Accessible Municipal Water Sources in Erelu Waterworks Zone, Oyo State, Nigeria.

Abstract

The inability of the municipality's pipe-borne water distribution systems in Nigeria's cities has resulted in the dependency of individuals on groundwater sources. This is important in solving the problem of water security, infrastructure, and health problems in areas that are experiencing rapid urbanization. Structured questionnaires were distributed to 898 households across four Local Government Areas in the Erelu waterworks zone. The data collected were analyzed using descriptive statistics and a one-sample t-test at a 0.05 significance level. Hand-dug wells constitute the majority of traditional water sources (74.66%), followed by motorized boreholes (19.50%), with piped water unavailable in any of the LGAs. Hand-dug wells constitute the predominant sources of water for consumption (49.82%), but sachet/bottled water usage has significantly risen to 18.68%, indicative of poor quality concerns. For cooking (73.42%), bathing (80.56%), laundry (81.07%), toilet flushing (81.53%), and car washing (76.91%), hand-dug wells remain the dominant water source, thereby implying the multi-purpose use of raw groundwater. The reliability of water sources differs widely; 54.61% have adequate water supply throughout the year, 19.60% rely only on rainy seasons, whereas 9.33% experience persistent water scarcity. Borehole water constitutes the preferred option (58.30%), mainly because of quality consideration (52.93%) and availability (28.14%). Although the majority (67.95%) reported Erelu water connections, actual functional provision is nearly non-existent – 41.72% due to the unavailability of pipes, 15.34% because of unaffordability, and 19.63% prefer more dependable water source options. Sachet/bottled water preference results from purity consideration (66.76%) and convenience away from home (12.75%). A one-sample t-test analysis shows statistically significant differences for AWS ($t=3.20$) and PPW ($t=3.15$) at $p<0.05$ levels, indicating disparities in types of sources used. The complete lack of potable water through piped connections highlights the paradox that exists between the availability of infrastructure and the failure to provide residents with water, thus making people dependent on contaminated groundwater sources.The dependence on groundwater implies a total breakdown in the municipality's ability to supply its citizens with potable water.

1.1 Introduction

Diverse water sources situated for human use determine how easily water reaches population groups and the stability and safety of their drinking water supplies. Water source selection is determined by geographic location, economic condition, and infrastructural capability of a household. Availability alone does not determine water source selection, as cost considerations, as well as cultural preferences and perceived safety levels, shape how people utilize water sources (Solihu&Bilewu, 2021). The water sources that rural people in low-income countries use typically involve unprotected hand-dug wells and surface Water since they lack basic infrastructure, but urban areas depend on piped systems and treated groundwater. Water source status is essential when considering the availability, access, and quality of household drinking water (Federal Ministry of Agriculture and Rural Development FMARD2023).

Surface water, groundwater, rainwater, and desalinated water comprise the major types of potable water sources which have their own proprietary qualities and limitations. Surface water comprises rivers, streams, lakes, and reservoirs, and they stand as the major drinking water sources, especially in places without other accessible water sources. The easy access to surface water along with its extraction at no cost makes it suitable for all population categories. Developing countries rely mainly on surface water sources for domestic, agricultural, and industrial purposes because they do not have modern water infrastructure systems (Delpla et al 2020). Surface water supply becomes more challenging through rising climate variability and environmental degradation, which decrease water amounts during droughts while floods bring increased contamination threats (IPCC, 2021).

In Nigeria, surface water is often dammed for treatment to provide pipe-borne water to cities.Pipe-borne water is widely regarded as one of the most reliable and efficient means of delivering potable water to households, communities, and institutions. The Water Corporation of Oyo State (WCOS) manages 14 water works distributed across the state, including major facilities at Asejire, Eleyele, Oyo, Iseyin, Ogbomoso, and other locations. However, despite these installations, the actual water supply coverage remains inadequate, with only 17.45% of households statewide having access to piped water supply, while in Ibadan municipality, approximately 55% of households are connected to the piped water system (Kehinde, 2003).

