Assessment of Water Demand and Supply in Tumfure, Akko Local Government, Gombe State, Nigeria

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ABSTRACT

Water scarcity remains a major challenge in many arid and semi-arid regions, impacting socio-economic development and public health. This study assesses the patterns of water demand and supply in Tumfure, Akko Local Government, Gombe State, Nigeria, a rapidly urbanising area facing increasing pressure on its water resources. A mixed-methods approach was employed, integrating quantitative data from 100 structured questionnaires and qualitative insights from key informant interviews and field observations. Findings reveal that 58% of residents rely on commercial water tankers, which are costly and unreliable, while 34% depend on piped water, and 8% use rainwater harvesting, mainly for non-drinking purposes. Infrastructure deficiencies (58%) and population growth (37%) were identified as the primary factors affecting water reliability. Socio-economic impacts include 40% of households reporting disruptions in education due to water shortages and income instability caused by fluctuating water costs. The study highlights the need for improved water infrastructure, community-based water management strategies, and policy interventions to enhance equitable water distribution. Addressing these challenges is essential for ensuring sustainable water supply, improving health outcomes, and reducing socio-economic disparities in Tumfure. Recommendations include improved water infrastructure, community-based water management

Keywords: Water supply demand, Tumfure, Gombe State, Water management

INTRODUCTION

Water is fundamental to life, yet access to clean and reliable water sources remains a pressing global challenge. According to the United Nations, over 2.2 billion people lack safe drinking water, with sub-Saharan Africa and South Asia being the most affected regions, (UNICEF, 2013). The availability of fresh water is constrained by factors such as climatic variability, rapid population growth, urbanization, and inadequate infrastructure, (Narmilan,2021). These challenges disproportionately impact developing nations, where water scarcity and poor-quality supply systems hinder socio-economic development and public health. At the national level, Nigeria faces significant disparities in water availability. While urban centres often benefit from structured water supply networks, rural and peri-urban areas experience inconsistent access, forcing residents to rely on unreliable and sometimes unsafe water sources.

Gombe State, located in the semi-arid Sahelian region, is characterized by low rainfall, high evaporation rates, and seasonal water scarcity. (Maina & Eziashi, 2016) Tumfure, a rapidly expanding settlement in Akko Local Government Area (LGA), is experiencing increasing pressure on its water resources due to urban expansion and rising population density. One of the major challenges in Tumfure is inadequate access to clean and safe drinking water. A significant portion of the population depends on water sources of questionable quality, raising concerns about public health and overall well-being. Additionally, rapid population growth has intensified demand,

straining the already insufficient water supply infrastructure. The geological formation of Tumfure, with its erratic rainfall patterns, further complicates water resource sustainability.

This study aims to assess the water demand and supply dynamics in Tumfure, aiming to identify key challenges and propose sustainable solutions to enhance water accessibility, quality, and sustainability. The study evaluates the availability of water sources in the community, examining the extent to which residents have access to reliable and sufficient water supply. Additionally, it investigates the reliability of existing water sources, assessing their capacity to meet the growing demand amid the challenges posed by population growth, and climatic and geological conditions.

