



ISSN: 2523-5664 (Print)
ISSN: 2523-5672 (Online)
CODEN: WCMABD

Water Conservation and Management (WCM)

DOI: <http://doi.org/10.26480/wcm.01.2026.201.209>



RESEARCH ARTICLE

SPATIAL DISPARITIES IN HOUSEHOLD WATER ACCESS AND THEIR IMPLICATIONS FOR WATER MANAGEMENT IN OYO STATE, NIGERIA

Ayobami Alani Oyelami^{a*}, Timothy Oyebamiji Ogunbode^a, Olumide Michael Owwoeye^b

^aEnvironmental Management and Crop Production Unit, College of Agriculture, Engineering and Science, Bowen University, Iwo, Nigeria.

^bSociology Programme, College of Social and Management Sciences, Bowen University, Iwo, Nigeria.

*Corresponding Author Email: timothyogunbode@bowen.edu.ng

This is an open access journal distributed under the Creative Commons Attribution License CC BY 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited

ABSTRACT

Article History:

Received 11 January 2026
Revised 18 February 2026
Accepted 15 March 2026
Available online 30 April 2026

This study examined the factors influencing household access to domestic water across four Local Government Areas (LGAs) in Oyo Zone, Oyo State, Nigeria, using exploratory factor analysis. Data were collected through structured questionnaires administered to residents and analysed using principal component extraction with varimax rotation. Results showed that five to six dominant factors explained more than 60% of the total variance in water accessibility in each LGA, indicating strong explanatory power. Key shared determinants across the zone included proximity to water sources, reliability of supply, and water quality, reflecting the importance of availability, consistency, and safety in household water access. Distance was the most influential factor in Atiba (Rotated Component Matrix value = 90.0), while water quality had the strongest effect across Oyo Zone (RCM = 87.2). Household preferences also significantly shaped access patterns, particularly in Oyo Zone (RCM = 92.3), driven by affordability, convenience, and cultural considerations. Distinct local challenges were identified, including high patronage levels in Afijio, physical access constraints in Atiba and Oyo Zone, and limited piped water connectivity in Oyo Zone. The findings reveal considerable spatial variation in water access conditions within the same geopolitical region. The study concludes that improving equity in water access requires location-specific interventions. Recommended actions include expanding piped water infrastructure, improving supply reliability and quality, reducing travel distance to water points, and addressing physical access barriers. Incorporating household preferences into water planning can enhance sustainability and user acceptance while strengthening water governance and equitable domestic water provision.

KEYWORDS

Household water access, Exploratory factor analysis, Spatial variability

1. INTRODUCTION

Access to potable water remains one of the most pressing developmental challenges across the globe, particularly in the Global South. (Shemer et al., 2023; Okesanya et al., 2024). According to the World Health Organization (WHO) and UNICEF Joint Monitoring Programme (JMP), over 2 billion people worldwide lack access to safely managed drinking water services, with the majority residing in low- and middle-income countries (The Lancet Global Health, 2020; Biswas et al., 2024).

While developed nations have made substantial progress in universal water access through robust infrastructure, governance frameworks, and technological innovation, developing countries continue to face complex constraints ranging from rapid urbanisation, population growth, poor investment in water infrastructure, institutional inefficiencies, and the impacts of climate change (Shehu et al., 2022).

Thus, the global promotion of water accessibility through the United Nations' Sustainable Development Goal 6 becomes desirable. In Sub-Saharan Africa, the situation of water accessibility is, especially, severe

(Ogunbode et al., 2025). The region records some of the lowest water access rates globally, where nearly 400 million people lack access to basic drinking water services, and rural communities are disproportionately affected (De Guzman et al., 2023; Merid et al., 2023).

Countries such as India, Bangladesh, and Ethiopia have made considerable efforts to expand access to clean water, often through decentralised governance, community participation, and alternative sources like rainwater harvesting (Onu et al., 2023; World Bank, 2023). In India, programmes like the *Jal Jeevan Mission* aim to provide rural households with piped water connections (Government of India, 2024; Singh and Naik, 2024).

While some progress has been made, many rural areas, struggle with unreliable supply, ageing infrastructure and water quality issues (Obeta et al., 2018). Bangladesh has also made strides by involving local governments and non-governmental organisations in rural water provision (Syed et al., 2021; Sarkar et al., 2022). The challenges like groundwater contamination—particularly from arsenic—pose serious health risks (Ahmad et al., 2018; Parvin et al., 2022; Habib et al., 2024).

Quick Response Code



Access this article online

Website:
www.watconman.org

DOI:
10.26480/wcm.01.2026.201.209

Ethiopia, with support from international donors, has developed rural water projects, yet many of these initiatives are undermined by poor maintenance limited technical capacity at the community level, and funding gaps that affect long-term sustainability (Whaley and Cleaver et al., 2017).

Similarly, several African countries—including Ghana, Kenya and Uganda—have embraced collaborative approaches involving governments, private actors, and development partners to improve water access (Mangaiand De Vries et al., 2018).

Ghana, for instance, has invested in rural water systems managed by local communities, but the lack of consistent funding and poor oversight often leads to breakdowns and unequal distribution (Collord et al., 2021). In Kenya, reforms have aimed to strengthen regulatory frameworks and include private sector participation, yet informal settlements still face severe shortages due to weak infrastructure and irregular service (Bose et al., 2024).

Uganda has pursued performance-based management of water services through local authorities and NGOs, but issues like poor maintenance culture, fragmented institutional roles, and underfunding continue to hinder progress (Ekane et al., 2019; Adom and Simatele, 2024). Despite the efforts, a common thread across these countries is that policies often look good on paper, but practical implementation is fraught with delays, under-resourcing, and limited community engagement especially in vulnerable and hard-to-reach communities (Kroese et al., 2021).

Nigeria, Africa's most populous nation, faces a multi-layered crisis concerning potable water accessibility (Velenturf and Purnell, 2021; Ogunbode et al., 2025). Despite the abundance of surface and groundwater resources, access to clean and safe water remains elusive for many Nigerians (Ogunbode et al., 2024).

The Federal Ministry of Water Resources estimates that only about 67% of the population has access to basic drinking water services, while safely managed drinking water remains even lower (Azeez et al., 2023). The challenge is worsened by aging infrastructure, irregular power supply, uncoordinated institutional mandates, and poor monitoring mechanisms (Azeez et al., 2023).

Furthermore, rural and semi-urban areas in Nigeria are plagued by seasonal water shortages, high reliance on unsafe sources such as streams and unregulated wells, and high costs of alternative sources such as sachet or bottled water (Velenturf and Purnell, 2021; Ogunbode et al., 2025).

Oyo State, located in the South-West geopolitical zone of Nigeria, reflects many of the broader national challenges associated with potable water accessibility. The state is characterised by a mix of urban centres and vast rural communities.