Piped water systems offer numerous advantages, including consistent supply, reduced contamination risks, and convenience for users. The connectivity of households to piped water systems has far-reaching implications for public health, economic productivity, and gender equality. For instance, households connected to piped systems are less likely to rely on unsafe water sources, reducing the prevalence of waterborne diseases such as diarrhea, cholera, and typhoid (Okesanya et al., 2024). Additionally, improved connectivity alleviates the burden of water collection, which disproportionately affects women and children, freeing up time for education, employment, and other productive activities (Hall et al., 2020).

The inconsistencies associated with the provision of pipe–borne water in Nigerian cities in recent years have redirected households' attention to groundwater sources, particularly Hand Dug Well and Borehole. People have used Hand-Dug Well (HDW) as a water source since antiquity and have provided a reliable water source, especially under limited modern water infrastructural conditions. HDW offer domestic water supply at reasonable cost through accessible points. HDW allows for affordable construction cost, minimal construction skill, and no specialization for upkeep (Alhassan et al, 2024). It serves as a traditional water supply method throughout many developing countries, especially in areas lacking contemporary water system facilities (Nyika&Dinka, 2023). The widespread use of HDWs across socio-economic strata can be explained by three main drivers: expensive water resources, deficient piped water delivery, and the straightforward HDW construction process in favorable geological areas (Jagaba et al., 2020;

Gnimadi et al., 2024). The reliance on HDWs is driven by their affordability and ease of construction, particularly in areas with favorable geological conditions. It enables effective water supply for household needs along with agricultural activities and small industry requirements.

According to the British Geological Survey (2023) and the World Bank Group (2023), a borehole is a narrow, deep, circular hole drilled into the ground to explore and extract natural resources or to study geological formations in the subsurface. They are used for a wide range of applications, including water wells, drilling for oil and gas exploration, and geotechnical investigations. Nigeria officially established the Rural Water Supply and Sanitation Agency (RUWASSA) in 1990.The provision of water boreholes was, however, designed to fall under several key government agencies and organizations, each playing a crucial role in ensuring access to clean water. These are: (i) The Federal Ministry of Water Resources (FMWR). (ii) National Water Resources Institute (NWRI). (iii) Federal Ministry of Agriculture and Rural Development (FMARD); (iv) The Federal Ministry of Environment (FME); (v) Niger Delta Development Commission (NDDC). (vi) Under FMWR, we have the Rural Water Supply and Sanitation Agency (RUWASSA); (vii) State Water Agencies and (viii) Local Government Environmental Authorities (Water Aid Nigeria 2023, UNICEF 2023). (ix) International organizations like UNICEF, Water Aid, Oxfam, the World Bank, and various bilateral donors, which provide funding, technical expertise, and support for capacity building; (x) Community Development Associations (CDAs)

Households usually decide which water source to use based on what they can see, such as clarity, taste, and odor, rather than scientific test results (Montenegro-Ayo, 2020). Households may opt for cheaper but unsafe alternatives, such as untreated wells or vendor-supplied water, if improved sources like a piped system are not efficient or affordable. This highlights the tension between affordability and safety, as any barrier can force households to compromise on water quality (Jude, 2020).Beliefs along with cultural traditions may have an impact on the source people trust and find acceptable. Rural communities uphold natural water sources containing rivers and springs, because of their sacred healing properties that make them appealing despite contamination threats (Zamenian, 2020).

Water source consideration helps to influence health outcomes (reduce water-related diseases) and, by implication, enhance the overall well-being of communities. Water source consideration is integral to achieving several Sustainable Development Goals (SDGs), including SDG 6 (Clean Water and Sanitation), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 13 (building resilience to climate change), promote food security, improving the quality of life for millions of people in Nigeria and worldwide (United Nations Development Program, 2023). It plays a crucial role in climate resilience strategies by providing reliable water sources during droughts and periods of erratic rainfall, particularly where climate variability and desertification pose significant challenges (WaterAid Nigeria, 2023).

