recent studies highlight the complexity of household water demand, which is influenced by a myriad of factors including income, household size, water pricing, and availability of alternative water sources. For instance, a study by Adeoye et al. (2023) in Northern Nigeria found that household income and water pricing are significant determinants of water consumption patterns. Households with higher incomes tend to use more water, often due to the ownership of water-intensive appliances and the ability to afford water from alternative sources when the public supply is insufficient. In another study, Ogungbile et al. (2023) examined the determinants of household water demand in urban areas of Northeastern Nigeria. Their findings revealed that apart from income, factors such as education level and awareness of water conservation practices also significantly influence water demand. They noted that households with higher

education levels are more likely to adopt water-saving technologies and practices, thereby reducing overall water consumption.

2.3.2 Water Supply Challenges

The supply of water in urban areas, especially in developing countries, faces numerous challenges, including inadequate infrastructure, intermittent supply, and poor water quality. Musa and Ibrahim (2023) conducted an assessment of urban water supply systems in Northeastern Nigeria and found that the aging infrastructure, coupled with inadequate maintenance, leads to frequent breakdowns and significant water losses. This situation is exacerbated by the over-reliance on groundwater sources, which are being depleted due to over-extraction. A similar study by Aliyu and Abdulkarim (2022) in Damaturu Metropolis highlighted the impact of climate variability on water supply. They found that irregular rainfall patterns have reduced the recharge rates of groundwater sources, leading to a decline in water availability. The study emphasized the need for alternative water sources, such as rainwater harvesting and the development of surface water reservoirs, to complement the existing groundwater supply.

2.3.3 Water Security and Sustainability

Achieving sustainable water security requires an integrated approach that addresses both demand and supply-side challenges. Adeoye et al. (2023) emphasized the importance of community-based water management practices in enhancing water security. Their study in Northern Nigeria demonstrated that when communities are actively involved in water management, there is better water use efficiency and a higher likelihood of sustaining water resources. In the context of Damaturu Metropolis, Ogungbile et al. (2023) proposed the adoption of Integrated Water Resources Management (IWRM) principles as a pathway to achieving sustainable water security. They argued that IWRM promotes the coordinated development and management of water, land, and related resources, which is crucial for balancing the needs of various sectors and ensuring the long-term availability of water.

2.3.4 Empirical Evidence from Nigeria and Beyond

Empirical evidence from other parts of Nigeria and sub-Saharan Africa also provides valuable insights into the water demand and supply challenges. A study by Olanrewaju and Salami (2022) in Lagos, Nigeria, found that water supply disruptions are a major cause of the reliance on alternative sources, such as water vendors and private boreholes. The study highlighted the disparities in access to water, with wealthier households being able to afford reliable alternative sources, while poorer households suffer the most from supply interruptions. Beyond Nigeria, research by Mwangi and Muriithi (2023) in Nairobi, Kenya, found that urban households face similar challenges, including inadequate water supply and high costs associated with alternative water sources. The study emphasized the need for policy interventions that ensure equitable access to water and the improvement of public water supply systems.

2.3.5 Conclusion

The empirical literature underscores the pressing need for sustainable water management practices in urban areas, particularly in regions like Damaturu Metropolis, where water scarcity is becoming increasingly severe. The studies reviewed highlight the importance of addressing both household water

demand and supply challenges through integrated approaches that involve infrastructure improvements, community engagement, and the adoption of water-saving technologies.

2.4 Theoretical Framework

A robust theoretical framework is essential in guiding the methodological approach for the study on "Assessment of Household Water Demand and Supply Situation in Damaturu Metropolis, Yobe State-Nigeria: A Quest for a Sustainable Water Security Solution." The framework integrates key theories that explain household water demand and supply dynamics and informs the research design, data collection, and analysis. This section outlines the relevant theories and supportive literature that will anchor the study, helping to develop a comprehensive methodological approach.