MATERIALS AND METHODS

Study Area

Tumfure is a peri-urban settlement within Gombe Metropolis, situated in Akko Local Government Area, Gombe State, North-eastern Nigeria, located between 10°5'0"N and 10°8'0"N latitude and 11°6'0"E and 11°9'0"E longitude (Figure 1). The area experiences a tropical savanna climate with distinct wet and dry seasons, with annual rainfall ranging from 850 mm to 1,200 mm, primarily between May and October. The geology of Tumfure consists of deep aquifers, making borehole drilling expensive and limiting groundwater accessibility. (Mayomi., et al.,2018). The region is influenced by the broader geological framework of Gombe Metropolis, which includes Cretaceous-age sandstones and crystalline basement rock formations. Due to these geological constraints, residents rely on commercial water vendors, rainwater harvesting, and intermittent piped water supply (Maina & Bombom, 2023).
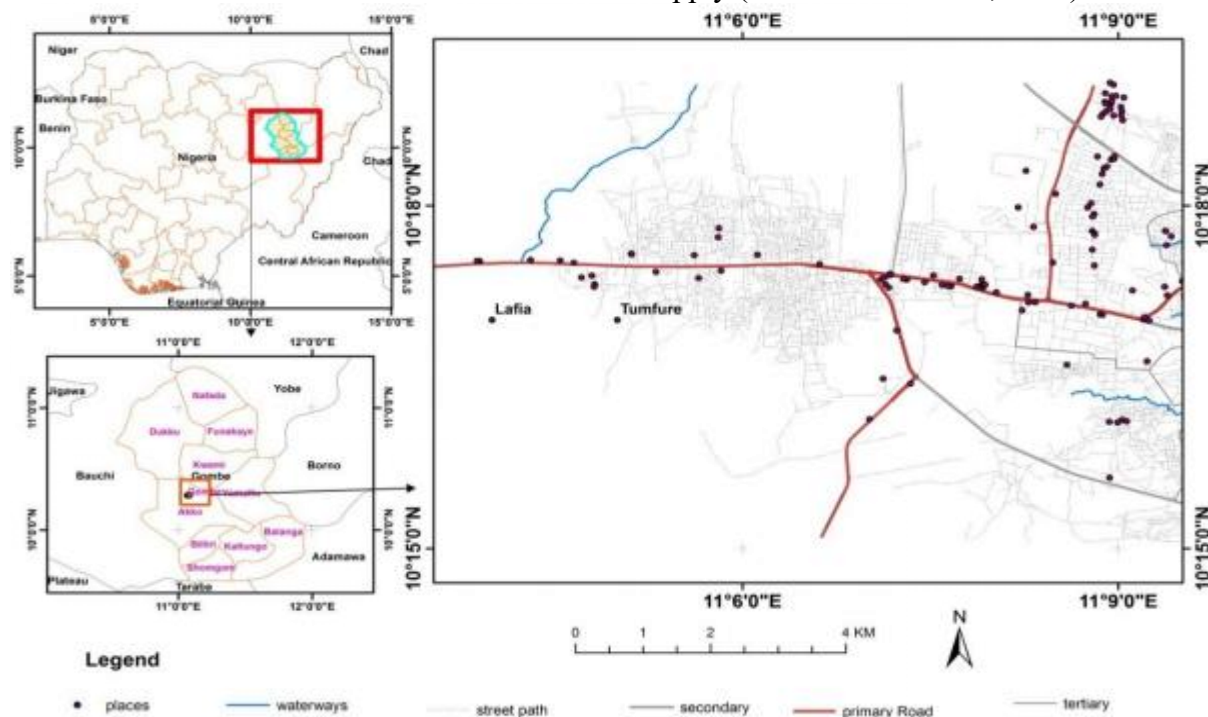

Figure 1: Nigeria, Gombe State, Study area
Source: Gombe State Geographic Information System (GOGIS), 2024

Research Design

This study employed a mixed-method approach, integrating both qualitative and quantitative techniques to assess water demand and supply in Tumfure. The research was structured to provide an in-depth analysis of key variables, addressing challenges such as rapid population growth, increasing reliance on groundwater, and the socio-economic impacts of water scarcity. The study adopted field surveys and quantitative approaches to investigate water usage patterns, availability, and reliability. Quantitative methods provided measurable insights into water consumption trends, while qualitative aspects, including direct field observations and key informant interviews, helped contextualise the environmental and human factors affecting the water supply.

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

Where: n = sample size

- N = population size (73,000)

- e = margin of error (0.1 or 10%) , Using this formula:

$$n = \frac{73000}{1 + 73000(0.1)^2} = \frac{73000}{1 + 730} = \frac{73000}{731} \approx 100$$

Data Analysis and Tools

Quantitative data obtained from the questionnaires were analysed using descriptive statistics such as percentages, means, and frequency distributions. These were presented in tables, bar charts, and pie charts to visually communicate key findings. The quantitative analysis was conducted using Microsoft Excel and the Statistical Package for Social Sciences (SPSS). Qualitative data from interviews and field observations were analysed using thematic analysis, allowing for the identification of key patterns and narratives that explain the water supply and demand situation in Tumfure in more depth.

Sampling Technique

A stratified random sampling technique was employed to select households for questionnaire administration, ensuring adequate representation across various socio-economic strata within Tumfure. This approach helped to capture a more balanced perspective of the community by considering socio-economic differences such as income level, education, and occupation.