1.2 The Study Area

Erelu Waterworks Zone is positioned between latitudes 7°40' and 7°56' north of the Equator and longitudes 3°51' and 3°59' east of the Prime Meridian. This zone represents the sole urban conglomerate within the Oyo region. The Oyo metropolis is centrally located within the zone relative to several key cities: it lies approximately 55 kilometers north of Ibadan, 36 kilometers west of Iwo, 45 kilometers south of Ogbomoso, 35 kilometers east of Iseyin, and 26 kilometers west of Ifeodan (see Figure 1.1). Rainfall distribution within the state varies, with the southern areas receiving about 1200 millimeters annually, while the northern regions receive approximately

900 millimeters. Extensive land use has resulted in the development of derived savanna landscapes (Britannica, 2024).Throughout the year, the average daily temperature typically fluctuates between 25°C (77.0°F) and 35°C (95.0°F) (Weatherspark, 2024).

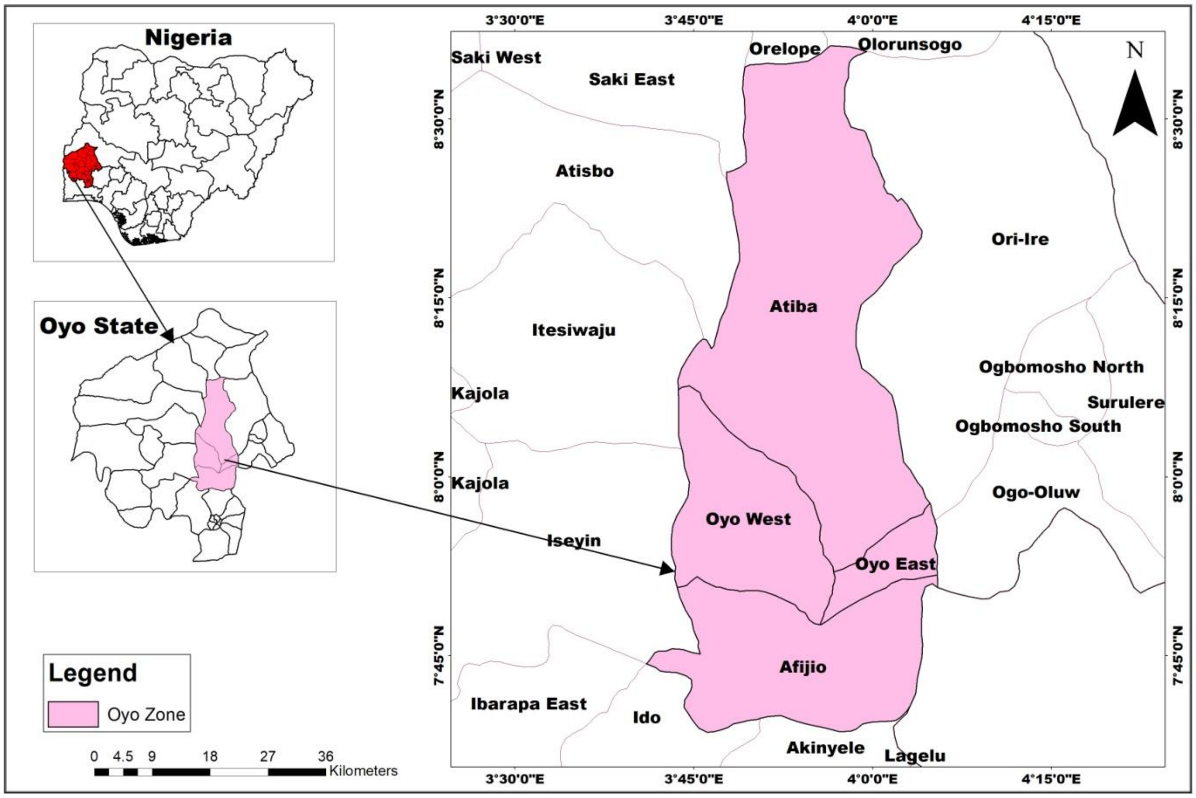

Figure 1.: Map of Oyo Zone

The terrain is characterized by the presence of occasional inselbergs, quartzite outcrops, and laterite formations. The drainage pattern observed is dendritic, characterized by tributaries joining the main river at irregular, acute angles. This dendritic configuration suggests that the drainage system has developed over relatively homogeneous rock formations (Oyelami and Gbadegesin, 2009). The United Nations World Urbanization Prospects (2025) projected the population of Oyo to be 428,798 in the year 2025.Additionally, Cityfact (2015) reported the populations of Akinmorin, Awe, Fiditi, Ilora, and Iware as 3,973; 14,304; 19,532; 27,212; and 1,697, respectively, in 2015.