While cities like Ibadan enjoy relatively better access to piped water through public supply networks, many other parts of the state—particularly the Oyo Zone—remain significantly underserved. The Oyo Zone, which encompasses local government areas such as Oyo Zone, Oyo zone, Atiba, and Afijio, continues to experience severe water supply deficiencies. These challenges are largely due to inadequate public water infrastructure, limited access to boreholes, high poverty rates, and increasing environmental degradation.

Although the Erelu Dam was originally commissioned in 1960 to serve as a major source of potable water for the zone, it has since become largely non-functional. Prolonged neglect, insufficient funding, and lack of regular maintenance have left the facility in a state of near-total disrepair. As a result, many residents are forced to rely on alternative sources such as hand-dug wells, water vendors, and rainwater harvesting—options that are often unsafe, expensive, and unreliable.

Given these contextual realities, there is a critical need to evaluate the drivers influencing potable water accessibility in the Oyo Zone to inform responsive policy design, effective interventions, and sustainable practices. The aim of this study is to evaluate the key drivers that influence potable water accessibility in Oyo Zone of Oyo State, Nigeria. objectives of the study are to: (i) compute various sources of potable water available to

households in Oyo Zone; and (ii) identify and examine various factors influencing potable water accessibility in the study area. Achieving these objectives is crucial for gaining insight into the range of potable water sources utilised by households and for identifying the key factors that affect access to safe water in Oyo Zone. The findings will support evidence-based planning and the development of effective strategies to enhance water accessibility and ensure sustainable supply in the area.

2. THEORETICAL BASIS FOR THE INVESTIGATION

The assessment of potable water accessibility in the Oyo Zone of Oyo State is best anchored in complementary theoretical frameworks that capture the complex interactions among socio-economic, environmental, and institutional determinants of water access.

A particularly relevant framework is the Sustainable Livelihoods Framework (SLF), which provides a holistic lens for understanding how households mobilise different forms of capital—human, social, financial, natural, and physical—to sustain their livelihoods and secure access to essential services such as water (Natarajan et al., 2022).

This framework is especially applicable in rural and peri-urban contexts, where water access is closely linked to poverty levels, infrastructural deficits, environmental conditions, and institutional capacity (Kiconco et al., 2025). The SLF further enables an examination of how vulnerability factors—such as economic shocks and climatic variability—interact with available resources and adaptive strategies to shape water availability and quality outcomes (Opiyo et al., 2014).

In addition, the Theory of Access provides a critical perspective by distinguishing between the formal rights to resources and the actual ability of individuals or communities to derive benefits from them. This distinction is particularly significant in the Oyo Zone, where the existence of public water infrastructure or policies does not necessarily translate into effective access.

Constraints such as inadequate infrastructure, limited financial capacity, and weak social or institutional networks often hinder the realisation of these rights (Sinharoy et al., 2019; Machado et al., 2022). The theory emphasises that access is shaped not only by legal and policy frameworks but also by power relations, knowledge systems, and technological availability (Adeniran et al., 2021).

Together, these frameworks provide a robust conceptual foundation for analysing potable water accessibility in the study area. They support a multidimensional approach that integrates livelihood dynamics with political and institutional processes, thereby offering deeper insights into the mechanisms that facilitate or constrain access to safe water in the Oyo Zone.

3. METHOD OF STUDY

3.1 Study Area

The Oyo zone of Oyo State in figure 1 is in southwestern Nigeria located between latitudes 07°48'N and 08°22'N, and longitudes 03°47'E and 04°05'E. It covers about 1,130 km², with land use divided into urban (5.12%; 57.9 km²), rural (59.07%; 667.5 km²), and forest reserve (35.81%; 404.6 km²). It shares boundaries with Orelope, Olorunsogo, Oriire, Ogo-Oluwa, Ejigbo, Iwo, Akinyele, Ido, Atisbo, and Saki Zone LGAs. The urban section lies between 7°40'–7°56'N and 3°51'–3°59'E, surrounded by towns such as Ibadan (55 km), Ogbomosho (45 km), Iseyin (35 km), Iwo (36 km), and Ifeodan (26 km).

The climate is tropical wet-and-dry (Aw) with average annual rainfall of 1,163 mm and about 208 rainy days. Rainfall peaks in September (226.06 mm), while the dry season (late November–February) sees January as the driest month (5.08 mm).

Rainfall supports tropical rainforest in the south and derived savanna in other parts, largely due to human activities. Average temperature is 27°C, with daily values ranging from 25°C to 35°C. April is hottest (33.3°C), and August is coolest (21.7°C).

Topographically, the zone lies on a broad upland plain with undulating

terrain, inselbergs, and quartzite ridges. Elevation ranges from 600 to 850 metres, reaching 1,100 metres at Oke Border in Awe. Valleys are typically V- or U-shaped, with flood-prone, swampy floors during the wet season.

The drainage system is dominated by tributaries of River Ogun, with some zoneern areas draining into River Oba. The dendritic drainage pattern reflects uniform underlying geology. Aawon Stream, fed by tributaries such Oyo's population has grown from 20,000 in 1850 to 801,800 in 2022. Key historical figures include 67,634 (1931), 112,349 (1963), and 560,983 (2006). In 2015, Akinmorin, Awe, Fiditi, Ilora, and Iware had populations of 3,973; 14,304; 19,532; 27,212; and 1,697 respectively.

The UN projects a population of 428,798 by 2025. Water supply is now largely dependent on groundwater, as the Erelu Water Works (commissioned in 1962) has become underutilised. as Awe, Jabata, Kosobo, Ilaka, and Sogidi, is dammed for domestic water supply. Vegetation belongs to the Guinea savanna zone but varies by topography and soil.

Fringing forests occur in poorly drained valleys, while upland forest outliers are scattered across the region. Farming has led to open savanna landscapes, though woodland savanna remains near forest reserves. Trees grow up to 8–10 metres, and grasses up to 2.4 metres.