Based on the 2006 National Population Census, Tumfure had an estimated population of 45,000. Applying a 2.6% annual growth rate, the projected population in 2024 is approximately 73,000. Using Taro Yamane's sampling formula at a 10% margin of error, the sample size for the study was calculated as follows:

RESULTS AND DISCUSSION

Demographic and Socio-Economic Characteristics of Respondents

The socio-demographic profile of the respondents provides insight into the population characteristics of Tumfure, which influence water demand and supply patterns. Data from the survey revealed that the majority of respondents were female (68%), while males constituted 38%. This gender distribution suggests that women, who are typically responsible for water collection and household water management, are the most affected by water scarcity issues in the community. In terms of age distribution, the largest proportion of respondents (46%) fell within the 18–30 age group, followed by

33% in the 31–43 age group, 13% in the 44–54 age group, and 8% aged 55 and above (Table 1). Wahl & Oswald (2010) suggest that older adults often have greater awareness and understanding of environmental changes due to their extended exposure and accumulated experiences over time, and younger respondents reflect the rapid population growth and youthful demographic structure of Tumfure, which contributes to increasing water demand.

Table 1: Frequency Distribution of Respondents Age

Age	Frequency (N=100)	Percentage (%)
18-30	46	46%
31-43	33	33%
44-54	13	13%
55+	8	8%
Total	**100**	**100%**

Source: Filed work (2024)

Marital status data showed that 63% of respondents were married, 33% were single, and 4% were widowed, with no reports of divorce or separation. Educational attainment was notably high, with 98% of respondents having completed tertiary education, while 2% had only secondary education (Figure 2). The high literacy rate suggests a potential for increased awareness of water conservation practices and sustainable management strategies.

These socio-economic characteristics are crucial in understanding water consumption patterns, as household size, income level, and employment status influence water access and affordability. The predominance of younger individuals and high literacy levels indicate a growing population with increasing water needs, highlighting the urgency for improved water supply infrastructure and management in Tumfure.
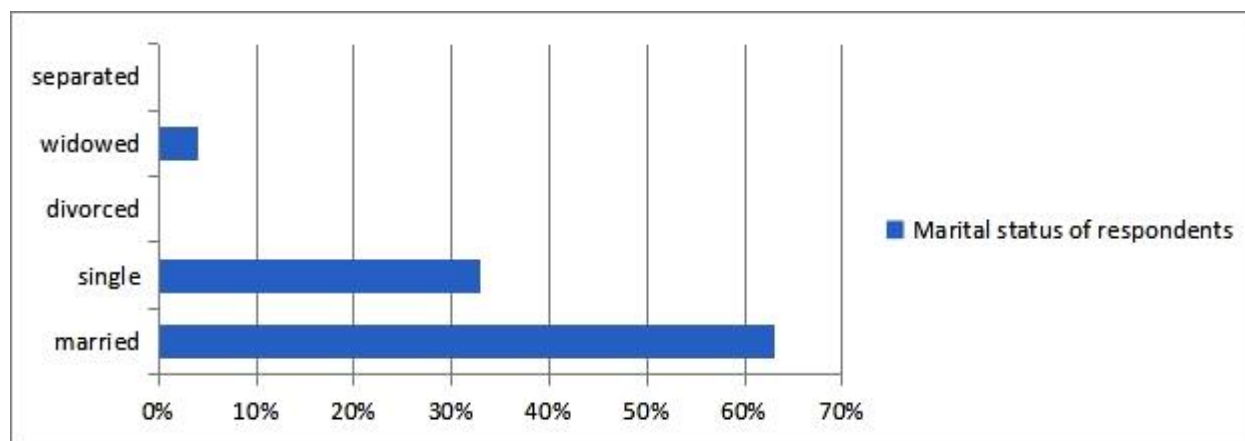

Figure 2: Marital Status of Respondents, 2024.