1.3 Data Sampling and Analysis.

The study rest on the administration of questionnaires.Determination of sample size in this study is premised on proportional sampling technique (Proportionate stratified random sampling).The concept was developed as part of the broader field of survey sampling and has been developed overtime by Arthur Bowley (1912), Jerzy Neyman (1934) Hansen M H, and Hurwitz W N (1943). It is used in the selection of sample that accurately reflects the proportions of different subgroups within a population. It is based on the principles of normal and binomial distributions where confidence interval can be computed using the Wilson score method (Vallejo et al 2013). It is given by:

nh = (Nh/N) x n, where:

nh = Sample size for stratum h

Nh = Population size for stratum h

N = Total population size.

n = Total desired sample size. Based on the above, the sample size was calculated as depicted below:

Table I : Sample Size by Local Government and Political Ward.

Local Government Area	Population (2022)	Population Per Ward	Population Per Household (using 5 per household)	Sample size (LGA)	Sample Size (Ward)
Afijio	188,900	15,742	37,780	236	24
Atiba	240,500	20,042	48,100	300	39
Oyo East	177,400	14,783	35,480	221	22
Oyo West	195,000	16,250	39,000	243	24
Total	891,800	66,817	160,360	1000	100

Source: Author Calculation, 2025

In order to capture the study area effectively, a multistage sampling method was adopted in selecting participants for this study. In the first, area that falls within each of the four local government areas in the zone was identified (Atiba, Afijio, Oyo East and Oyo West). In the second stage, the political wards in each of the four local government areas were also identified. These are 10 in each of Afijio, Oyo East, Atiba and Oyo West local government areas, making a total of 40 political wards. In the third stage, a neighborhood within each political ward was randomly selected for questionnaire administration. The approach ensures that all segments of the study area are represented. Structured questionnaires were distributed to 1000 households and 898 questionnaires were successfully retrieved across four Local Government Areas in the Erelu waterworks zone.

Descriptive approach involving percentages, frequency counts and variance were employed in the analysis of data. Inferential technique involves the use of one sample statistics, an inferential statistics, was used to determine the result.

The Result

2.1 Household All-time Available Water Sources.

The most commonly available water source in Oyo zone by far is the hand-dug well, which accounts for 74.66%. This suggests a strong reliance on traditional, manually excavated wells, likely due to limited access to piped infrastructure or affordability of mechanized boreholes. Hand-dug wells are especially prevalent in Atiba (31.78%) and Afijio (22.13%) of the total in Oyo zone, and their presence is relatively consistent across the other local governments too. The second most used source is the powered borehole (19.50%). These boreholes are often motorized and offer a more consistent water supply compared to open wells, indicating a growing infrastructure presence, higher income, or organizational support. Powered boreholes are slightly more common in Atiba (33.12%) and Afijio (26.75%).

Piped water was completely absent in all four local government areas. This highlights a major infrastructural deficiency—none of the surveyed households or communities reported access to municipal tap water. The absence of piped water is a critical finding, as it points to potential areas for government intervention and public health concern, given the reliance on less regulated water sources. Rainwater harvesting is used minimally (1.74%), which may be due to seasonal limitations or lack of storage facilities. However, its relatively low use also suggests that water collection systems may not be adequately developed or promoted in the study area. Bottled/sachet water accounted for just 2.98%. Although this is small, its presence indicates an emerging reliance on commercially packaged drinking water, likely as a supplementary or backup source. This is especially relevant for households concerned with water purity, though its limited use may reflect cost-related constraints.