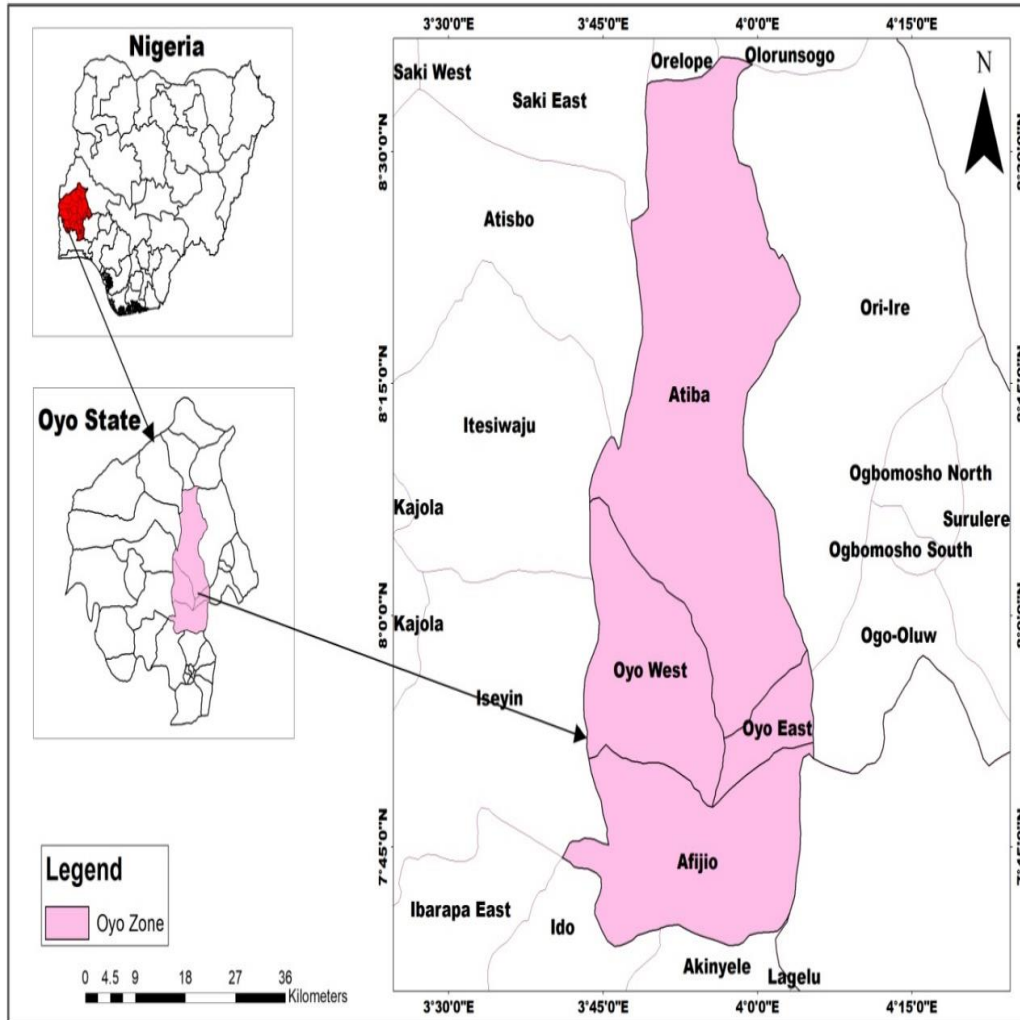


Figure 1: Map showing Oyo Zone of Oyo State, Nigeria

3.2 Data collection

3.2.1 The Questionnaire and its administration

The household questionnaire is divided into three sections. The first section focuses on household socio economic characteristics. Socio-economic data involved are: gender, age, marital status, household size, occupation, educational background, mode of house occupancy, age of dwelling, residential period, and monthly income.

The second section of the instrument asks about water availability while the third section is on water accessibility. Water Availability was identified in terms of sources, quantity, sufficiency, conservation, and preference.

The last section is on water accessibility and was determined through indices like protectiveness, physical distance to the source, time distance to the source, delay period at water fetching point, challenges searching for water, and payment for water.

Specifically, pipe-borne water access was measured in terms of: source distance, service frequency, presence of public water points, preference, and significance. Underground water access was measured in terms of distance

to contaminants, source improvement, drinkability, treatment, and safety precautions. Bottle/Sachet water access was examined through yardsticks like distance to sales point, consumption rate, interest, challenge, cost and uses. And surface water access was measured through distance, neatness, and uses yardsticks.

Households in the zone are the target population, and the interest of the study is on potable water accessibility. The questionnaires were developed based on ideas expressed in the literature, suggestions by potable water professionals and real-life experiences. The administration of the survey was held between July and November 2024. Morning and evening time were selected for the exercise to ensure that potential respondents were met at home. Women were more involved in the survey because of their roles as custodians of household water provision in the zone.

3.2.2 Sampling Size

Sample size for each of the LGA (Table 1) in the zone was determined by Proportional (Stratified) Allocation Based on Land Area per LGA (Hameed et al., 2025) that make up of the zone. The summary of the calculation is in table 1:

Table 1: Sample Size chosen across the Zone Units

S/N	Local Government	Land Coverage (km ²)	Sampled Neighbourhoods	No of Questionnaire
1.	Afijio	59.84775	11	275
2.	Atiba	83.25487	15	375
3.	Oyo zone	68.35943	12	300
4.	Oyo West	54.52795	10	250
Total	Oyo Zone	265.99	48	1200

3.3 Data Analysis

3.3.1 Descriptive Statistics

Questionnaire information was subjected to descriptive analysis involving the use of frequency, mean, percentage, standard deviation, and tabulation of data. Bar and line graphs were produced to show the relationships among independent and dependent variables in the study area.

3.3.2 Factor Analysis

Factor analysis, a multivariate statistic, was carried out to determine the factors that influence water accessibility in each of the local government areas and their strength in predicting household water accessibility in the study area.

The determinants involved in the analysis are between measured variables by showing multivariate patterns that may help in classifying the original data. The dataset was subjected to KMO and Bartlett’s tests to determine its fitness to factor analysis. Eigen value was set at 1.000, thus any variable that fails to meet that standard is discarded as insignificant in the explanation of the determinants.

4. RESULTS AND DISCUSSION

4.1 Descriptive Analysis

4.1.1 Some Basic Attributes Of Respondents

Gender Distribution: The gender composition of the respondents reveals a clear dominance of females, who constitute 67.8% of the sample, while males account for 31.2% in figure 2. The remaining 1.0% did not disclose their gender.

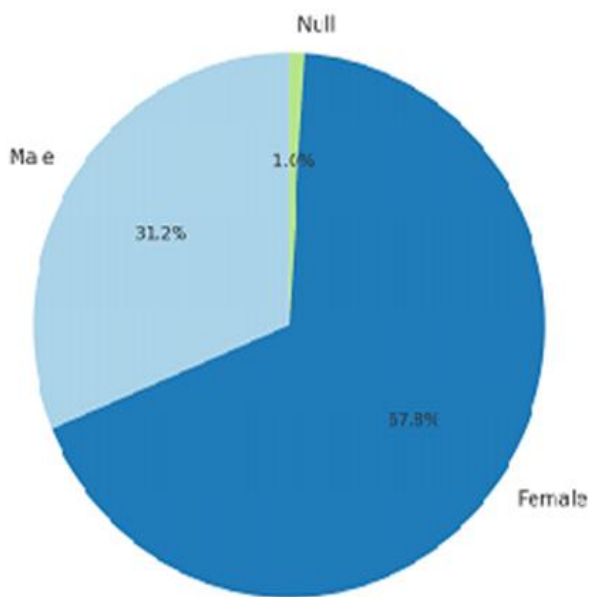


Figure 2: Gender distribution in Oyo zone

This skewed gender distribution may be attributed to the fact that women are often more present at home and more likely to respond to surveys that involve household-level data, especially those related to domestic water use, sanitation, and hygiene.