Availability and Reliability of Water Sources

Geological and infrastructural factors largely constrain water availability in Tumfure. Findings indicate that the community relies on three primary water sources: commercial water tankers (58%), piped water (34%), and rainwater harvesting (8%), while boreholes contribute 0% to the water supply. The dominance of commercial tankers highlights the inadequacy of the formal water supply system, as residents are forced to depend on expensive and often inconsistent private vendors. Although piped water accounts for 34% of supply, its availability remains unreliable due to inconsistent distribution and infrastructural challenges. Rainwater harvesting, which contributes 8%, is limited to the wet season and is primarily used for non-drinking purposes (Figure 3). The complete absence of borehole usage reflects the geological constraints that make groundwater extraction difficult and costly for residents (Giordano, et al., 2018).
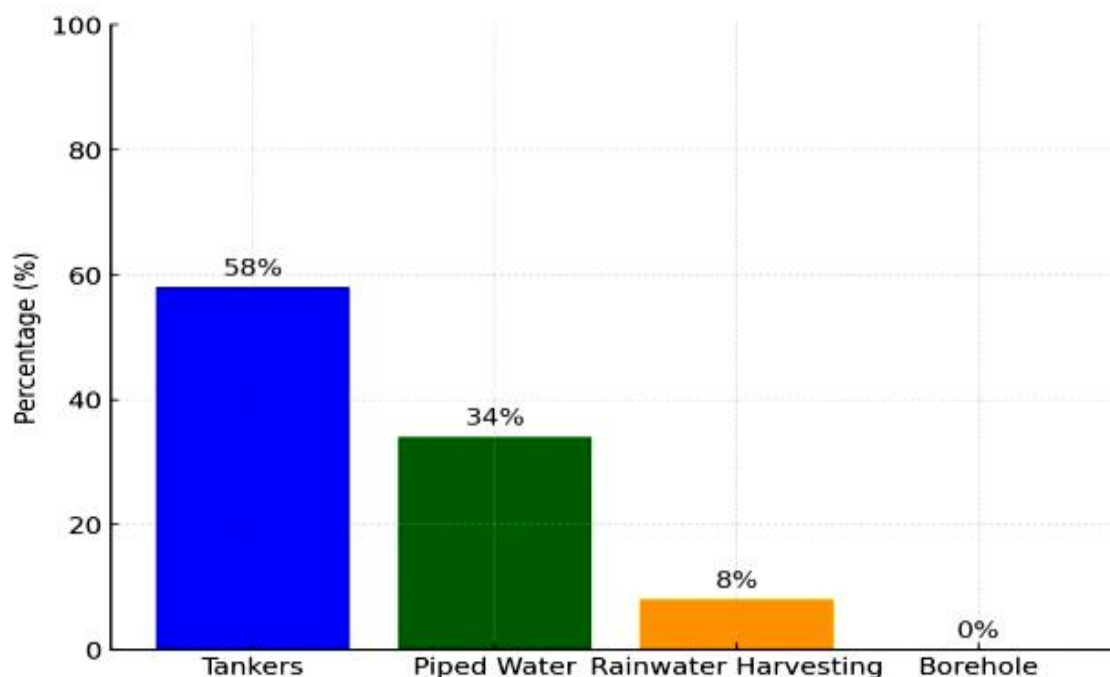
Figure 2: Primary Water Sources in the Study Area.

Geological factors significantly influence water accessibility in Tumfure. Survey results showed that 44% of respondents identified geology as the primary determinant of water availability. The presence of deep aquifers makes borehole drilling costly and technically challenging, further restricting groundwater access. Additionally, seasonal variations impact water supply, with 41% of respondents reporting increased water availability during the rainy season, while 15% noted unpredictable fluctuations. Accessibility remains a critical concern, as most respondents expressed dissatisfaction with the ease of obtaining water. Despite the growing water demand, there are no known government or community-led initiatives aimed at improving water access. The absence of interventions exacerbates the existing water challenges, forcing residents to rely on costly and unreliable sources. Addressing these challenges requires coordinated efforts from government agencies, private sector stakeholders, and community members to enhance water

security in the region (Giordano & Barron 2019).