As a whole, the result shows a dependency on basic and mostly unregulated water sources in the study area, with hand-dug wells and powered boreholes dominating the landscape. Hand-dug wells are often exposed to environmental contamination, and the use of such wells for cooking also brings attention to potential hygiene risks, especially in the absence of systematic water treatment. The complete absence of piped water is a clear indication of both infrastructural gaps and community adaptation through alternative means (see figure I1).

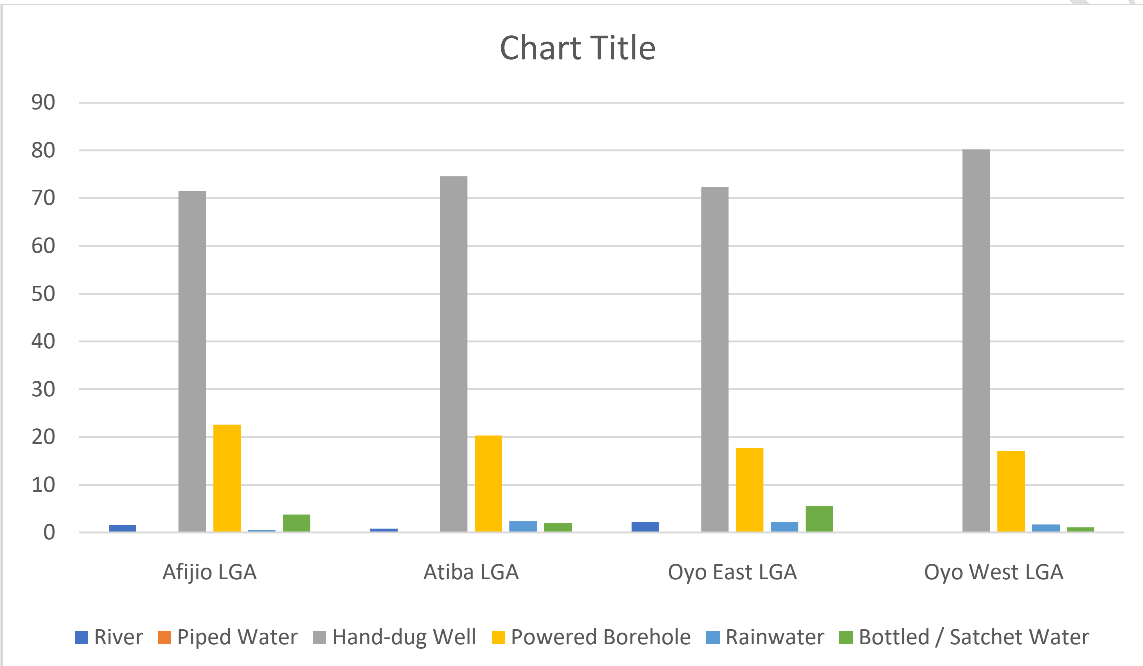

Figure 1I: Household all-time Available Water Sources

Source: Authors' fieldwork, 2025

2.2 Household Sources of Drinking Water

Hand-dug wells are the most accessible sources for drinking water, as indicated by 49.82% of all sources. This mirrors the trend seen in the general water source table but has a crucial implication: a significant number of people consume water directly from hand-dug wells. Powered boreholes are the second most common source (21.39%). This is an encouraging sign, as powered boreholes generally offer more secure access to groundwater, which is less prone to contamination than surface water. The highest access was in Oyo West (28.57%), indicating perhaps more investment in borehole infrastructure in that area.

One of the most notable shifts compared to the general water source data is the sharp rise in bottled/sachet water use for drinking (18.68%**).** This shows a strong public preference for packaged water specifically for drinking, likely due to perceptions of purity and safety. The trend is fairly even across the four LGAs, suggesting that despite financial or infrastructural limitations, many residents prioritize safe water consumption (see III).