This pattern is consistent with findings from other household-based studies in Nigeria where women typically serve as primary water managers (Ogunbode and Ifabiyi, 2017). **Age Distribution:**

The age structure indicates that the majority of respondents fall within the economically active age brackets: 36–50 years (37.5%) and 18–35 years (33.7%) (Figure 3). Younger individuals below 18 years represent 11.5%, while older adults aged 51–65 years and above 65 years constitute 10.1% and 5.8% respectively.

The age profile suggests that most respondents are adults actively involved in household decision-making and possibly livelihood activities. The low representation of the elderly may reflect demographic realities, as well as limited participation of older residents in household surveys (Ogunbode et al., 2024).

Household Size Distribution: Household sizes vary, with most households (40.4%) comprising 6–10 persons, followed by 1–5 persons (34.6%). Households with 11–15 persons make up 13.5%, while larger households (more than 15 people) constitute a small fraction (3.4% combined in figure 4. Notably, 8.1% of respondents did not indicate household size.

These figures imply that extended families or moderately large households are quite common in Oyo Zone, a pattern typical of many Nigerian communities where cultural norms favour communal living and shared housing arrangements (Ogunbode et al., 2024). **Marital Status Distribution:** The marital status of respondents shows that a majority—61.5%—are married, while 27.9% are single.

Widows make up 6.3%, and divorced, separated, and null responses account for the rest in figure 5. The high proportion of married individuals suggests that the sample largely consists of household heads or spouses directly involved in family welfare, including decisions around water use, sanitation, and environmental cleanliness.

This demographic balance supports the reliability of the data for assessing household-level conditions and practices (Ogunbode et al., 2023a). Overall, the demographic structure of respondents in Oyo Zone LGA reflects a gendered, adult, and family-oriented population, with moderately large household sizes and high marriage rates. These characteristics are crucial for interpreting household water use patterns, sanitation behaviour, and participation in community-based environmental programmes.

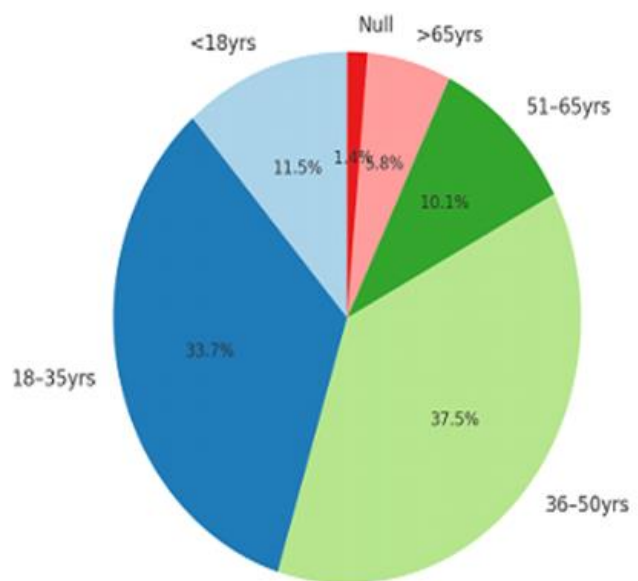


Figure 3: Age distribution in Oyo zone

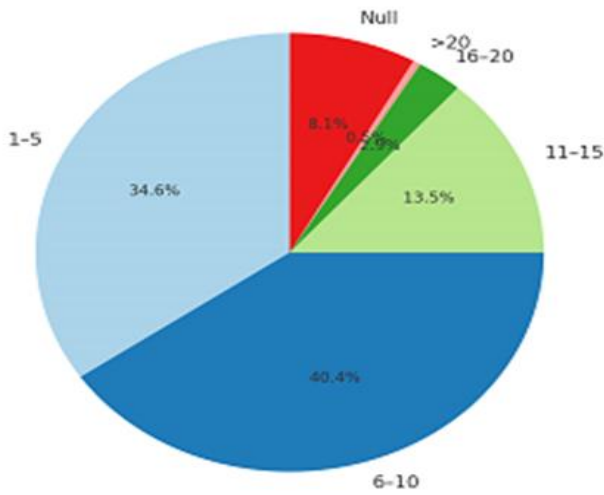


Figure 4: Household size distribution

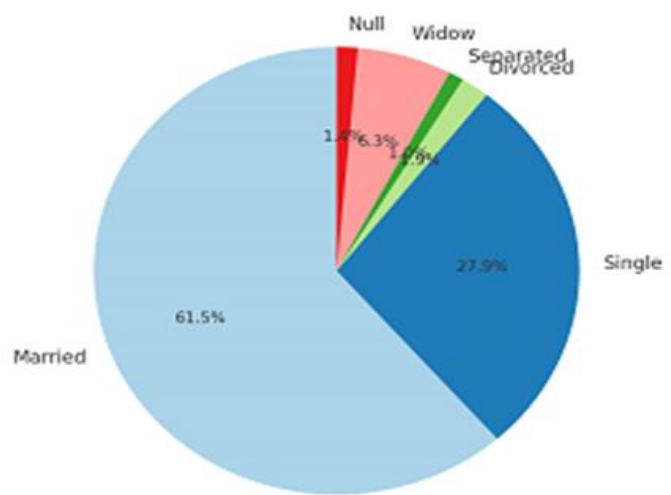


Figure 5: Respondents' Marital status

4.2 Reliable Water Sources In Oyo Zone

Table 2: Reliable Household Water Sources Available in Oyo Zone presents an overview of the major sources of water accessible to households in the area. The table underscores the diversity and reliability of water sources used, with the recognition that many households may depend on multiple sources simultaneously to meet their daily water needs due to the unreliability or seasonality of certain sources.

The most accessed water source across households in Oyo Zone is groundwater from hand-dug wells, recorded by 223 households, representing 89% of the sample. This overwhelming reliance on hand-dug wells suggests that groundwater remains the most accessible and dependable source for domestic use in the zone.

Hand-dug wells are generally inexpensive to construct and often located within or near residential compounds, offering households a convenient and relatively constant water supply. (Oyerinde and Jacobs, 2022,2023). However, the widespread use also raises concerns about water quality, particularly in areas where proper lining, covering, or treatment is lacking.

Deep boreholes are another important source of household water, used by 17 households, which represents 71% of respondents. This seemingly contradictory figure (17 households yet 71%) likely indicates either a misalignment in data representation or that the 71% refers to a subset of the population sampled within a specific area where deep boreholes are predominant.

Deep boreholes are typically more reliable and provide higher quality water than shallow wells or surface sources. They are especially useful in dry seasons when shallow sources may dry up. However, access is often limited by high installation and maintenance costs, suggesting that only better-resourced households or communities can rely on them (Oyerinde and Jacobs, 2022).

Pipe-borne water and surface streams/rivers are each reported by 11 households, making up only 0.92% respectively. This indicates that formal, centralised water supply systems (i.e., municipal pipe-borne water) are largely underdeveloped or poorly maintained across the Oyo Zone. The negligible reliance on pipe-borne water could reflect the limited reach of urban infrastructure, ageing pipelines, intermittent supply, or complete non-functionality of public water utilities in some areas (Ogunbode and Oyebamiji, 2025).