Reliability of Water Sources in Tumfure Akko LGA

Water reliability in Tumfure remains a critical issue affecting residents' access to a consistent supply. Survey results indicate that 16% of respondents experience a constant water supply throughout the year, while 47% noted an increase in reliability during the wet season. However, 30% reported that water fluctuates unpredictably, making access uncertain. Notably, only 6% observed an increase in reliability during the dry season, highlighting the severe seasonal water scarcity (Figure 4). The findings highlight the vulnerability of Tumfure's water supply system, particularly during the dry season when availability significantly declines. The heavy reliance on seasonal rainfall suggests that existing infrastructure is inadequate to meet demand year-round. The high percentage of unpredictable fluctuations further exacerbates the challenge, leaving residents with uncertain access to water.
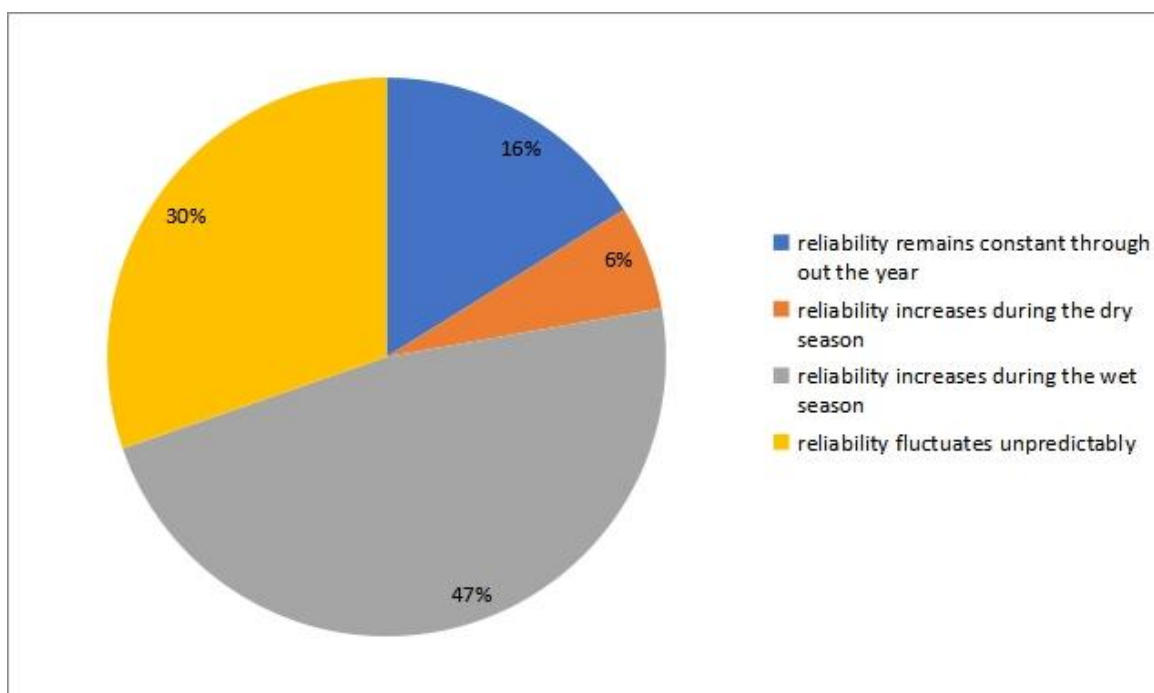
Figure 4: Respondents' perception on seasonal reliability of water sources, 2024.

Infrastructure deficiencies emerged as the most significant factor influencing water reliability, as identified by 58% of respondents. The increasing population in Tumfure was cited as another contributing factor by 37%, while only 5% attributed reliability issues to financial limitations. These findings suggest that the existing water supply infrastructure is struggling to meet the growing demand, leading to frequent supply interruptions and scarcity. When asked about their satisfaction with the current reliability of water sources, only 18% of respondents expressed satisfaction, while 39% were dissatisfied, and 43% remained neutral. The dissatisfaction largely stems from irregular water supply, the high cost of purchasing water from commercial vendors, and the inability of the public water supply system to meet demand. Given these challenges, improving infrastructure, enhancing water storage facilities, and investing in alternative water sources, such as boreholes and rainwater harvesting systems, could significantly improve the reliability of the water supply in Tumfure. Addressing these concerns is critical to

ensuring a more sustainable and equitable water supply system for the community.