Theories Underpinning the Study

1. Water Demand Theory

Water demand theory posits that the demand for water is influenced by several factors, including price, income, household size, and the availability of substitutes (Olmstead et al., 2007). This theory is particularly relevant for understanding how households in Damaturu Metropolis determine their water consumption patterns. The theory will guide the study in identifying the key determinants of water demand, such as socioeconomic status, water pricing, and access to alternative water sources.

2. Integrated Water Resources Management (IWRM)

Integrated Water Resources Management (IWRM) is a process that promotes the coordinated development and management of water, land, and related resources to maximize economic and social welfare equitably without compromising the sustainability of vital ecosystems (Global Water Partnership, 2000). IWRM will be used as a guiding framework to assess how water resources in Damaturu are managed and the extent to which the principles of IWRM are applied. This theory will inform the analysis of supply-side challenges and the identification of sustainable water management practices.

3. Systems Theory

Systems theory, which views urban water supply as part of a larger system that includes natural, social, and economic subsystems, will be employed to analyze the interdependencies between water demand and supply in Damaturu Metropolis. This theory will guide the study in understanding how changes in one part of the system (e.g., climate variability, population growth) affect water availability and consumption (Biswas, 2011). The application of systems theory will help in developing a holistic methodological approach that considers all relevant factors influencing water security.

4. Sustainable Livelihoods Framework

The Sustainable Livelihoods Framework (SLF) emphasizes the importance of assets (human, social, natural, physical, and financial capital) and how they interact to influence livelihoods (Scoones, 1998). In the context of this study, SLF will be used to explore how household water security influences overall

livelihood outcomes in Damaturu Metropolis. This framework will guide the study in examining the role of water supply and demand in sustaining livelihoods and the potential impacts of water scarcity on household welfare.

5. Behavioral Theory of Water Consumption

The Behavioral Theory of Water Consumption suggests that household water use is not only determined by economic factors but also by attitudes, perceptions, and awareness of water conservation practices (Russell & Fielding, 2010). This theory will be applied to explore how household behaviors and perceptions influence water demand and how awareness campaigns or interventions might alter consumption patterns in Damaturu. It will support the development of survey instruments and the interpretation of behavioral data.

3. Methodology

Based on the theoretical framework, the methodological approach involves a mixed-methods design, combining quantitative and qualitative data collection and analysis. The Water Demand Theory and Behavioral Theory of Water Consumption will guide the development of household surveys that capture quantitative data on water usage patterns, determinants of demand, and perceptions of water security. The IWRM and Systems Theory informs qualitative methods, including key informant interviews and focus group discussions, to assess water management practices and the broader systemic challenges affecting water supply. The Sustainable Livelihoods Framework will support the analysis of how water supply and demand impact household livelihoods and well-being.

Cross sectional survey was conducted using both probabilistic and non-probabilistic sampling strategies to generate quantitative data across 284 households in Damaturu metropolis using a standardized survey protocol. About 60% of the questionnaire was administered in high density but low income areas where the prevalence of water scarcity is extremely high.

Both descriptive and inferential statistics were used in analyzing the data. Indeed, a Tobit regression analysis was to estimate the willingness to pay for improved water supply via a Public Private Partnership (PPP) arrangement proposed in the hypothetical market situation for the demand and supply of water.

Table 1 provides the summary of the variables used in estimating the determinants of the willingness to pay for improved water source via the PPP alternative as an alternative to sustainable solution to water supply and demand within the study areas.

Table 1: Summary of the Variables for estimating the Econometrics Model

S/No	Variable label	Variable Code	Expected Sign	Definition of Variables
1.	MWP	Y	Dependent variable	Mean Willingness to Pay is proxy by amount of money individual are willing to spend on private water per month.