Similarly, the minimal use of surface streams or rivers likely stems from concerns about water safety, contamination, distance, and seasonal variability, making them less desirable for routine household use. It is important to note that because many households may combine water from more than one source, the percentages do not sum to 100%. Households might use hand-dug wells for washing and bathing, deep boreholes for drinking and cooking, and perhaps pipe-borne water when available, as a supplementary source. This multi-source strategy reflects a practical adaptation to fluctuating water availability and quality across the region.

In summary the table reveals a strong dependence on informal and semi-formal water sources, with hand-dug wells and deep boreholes serving as the primary means of access. The near absence of pipe-borne water underscores the need for substantial investment in public water infrastructure. Addressing the challenges of access, safety, and reliability will require a multifaceted approach that supports both the expansion of formal water services and the sustainable use of existing informal systems.

Table2: Reliable household water sources available in Oyo Zone			
S/no	Water source	Oyo zone	Percentage
1.	Pipe-borne water	11	0.92
2.	Groundwater (Hand-dug)	223	89
3.	Surface stream/River	11	0.92
4.	Deep boreholes	17	71

4.3 Household Water Usage Patterns In Oyo Zone

The data presented in Table 3: Household Water Usage in Oyo Zone reveals a comprehensive pattern of how households allocate water for various domestic and semi-domestic activities. A total of 250 households were surveyed, and the responses indicate that certain water uses are universally prioritised, while others are dependent on factors such as infrastructure availability, socio-economic conditions, and lifestyle preferences.

The first four categories — cooking, bathing, drinking, and washing — each recorded 100% usage across all households. This reflects the essential nature of these activities in daily household life. These functions represent the core necessities for survival, hygiene, and general well-being, thus indicating that water is consistently available and prioritised for them in all households surveyed, regardless of individual differences in income or living environment (Shemmer et al., 2022).

A second tier of water usage includes cleaning (74%), auto washing (72%), livestock feeding (72%), and mopping (67%). These uses, while not universal, are still prevalent in a large proportion of households. The significant use of water for livestock feeding suggests the presence of small-scale animal husbandry within households, a common feature in semi-urban and rural settings in Oyo Zone.

Likewise, the fairly high percentage of auto washing indicates either widespread private vehicle ownership or small-scale car wash operations within residential premises. Cleaning and mopping, though slightly less than universal, remain crucial to maintaining household sanitation and living standards. Water usage for flushing toilets (65%) shows that while a majority of households use water-based sanitation, about one-third still

rely on alternative means such as pit latrines or other dry sanitation systems. This points to infrastructure gaps, especially in rural areas or among low-income households, where access to water-borne toilet systems may be limited or unaffordable.

The less common uses of water include lawn watering (53%), home gardening (51%), and industrial processing (31%). These activities are typically discretionary and depend on the availability of additional water beyond basic needs. The fact that just over half of the households engage in home gardening and lawn watering suggests that a considerable number of households have access to land and enough water supply to maintain such practices, which may contribute to food security or aesthetics. However, the relatively low percentage involved in industrial processing (31%) implies that household-based commercial or artisanal water-dependent activities are limited, possibly due to lack of capital, water constraints, or the residential nature of the communities.

In summary, the table highlights a clear hierarchy of water needs among households in Oyo Zone. While basic and hygiene-related water uses are universally met, the ability to allocate water for secondary and economic purposes depends largely on household resources and infrastructure availability. These insights are critical for informing policy and infrastructure development that aims to ensure water sufficiency not just for survival, but for sustainable livelihoods and improved quality of life across the zone.

Table 3: Household water usage in Oyo zone

S/No	Water use category	Frequency	%
1.	Cooking	250	100
2.	Bathing	250	100
3.	Drinking	250	100
4.	Washing	250	100
5.	Mopping	168	67
6.	Cleaning	185	74
7.	Auto washing	180	72
8.	Flushing	163	65
9.	Livestock feeding	180	72
10.	Lawn watering	133	53
11.	Home gardening	128	51
12.	Industrial processing	78	31

4.4 Water Accessibility Drivers In Oyo Zone

Access to clean and reliable water is essential for public health, economic development, and overall well-being. However, water accessibility varies across different regions due to factors such as distance to water sources,

reliability of supply, quality of available water, and infrastructural limitations. This section examines the key determinants of water accessibility in the Zone using factor analysis, the study identifies and compares the major variables influencing water accessibility in these LGAs, highlighting both common challenges and location-specific factors. The findings provide insights into the critical barriers affecting water availability and offer recommendations for improving water access across the region.

The factor analysis results highlight the key determinants of water accessibility in Oyo zone Local Government Area, Oyo State, Nigeria. The Kaiser-Meyer-Olkin (KMO) value of 58.0 and the significance level ($p < 0.005$) confirm that the dataset is suitable for factor analysis. Six major factors in Table 4 were identified, collectively explaining 62.098% of the variance in water accessibility.

The most significant determinant is the connectivity of homes to pipe-borne water, with an eigenvalue of 1.723 and a variance contribution of 12.309%. The Rotated Component Matrix (RCM) value of 74.1 suggests that access to piped water plays a crucial role in determining water availability, as households with direct connections have better access compared to those relying on alternative sources (Ogunbode et al., 2024). Proximity to the water source is the second major factor, with an eigenvalue of 1.584 and a variance contribution of 11.315%, bringing the cumulative variance to 23.623%. The RCM value of 60.6 suggests that while proximity is important, it is relatively less influential compared to other determinants such as piped water access and time spent fetching water (Aikowe, et al., 2021; Gebremichae et al., 2021; Tshililo et al., 2022).

Another key determinant is time spent trekking to the water source, which has an eigenvalue of 1.583 and a variance contribution of 11.318%. The high RCM value of 81.8 suggests that the longer the trekking time, the more difficult it is for residents to access water conveniently, especially in areas without reliable nearby sources (Aikowe and Mazancová, 2022; Shemer et al., 2023).

The type of water source also influences accessibility, with an eigenvalue of 1.601 and a variance contribution of 10.722%, bringing the cumulative variance to 45.653%. The RCM value of 68.7 suggests that factors such as whether water comes from a borehole, well, river, or municipal supply significantly impact accessibility, as some sources may be less reliable or convenient.

Water quality is another important determinant, with an eigenvalue of 1.232 and a variance contribution of 8.803%. The RCM value of 78.5 suggests that residents prioritise clean and safe water sources, as poor-quality water can discourage usage and force households to seek alternative sources, even at greater distances.

Lastly, household preference, with an eigenvalue of 1.182 and a variance contribution of 8.442%, brings the cumulative variance explained to 62.098%. The RCM value of 76.8 indicates that personal choices, based on factors such as cost, convenience, and cultural preferences, strongly influence water accessibility (Gebremichael et al., 2021; Ogunbode et al., 2023a).