Socio-Economic Impact of Water Demand and Supply Dynamics on Study Area Residents

The availability and reliability of water in Tumfure have significant socio-economic implications, affecting income levels, education, health, and community cohesion. Water scarcity has led to increased financial burdens on households, as residents frequently spend substantial portions of their income on purchasing water from private vendors. The survey revealed that fluctuations in water supply create income instability, particularly for low-income households that rely on government-subsidised water sources. Education is another sector affected by water demand and supply challenges. Although the majority of respondents reported no direct impact on educational infrastructure, 40% indicated that irregular water supply negatively affects student attendance and academic performance. Students, particularly those from households that lack reliable water access, often spend considerable time

fetching water, which disrupts their studies and school attendance.

Health-related issues linked to water scarcity were less pronounced in the survey responses, as residents did not report a significant increase in waterborne diseases during periods of water shortages. However, interviews with health professionals revealed seasonal spikes in illnesses such as typhoid, likely due to the consumption of untreated rainwater during the wet season (Musa, 2009). Addressing these issues through improved water infrastructure, equitable distribution strategies, and targeted interventions for low-income residents is necessary to enhance social and economic well-being in Tumfure.

Water Management Practices in the Study Area

Water management practices in Tumfure remain largely informal and individualized, with minimal community-driven or government-supported initiatives aimed at improving water access. The study found that overhead water tanks (GP tanks) were the most widely used water storage method, with most of the respondents relying on this practice. However, the capacity and effectiveness of this method varied significantly across income groups, as higher-income households were able to afford multiple or larger storage tanks, while lower-income households had limited storage capacity. (Abdullahi, 2020). The choice of water management practices was primarily influenced by financial resources. Households with greater financial capacity invested in larger storage solutions and alternative water sources such as private boreholes or commercial water deliveries. In contrast, lower-income households depended on limited water supplies from public sources, often facing challenges in securing sufficient water for daily needs (Damkjaer & Taylor 2017). To enhance water sustainability in Tumfure, efforts should focus on increasing community engagement, promoting water conservation awareness, and implementing government-supported initiatives that ensure equitable water distribution. Strengthening local governance structures for water management can also help optimize water resource allocation and promote long-term water security for residents. (Gleick 1996)

The findings of this study highlight the critical challenges associated with water demand and supply in Tumfure. Regarding the availability of water sources, the study confirmed that Tumfure relies on three primary sources: commercial water tankers, intermittent piped water, and seasonal rainwater harvesting. The geological conditions of the area significantly limit the feasibility of borehole drilling, further constraining water access. Comparisons with previous studies, such as the Inventory of Rural Domestic Water Supply Points in Gombe State (Ahmad et al., 2019), confirm that natural water sources in the region are highly variable and often unreliable. In assessing the reliability of water sources, the study revealed that commercial water supply and piped water are both inconsistent, with no major improvements reported. The high reliance on water vendors aligns with findings from Paul (2009), who identified similar supply shortages in Gombe Metropolis. Rainwater harvesting, while used by some residents, remains an unreliable solution due to seasonal constraints.

The socio-economic impacts of water demand and supply, findings showed that water scarcity contributes to financial strain on households, affects educational attendance, and indirectly influences health conditions. However, unlike other studies that report severe health crises due to poor water supply, the study found that Tumfure residents did not report a significant increase in waterborne diseases, possibly due to some level of awareness regarding water treatment

practices. Lastly, finding water management practices revealed that no formal community-led initiatives exist to improve water accessibility. The reliance on individual storage solutions, such as overhead tanks, highlights the urgent need for a coordinated approach to water management. Similar studies in urban areas, such as those by Ezenwaji and Eduputa (2017) in Enugu, suggest that implementing institutional reforms, demand management techniques and community-based solutions can enhance water security in rapidly urbanising regions.

Water availability in Tumfure is highly constrained, with commercial water tankers serving as the primary but costly source. Water reliability is inconsistent, with significant fluctuations due to seasonal changes and inadequate infrastructure. The socio-economic impacts of water scarcity include financial burdens, disruptions in education, and disparities between income groups in terms of water access. Water management practices are largely individualistic, with limited community participation and no formal water conservation programs in place.

Conclusion

The study underscores the urgent need for improved water infrastructure and sustainable management strategies in Tumfure. Given the existing challenges, recommendations should focus on expanding the public water supply, promoting affordable borehole drilling options, and increasing community involvement in water resource management. Implementing long-term solutions such as rainwater harvesting programs, improved storage facilities, and regulatory oversight on water pricing will contribute to enhanced water security in the region.

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