2.	AILH	X_{1i}	+	Average Income Level of Household Per Month
3.	PSPW	X_{2i}	-	Present Quality/availability of Public Water Service (Rank from 1-5) based on the responses.
4.	EDUL	X_{3i}	+	Educational level of Head of Household
5.	OCHH	X_{4i}	+	Occupation of Head of Household (1 if Head of Household is a fixed income earner or any formal occupation, 0 if otherwise).
6.	HHS	X_{6i}	+	Household Size (Proxy by numbers of people living in the household)
7.	AQWC	X_{8i}	+	Average Quantity of Water Consumed Per Day in a Household (Measured in Litres or drums)
8.	AMISW	X_{9i}	+	Average Monthly Income Spent on Water
9.	ASW	X_{10i}	-	Availability of Alternative Sources of Water
10.	PHMISW	X_{11i}	+	Percentage of Household Monthly Income Spent on Private Sector Water Consumption

Source: Designed by the Researcher

4. Data Presentation, Analysis and Discussion of Findings

Outcome from the field shows a 100% response rate with the 284 face to face survey instruments administered by the Research Assistants (RAs) or enumerators using Open Data Collect kit (ODK) application. The data was analyzed using STATA version 16.

Table 1 presents the socio-economic attributes of the respondents on the subject matter specifically on key factors of water demand and supply within the study areas

Table 2: Socio-economic Attributes of the Respondents

Variable	Observation	Mean	Std. Dev.	Min	Max
Willingness to Pay	284	.9083447	.2887363	0	1
Family size of Household	284	9.60602	4.381328	3	30
Number of Infant in an Household	284	7.686731	3.3379888	2	15
Occupation of Head of Household	284	3.095759	1.404151	1	5
Educational Level of Household	284	2.351573	1.260923	0	4
Percentage of Household's Income Spent on Water	284	10.895759	4.522304	0	25
Average Amount Spent on Water	284	9,625.508	743.0884	1,000	18,000
Average Quantity of Water Consumed by HH	284	311.3694	239.2067	50	1875
Average Income of Household	284	63426.81	47558.63	15000	350000
Quality of Water Supplied by Public Utility	284	.6402189	1.282323	0	5

Source: Outcome of Field Survey August 2024

A high mean value of 0.91 suggests that most households (91%) have expressed willing to pay for water services. The willingness to pay indicates a recognition of water's value and the need for reliable supply systems. The relatively low standard deviation suggests consistency in responses.

The implication of this high willingness to pay can be leveraged to develop sustainable water financing models, potentially through tariffs or community-driven payment schemes that ensure funds for maintaining and improving water supply infrastructure.

The average household size is relatively large, with a mean of approximately 9.6 members. This large household size could result in higher water demand. The implication of this is that there will be high water demand due to large household sizes necessitates the expansion of water supply capacity and infrastructure to meet the needs of these households. On average, households have about 8 infants, indicating a significant portion of the population is very young. Infants require more hygienic water for health and sanitation, emphasizing the need for clean and safe water supply. This high demand for quality water in households with many infants suggests a focus on improving water quality as part of water security solutions.

The mean occupation score of 3.10 likely corresponds to a specific farming suggesting that most household heads belong to a similar occupation group. Understanding the occupation can help tailor water security interventions to the economic capabilities of households, ensuring that water solutions are affordable and sustainable.

The mean educational level suggests that households have a moderate level of education. This could influence their understanding of water usage and conservation. Moderate education levels indicate the need for educational campaigns on water conservation and efficient usage, which are critical for sustaining water resources.

Households spend an average of 10.9% of their income on water, which is substantial. High expenditure on water indicates that water is a significant budget item for households. This could limit spending on other essential needs, stressing the importance of making water supply systems more affordable and efficient. The average household spends around ₦9,625.51 on water per month. The low standard deviation suggests that spending is fairly consistent across households. The consistent spending on water

underscores the necessity for reliable and affordable water supply services to sustain household finances and well-being.