Overall, the results suggest that improving piped water connectivity, reducing trekking time, and ensuring water quality and reliability should be prioritised to enhance water accessibility in Oyo zone LGA. Additionally, understanding household preferences and expanding sustainable water sources can help ensure more equitable and convenient access to water for residents.

Table 4: Determinants of water accessibility in Oyo zone LGA

Figure 1. S/No	Figure 2. Variable name	Figure 3. RCM	Figure 4. Eigen Value	Figure 5. % Variance offered	Figure 6. %Cumulative variance offered
1.	Figure 7. Connectivity of homes to Pipe borne water	Figure 8. 74.1	Figure 9. 1.723	Figure 10. 12.309	Figure 11. 12.309
2.	Figure 12. Proximity to source	Figure 13. 60.6	Figure 14. 1.584	Figure 15. 11.315	Figure 16. 23.623
3.	Figure 17. Time spent trekking to water source	Figure 18. 81.8	Figure 19. 1.583	Figure 20. 11.318	Figure 21. 34.931

Table 4 (Cont): Determinants of water accessibility in Oyo zone LGA

4.	Figure 22. Type of water source	Figure 23. 68.7	Figure 24. 1.601	Figure 25. 10.722	Figure 26. 45.653
5.	Figure 27. Quality of water from the source	Figure 28. 78.5	Figure 29. 1.232	Figure 30. 8.803	Figure 31. 54.456
6.	Figure 32. Household preference	Figure 33. 76.8	Figure 34. 1.182	Figure 35. 8.442	Figure 36. 62.098

Note: RCM means Rotated Component Matrix

4.5 Comparison of Water Accessibility Determinants Across Four Local Governments in Oyo Zone, Oyo State, Nigeria

Further investigation was carried out to discover those influencers of water accessibility in the region for possible comparisons. The factor analysis results highlight both similarities and differences in the determinants of water accessibility across the four Local Government Areas (LGAs) in the Oyo Zone—Afijio, Atiba, Oyo Zone, and Oyo zone as presented in Table 5. The findings reveal that several core factors consistently influence water accessibility, while some determinants are unique to specific LGAs, reflecting localised challenges.

One of the most common determinants across all four LGAs is distance or proximity to the water source, indicating that the farther residents must travel, the lower their accessibility. This challenge is particularly pronounced in Atiba, where the Rotated Component Matrix (RCM) value for distance is 90.0, the highest among the LGAs. Similarly, water reliability, measured by the consistency of supply, is a major concern in all four LGAs, with RCM values ranging from 75.9 in Afijio to 85.2 in Atiba.

This suggests that an unreliable water supply forces residents to seek alternative sources, increasing the time and effort required to fetch water. Additionally, water quality is a critical factor in all four LGAs, with RCM values between 78.5 in Oyo zone and 87.2 in Oyo Zone.

This indicates that residents prioritise clean and safe water sources, as contamination risks influence their choice of water sources. Another common determinant is household preference, which plays a crucial role in Atiba, Oyo Zone, and Oyo zone. The high RCM value of 92.3 in Oyo Zone suggests that socioeconomic factors, cultural beliefs, and personal convenience significantly shape water accessibility patterns.

Despite these commonalities, some determinants are unique to specific LGAs, reflecting distinct challenges. In Afijio, the rate of patronage of a given water source (RCM = 74.3) affects accessibility, indicating that congestion and high demand impact availability.

In Atiba, challenges associated with reaching a water source (RCM = 75.4) emerge as a key factor, suggesting that terrain, poor road networks, or long queues hinder access. Oyo Zone also experiences challenges associated with reaching a source (RCM = 75.0), along with time spent trekking to the water source (RCM = 80.6), reinforcing the importance of proximity in this LGA.

In Oyo zone, connectivity to pipe-borne water (RCM = 74.1) is a unique determinant, showing that households with direct piped connections have significantly better access than those relying on other sources.

Additionally, the type of water source (RCM = 68.7) influences accessibility, as the availability and reliability of boreholes, wells, rivers, or municipal water systems vary across communities.

The variance explained by these factors also differs among LGAs, reflecting variations in the severity of water accessibility challenges. In Afijio, the total variance explained is 63.056%, with distance, reliability, and quality being the major issues.

In Atiba, 66.922% of the variance is explained, with key challenges including reliability, distance, household preference, and accessibility barriers. Oyo Zone has a total variance of 65.178%, where time spent trekking, reliability, quality, and household preferences are major concerns. Oyo zone explains 62.098% of the variance, with connectivity to piped water, proximity, trekking time, and quality as the primary factors.

Table 5: Composite Table showing water accessibility determinants across the LGA

S/N	Variable Name	Afijio	Atiba	Oyo Zone	Oyo zone
1	Distance from water source	✓	✓		
2	Reliability of the source (Volume)	✓	✓	✓	
3	Quality of water from the source	✓	✓	✓	✓
4	Rate of patronage of a given source	✓			
5	Water source type / Type of water source	✓			✓
6	Household preference		✓	✓	✓
7	Accessibility to the source		✓		
8	Challenges associated with reaching the source		✓	✓	
9	Time spent trekking to water source			✓	✓
10	Proximity to source			✓	✓
11	Connectivity of homes to pipe-borne water				✓

4.6 Key Insights and Policy Implications

Overall, while distance, reliability, and water quality are common concerns across all four LGAs, the severity of these issues varies. Atiba and Oyo Zone face significant challenges with trekking time and accessibility barriers, while Oyo zone has a stronger emphasis on piped water connectivity. Addressing these challenges requires expanding piped water networks, particularly in Oyo zone, ensuring reliable and safe water supply across all LGAs, and reducing travel distances, especially in Atiba and Oyo Zone. Furthermore, improving accessibility through better infrastructure and addressing household preferences can enhance water availability and equity. By implementing targeted interventions tailored to both shared and unique challenges, water accessibility in the Oyo Zone can be significantly improved.

5. CONCLUSION AND RECOMMENDATION

This study explored the underlying factors influencing water accessibility across four Local Government Areas (LGAs) in Oyo Zone, Oyo State, Nigeria—Afijio, Atiba, Oyo Zone, and Oyo zone—using factor analysis. The findings reveal that while each LGA faces unique challenges, there are several consistent determinants shaping water access. Proximity to water sources, reliability of supply in terms of volume, and water quality emerged as the most significant factors across all LGAs. These determinants directly influence household decisions and behaviours around water collection and usage. Additionally, household preferences—shaped by cost, convenience, and cultural values—were identified as critical considerations, especially in Oyo Zone and Oyo zone. Unique location-specific factors such as high patronage in Afijio, piped water connectivity in Oyo zone, and trekking time and access barriers in Atiba and Oyo Zone further illustrate the diverse realities of water accessibility within the zone. With variance explanations ranging from 62.1% to 66.9% across LGAs, the study confirms that these identified factors have a substantial influence on household access to water.

In light of these findings, several policy actions are recommended. First, expanding the piped water infrastructure, particularly in Oyo zone, would significantly reduce reliance on alternative and often distant sources. Equally important is the need to enhance the reliability and quality of water sources across all LGAs to ensure consistent and safe supply. In areas where long distances or difficult terrain hinder access—such as Atiba and Oyo Zone—strategies should focus on increasing the number of water points and improving road infrastructure. Addressing high patronage and congestion at existing sources, especially in Afijio, can improve access equity. Furthermore, understanding and integrating household preferences into planning processes will promote community acceptance and long-term sustainability. Overall, a decentralised, LGA-specific approach that reflects both shared and localised challenges is essential to improving water accessibility across Oyo Zone.

CLINICAL TRIAL NUMBER

Not applicable

CONSENT TO PUBLISH

Not applicable

INFORMED CONSENT STATEMENT

Informed consent was obtained from all individuals to take part in the survey.

COMPETING INTEREST

The authors declare that they have no competing interests.

ETHICS APPROVAL

All protocols were approved by Bowen University Research Ethics Committee (BUREC). All experiments were performed in accordance with relevant guidelines and regulations of BUREC.

FUNDING

This research received no funding or sponsorship from any source.

DATA AVAILABILITY

Data used in this study is available on reasonable request from the corresponding author

AUTHORS CONTRIBUTION STATEMENT

AAO and TOO: Conceptualization, validation, visualization, formal analysis, supervision, writing draft, edit and review; AAO: Project investigation, formal analysis, writing draft, edit and review; OMO: edit and review

REFERENCES

- Adeniran, A., Daniell, K. A., and Pittock, J., 2021. Water infrastructure development in Nigeria: Trend, size, and purpose. *Water*, 13(17), 2416. <https://doi.org/10.3390/w13172416>
- Adeoti, O. S., Kandasamy, J., and Vigneswaran, S., 2023. Water infrastructure sustainability in Nigeria: A systematic review of challenges and sustainable solutions. *Water Policy*, 25(11), 1094–1111. <https://doi.org/10.2166/wp.2023.173>
- Adeyeye, K., Gibberd, J., and Chakwizira, J., 2020. Water marginality in rural and peri-urban communities. *Journal of Cleaner Production*, 273, 122594. <https://doi.org/10.1016/j.jclepro.2020.122594>
- Adom, R. K., and Simatele, M. D., 2024. Overcoming systemic and institutional challenges in policy implementation in South Africa's water sector. *Sustainable Water Resources Management*, 10, 69. <https://doi.org/10.1007/s40899-024-01040-3>
- Agbo, S., 2024. Perspective chapter: Improving health budgeting and management practices in low- and middle-income countries (LMIC): Using 3 country case studies—Nigeria, Kenya and Tanzania.

- IntechOpen. <https://doi.org/10.5772/intechopen.1004996>
- Ahmad, S. A., Khan, M. H., and Haque, M., 2018. Arsenic contamination in groundwater in Bangladesh: Implications and challenges for healthcare policy. *Risk Management and Healthcare Policy*, 11, Pp. 251–261. <https://doi.org/10.2147/RMHP.S153188>
- Aikowe, J. O., and Mazancová, J., 2021. Barriers to water access in rural communities: Examining the factors influencing water source choice. *Water*, 13(19), 2755. <https://doi.org/10.3390/w13192755>
- Arko, A. B., 2024. Does collaborative governance work? Looking at Ghana's response to the COVID-19 pandemic. *Cogent Social Sciences*, 10(1). <https://doi.org/10.1080/23311886.2024.2420436>
- Asbetsadik, T., Alemayehu, A., Wolde, D., et al., 2025. Enhancing the sustainability of rural water supply schemes in Emegua Kebele: The role of community participation and key challenges. *Discover Sustainability*, 6, 244. <https://doi.org/10.1007/s43621-025-01098-9>
- Azeez, O., Henderson-Mitchell, R. J., LaFavor, M. C., and Gregg, A., 2023. Socioeconomic predictors of access to improved water sources, sanitation facilities, and household water treatment in Nigeria. *Journal of Water, Sanitation and Hygiene for Development*, 13(11), 875–884. <https://doi.org/10.2166/washdev.2023.169>
- Biswas, S., Adhikary, M., Alam, A., Islam, N., and Roy, R., 2024. Disparities in access to water, sanitation, and hygiene (WASH) services and the status of SDG-6 implementation across districts and states in India. *Heliyon*, 10(18), e37646. <https://doi.org/10.1016/j.heliyon.2024.e37646>
- Bose, D., Bhattacharya, R., Kaur, T., et al., 2024. Overcoming water, sanitation, and hygiene challenges in critical regions of the global community. *Water-Energy Nexus*, 7, Pp. 277–296. <https://doi.org/10.1016/j.wen.2024.11.003>
- Collord, M., Goodfellow, T., and Asante, L. A., 2021. Uneven development, politics and governance in urban Africa: An analytical literature review (ACRC Working Paper 2021-02). The University of Manchester. <https://www.african-cities.org>
- De Guzman, K., Stone, G., Yang, A. R., et al., 2023. Drinking water and the implications for gender equity and empowerment: A systematic review of qualitative and quantitative evidence. *International Journal of Hygiene and Environmental Health*, 247, 114044. <https://doi.org/10.1016/j.ijheh.2022.114044>
- Ekane, N., Kjellén, M., Westlund, H., Ntakarutimana, A., and Mwesige, D., 2019. Linking sanitation policy to service delivery in Rwanda and Uganda: From words to action. *Development Policy Review*. <https://doi.org/10.1111/dpr.12428>
- Gebremichael, S. G., Yismaw, E., Tsegaw, B. D., and Shibeshi, A. D., 2021. Determinants of water source use, quality of water, sanitation and hygiene perceptions among urban households in North-West Ethiopia: A cross-sectional study. *PLoS ONE*, 16(4), e0239502. <https://doi.org/10.1371/journal.pone.0239502>
- Gedamu, G., Mitiku, K. W., Belay, M. A., et al., 2025. Barriers to the sustainability of rural water schemes in Sub-Saharan African countries: A systematic review. *Journal of Water, Sanitation and Hygiene for Development*, 15(5), Pp. 427–442. <https://doi.org/10.2166/washdev.2025.101>
- Habib, M. A., Reza, A. H. M. S., Hasan, M. I., et al., 2024. Evaluating arsenic contamination in northwestern Bangladesh: A GIS-based assessment of groundwater vulnerability and human health impacts. *Heliyon*, 10(6), e27917. <https://doi.org/10.1016/j.heliyon.2024.e27917>
- Hameed, L. M. A., Abbood, S. N., and Jawad, E. H., 2025. A cross-sectional statistical survey analysis on consumer perceptions of domestic relative to foreign goods in Iraq. *Sustainable Engineering and Innovation*, 7(2), 271–284. <https://doi.org/10.37868/sei.v7i2.id529>
- Machado, A. V. M., Oliveira, P. A. D., and Matos, P. G., 2022. Review of community-managed water supply—factors affecting its long-term