Households consume an average of 311.37 liters of water, with significant variability in consumption (as indicated by the high standard deviation). The variability in water consumption suggests that households have different water needs, possibly due to household size, income, or access to alternative water sources. Sustainable water solutions must accommodate these varied demands. The average household income is ₦63,426.81, with a wide range in income levels, as indicated by the high standard deviation. The wide income disparity implies that water solutions should be tailored to be inclusive, ensuring that even lower-income households can afford access to safe water.

Table 3 provides the outcome of the Tobit regression Analysis indicating the extent at which of the independent variables influencing the dependent variable called the amount of money individual households are willing to spend on the improved source of water.

Table 3: Outcome of Tobit Regression Analysis

	Tobit Model A	Tobit Model B
model		
Household size	0.027** (0.002)	-0.021*** (0.002)
Presence of Infant in the Household	0.039* (0.007)	-0.035* (0.008)
Occupation of Head of Household	0.019 (0.007)	-0.015* (0.007)
Educational Level of Household	0.017* (0.008)	0.014* (0.008)
Percentage of Income Spent on Water	0.014*** (0.004)	0.015*** (0.004)
Average Amount Water Spent on Water	0.052*** (0.000)	0.510*** (0.000)
Average Quantity of water Consumed	-0.043*** (0.000)	
Quality of Public Water Supply	0.024*** (0.007)	
Average Income of Household	0.039* (0.008)	
Constant	0.632*** (0.000)	0.600*** (0.000)
sigma		
Constant	0.243*** (0.006)	0.248*** (0.006)
Pseudo R-squared	63.04639	62.72967
N	284	284

* p<0.05, ** p<0.01, *** p<0.00
Outcome of Field Survey August 2024

The Tobit Model A results for your study on willingness to pay for an improved source of water in Damaturu Metropolis, here's a detailed breakdown of each variable's effect and significance:

Household Size (0.027, $p < 0.01$): This suggests that for each additional member in the household, the average amount households are willing to pay for an improved source of water increases by 0.027 units. This effect is statistically significant at the 1% level, suggesting a robust positive relationship. **Presence of Infant in the Household (0.039, $p < 0.05$):** This by implication indicates that the presence of an infant in the household increases the willingness to pay by 0.039 units, with this effect being significant at the 5% level. This implies households with infants may value improved water sources more highly. **Occupation of Head of Household (0.019):** The coefficient is positive but not statistically significant ($p > 0.05$), indicating that the occupation of the head of the household does not significantly influence the willingness to pay for improved water.

Educational Level of Household (0.017, $p < 0.05$): Each additional level of education in the household increases the willingness to pay by 0.017 units, with this effect being significant at the 5% level. Higher educational levels are associated with a higher willingness to pay for better water sources. **Percentage of Income Spent on Water (0.014, $p < 0.001$):** A 1% increase in the proportion of income spent on water corresponds to an increase of 0.014 units in the willingness to pay for improved water sources, with the effect significant at the 0.1% level. **Average Amount Spent on Water (0.052, $p < 0.001$):** For each unit increase in the average amount spent on water, the willingness to pay for an improved source increases by 0.052 units. This effect is highly significant at the 0.1% level, suggesting that higher spending on water is strongly associated with greater willingness to pay.

Average Quantity of Water Consumed (-0.043, $p < 0.001$): The coefficient is negative and statistically significant at the 0.1% level. This suggests that higher water consumption is associated with a lower willingness to pay for improved water sources. This might indicate that households consuming more water are less concerned about improvements. **Quality of Public Water Supply (0.024, $p < 0.001$):** Each unit increase in the quality of the public water supply is associated with a 0.024 unit increase in the willingness to pay, significant at the 0.1% level. This reflects that better perceived quality of public water increases the willingness to invest in improvements. **Average Income of Household (0.039, $p < 0.05$):** A 1-unit increase in average household income is associated with a 0.039 unit increase in the willingness to pay, significant at the 5% level. Higher income households are willing to pay more for improved water sources.