- sustainability. *Water*, 14(14), 2209. <https://doi.org/10.3390/w14142209>
- Mangai, M. S., and De Vries, M. S., 2018. Co-production as deep engagement: Improving and sustaining access to clean water in Ghana and Nigeria. *International Journal of Public Sector Management*, 31(1), 81–96. <https://doi.org/10.1108/IJPSM-03-2017-0084>
- Merid, M. W., et al., 2023. Impact of access to improved water and sanitation on diarrhea reduction among rural under-five children in low and middle-income countries: A propensity score matched analysis. *Tropical Medicine and Health*, 51(1), 36. <https://doi.org/10.1186/s41182-023-00525-9>
- Natarajan, N., Newsham, A., Rigg, J., and Suhardiman, D., 2022. A sustainable livelihoods framework for the 21st century. *World Development*, 155, 105898. <https://doi.org/10.1016/j.worlddev.2022.105898>
- Obeta, M. C., 2018. Rural water supply in Nigeria: Policy gaps and future directions. *Water Policy*, 20(3), Pp. 597–616. <https://doi.org/10.2166/wp.2018.129>
- Ogunbode, T. O., and Ifabiyi, P. I., 2017. Domestic water utilization and its determinants in the rural areas of Oyo State, Nigeria, using multivariate analysis. *Asian Research Journal of Arts and Social Sciences*, 3(3), 1–13.
- Ogunbode, T. O., et al., 2024. Evaluation of non-consumptive household water management in Nigeria. *Environmental Research Communications*, 6, 075022. <https://doi.org/10.1088/2515-7620/ad5e3d>
- Ogunbode, T. O., et al., 2024. Sustainable Development Goal 6 and the challenge of pipe-borne water connectivity in a growing tropical city: A case study. *Discover Sustainability*, 5, 53. <https://doi.org/10.1007/s43621-024-00239-w>
- Ogunbode, T. O., et al., 2023. Household preference for wastewater reuse/recycling practice determinants in a growing community in Nigeria. *Frontiers in Environmental Science*, 10, 1051532. <https://doi.org/10.3389/fenvs.2022.1051532>
- Ogunbode, T. O., et al., 2023. Analysis of household daily water consumption dynamics in the tropical environment. *Scientifica*, 9956847. <https://doi.org/10.1155/2023/9956847>
- Ogunbode, T. O., et al., 2025. Assessing water security in Sub-Saharan Africa in the context of climate change threats. *International Journal of Climate Change Strategies and Management*, 17(1), 805–826. <https://doi.org/10.1108/IJCCSM-03-2024-0031>
- Ogunbode, T. O., et al., 2025. Evaluating basic household characteristics influencing domestic water demand in tropical environments. *Applied Water Science*, 15, 9. <https://doi.org/10.1007/s13201-024-02323-y>
- Okesanya, O. J., et al., 2024. Water, sanitation, and hygiene (WASH) practices in Africa: Exploring the effects on public health and sustainable development plans. *Tropical Medicine and Health*, 52, 68. <https://doi.org/10.1186/s41182-024-00614-3>
- Omarova, A., Tussupova, K., Hjorth, P., Kalishev, M., and Dosmagambetova, R., 2019. Water supply challenges in rural areas: A case study from Central Kazakhstan. *International Journal of Environmental Research and Public Health*, 16(5), 688. <https://doi.org/10.3390/ijerph16050688>
- Opiyo, F. E., Wasonga, O. V., and Nyangito, M. M., 2014. Measuring household vulnerability to climate-induced stresses in pastoral rangelands of Kenya: Implications for resilience programming. *Pastoralism*, 4, 10. <https://doi.org/10.1186/s13570-014-0010-9>
- Oyerinde, A. O., and Jacobs, H. E., 2022. The complex nature of household water supply: An evidence-based assessment of urban water access in Southwest Nigeria. *Journal of Water, Sanitation and Hygiene for Development*, 12(3), Pp. 237–247. <https://doi.org/10.2166/washdev.2022.176>
- Parvin, F., Haque, M. M., and Tareq, S. M., 2022. Recent status of water quality in Bangladesh: A systematic review, meta-analysis and health risk assessment. *Environmental Challenges*, 6, 100416. <https://doi.org/10.1016/j.envc.2021.100416>
- Rajendrakumar, S., et al., 2025. Drivers and barriers towards achieving SDG 6 on clean water and sanitation for all: An Indian perspective. *World Development Sustainability*, 7, 100228. <https://doi.org/10.1016/j.wds.2025.100228>
- Ribot, J. C., & Peluso, N. L., 2003. A theory of access. *Rural Sociology*, 68(2), 153–181. <https://doi.org/10.1111/j.1549-0831.2003.tb00133.x>
- Segnon, A. C., et al., 2020. Differential household vulnerability to climatic and non-climatic stressors in semi-arid areas of Mali, West Africa. *Climate and Development*, 13(8), Pp. 697–712. <https://doi.org/10.1080/17565529.2020.1855097>
- Shehu, B., and Nazim, F., 2022. Clean water and sanitation for all: Study on SDG 6.1 and 6.2 targets with state policies and interventions in Nigeria. *Environmental Sciences Proceedings*, 15(1), 71. <https://doi.org/10.3390/environsciproc2022015071>
- Shemer, H., Wald, S., and Semiat, R., 2023. Challenges and solutions for global water scarcity. *Membranes*, 13(6), 612. <https://doi.org/10.3390/membranes13060612>
- Sinharoy, S. S., Pittluck, R., and Clasen, T., 2019. Review of drivers and barriers of water and sanitation policies for urban informal settlements in low-income and middle-income countries. *Utilities Policy*, 60, 100957. <https://doi.org/10.1016/j.jup.2019.100957>
- The Lancet Global Health. 2020. Water and sanitation in a post-COVID world. *The Lancet Global Health*, 8(9), e1101. [https://doi.org/10.1016/S2214-109X\(20\)30368-5](https://doi.org/10.1016/S2214-109X(20)30368-5)
- Tshililo, F. P., et al., 2022. Analysis of the determinants of household water access and payments among the urban poor: A case study of Diepsloot Township. *Physics and Chemistry of the Earth*, 127, 103183. <https://doi.org/10.1016/j.pce.2022.103183>
- Velenturf, A. P. M., and Purnell, P., 2021. Principles for a sustainable circular economy. *Sustainable Production and Consumption*, 27, 1437–1457. <https://doi.org/10.1016/j.spc.2021.02.018>
- Whaley, L., and Cleaver, F., 2017. Can 'functionality' save the community management model of rural water supply? *Water Resources and Rural Development*, 9, 56–66. <https://doi.org/10.1016/j.wrr.2017.04.001>
- World Bank. 2023. Promoting sustainable and equitable WASH in Ethiopia