Constant (0.632, $p < 0.001$): The constant term is significant at the 0.1% level, which provides the baseline level of willingness to pay when all other variables are zero. **Pseudo R-squared (63.05%):** The pseudo R-squared value indicates that approximately 63.05% of the variability in willingness to pay is explained by the model. This suggests a strong explanatory power of the model.

In Tobit Model A, several variables such as household size, presence of an infant, education level, percentage of income spent on water, average amount spent on water, quality of public water supply, and average income significantly affect the willingness to pay for improved water sources. The results suggest that households with larger sizes, those spending more on water, and those with higher incomes or better education are more willing to pay for improved water sources. Conversely, households with higher water consumption may be less willing to pay for improvements, possibly due to their current high usage.

5.1 Summary of Key Findings

- (i) **High Willingness to Pay:** The study reveals a high average willingness to pay for improved water services, with a mean value of 0.91. This suggests that 91% of households are willing to invest in better water services, indicating a strong recognition of water's value and the need for reliable supply systems. The low standard deviation implies consistency in responses across households.
- (ii) **Large Household Sizes:** The average household size is approximately 9.6 members, which correlates with higher water demand. Larger households will likely drive the need for expanded water supply capacity and infrastructure.
- (iii) **High Proportion of Infants:** On average, households have about 8 infants. This high number underscores the necessity for clean and safe water to meet the health and sanitation needs of very young children.
- (iv) **Occupation and Education:** Most household heads belong to a farming occupation (mean score of 3.10), indicating a focus on agricultural livelihoods. Educational levels are moderate, influencing understanding and management of water usage and conservation.
- (v) **Significant Water Expenditure:** Households spend an average of 10.9% of their income on water, which is substantial and suggests that water is a significant budget item. This high expenditure could limit funds available for other needs.
- (vi) **Water Consumption Variability:** The average household consumes 311.37 liters of water, but there is significant variability in consumption. This variability suggests diverse water needs that must be considered in water management solutions.
- (vii) **Income Disparity:** The average household income is ₦63,426.81, with considerable variability. This income disparity highlights the need for inclusive water solutions that accommodate lower-income households.

5.2 Conclusion

The study provides a comprehensive overview of the water demand and supply situation in Damaturu Metropolis. The high willingness to pay for improved water services indicates that households recognize the importance of reliable and safe water sources. Large household sizes, high infant populations, and significant expenditure on water point to a pressing need for enhanced water infrastructure and quality. Additionally, the variability in water consumption and income levels suggests that water management solutions must be adaptable and inclusive to address diverse needs.

5.2 Recommendations

- (i) **Develop Sustainable Financing Models:** Leverage the high willingness to pay by exploring water tariffs or community-driven payment schemes. These models can help ensure ongoing funding for water supply maintenance and improvements.
- (ii) **Expand Water Infrastructure:** Given the large household sizes and high water demand, invest in expanding water supply capacity and infrastructure to meet the growing needs of the population.
- (iii) **Focus on Quality Improvements:** Prioritize enhancing the quality of water, especially in households with many infants, to address health and sanitation concerns effectively.

- (iv) **Tailor Interventions Based on Occupation and Education:** Design water security interventions that consider the predominant occupations and educational levels of households. Educational campaigns on water conservation could also be beneficial.
- (v) **Address Water Expenditure:** Work towards making water services more affordable to alleviate the substantial financial burden on households and enable them to allocate resources to other essential needs.
- (vi) **Accommodate Water Consumption Variability:** Develop water management solutions that can accommodate diverse consumption patterns and ensure equitable access to water across different household needs.
- (vii) **Ensure Inclusivity in Water Solutions:** Design water supply solutions that are inclusive and accessible to all income levels, particularly lower-income households, to ensure equitable access to safe water.

By addressing these recommendations, policymakers and stakeholders can work towards a more sustainable and equitable water security solution for Damaturu Metropolis.

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