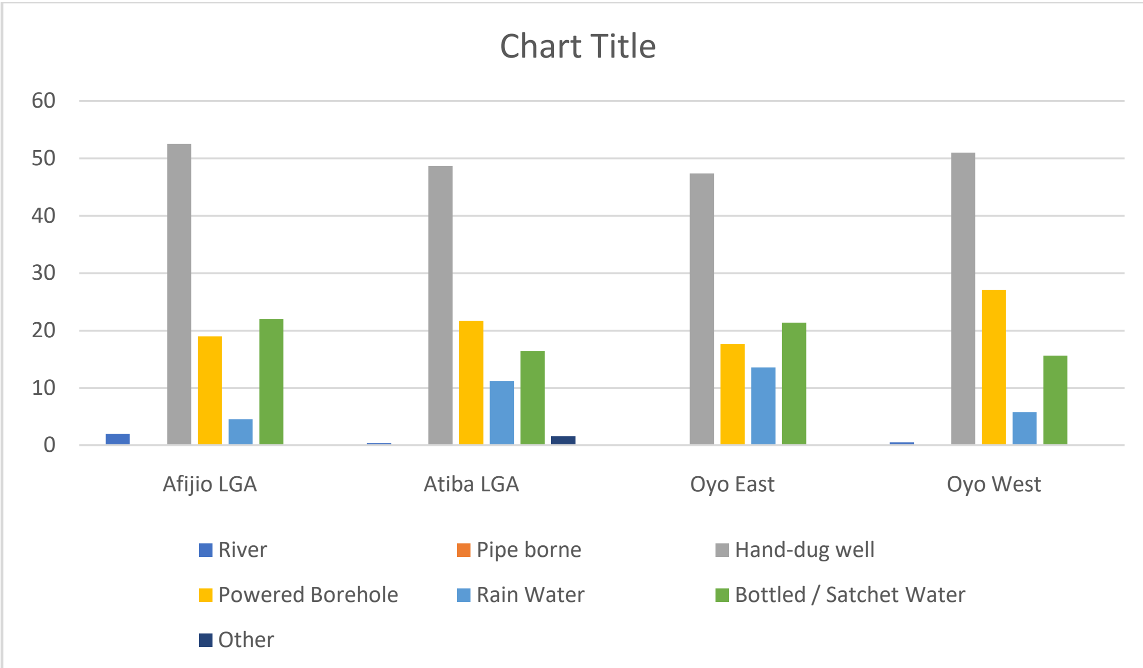

Figure III: Sources of Drinking Water in Erelu Waterworks Zone

Source: Authors fieldwork, 2025

2.3 **Water Sources Used for Cooking**

Hand-dug wells remain the dominant source, thus reiterating the reliance of households on this relatively accessible but often unregulated and untreated source. Atiba and Afijio lead in this usage, with 199 and 136 counts respectively, indicating that in these areas, hand-dug wells are central to everyday domestic life.

The second most used source is the powered borehole**.** This is encouraging in terms of water safety and pressure reliability, especially for a daily task like cooking. Powered boreholes are more evenly distributed across the LGAs but are slightly more concentrated in Afijio and Atiba. This shows existing or emerging borehole infrastructure in these locations, driven by local initiatives, community efforts, or government projects.

Rainwater appears as a cooking source in 21 cases, particularly in Atiba (9) and Oyo East (9). The use of rainwater for cooking may be opportunistic and seasonal, and it reflects some level of environmental adaptation. Bottled or sachet water is used in just 24 cases for cooking, with slightly higher usage in Oyo East and Oyo West. The limited use is likely due to cost commercial water options are often too expensive for high-volume domestic activities like cooking. These instances may represent households with higher income levels or those with strong safety concerns.

Surprisingly, river water is still used for cooking in 11 cases**,** mainly in Afijio (10). Cooking with river water is highly risky without prior treatment, as rivers are exposed to various pollutants. This reflects not just infrastructural gaps, but also perhaps a degree of isolation, economic hardship, or cultural continuity in water usage practices. Once again, pipe-borne water is absent in this category, consistent with the previous two tables. This reinforces the urgent infrastructural void in piped municipal water delivery, even for critical household tasks like cooking (see Table IV).

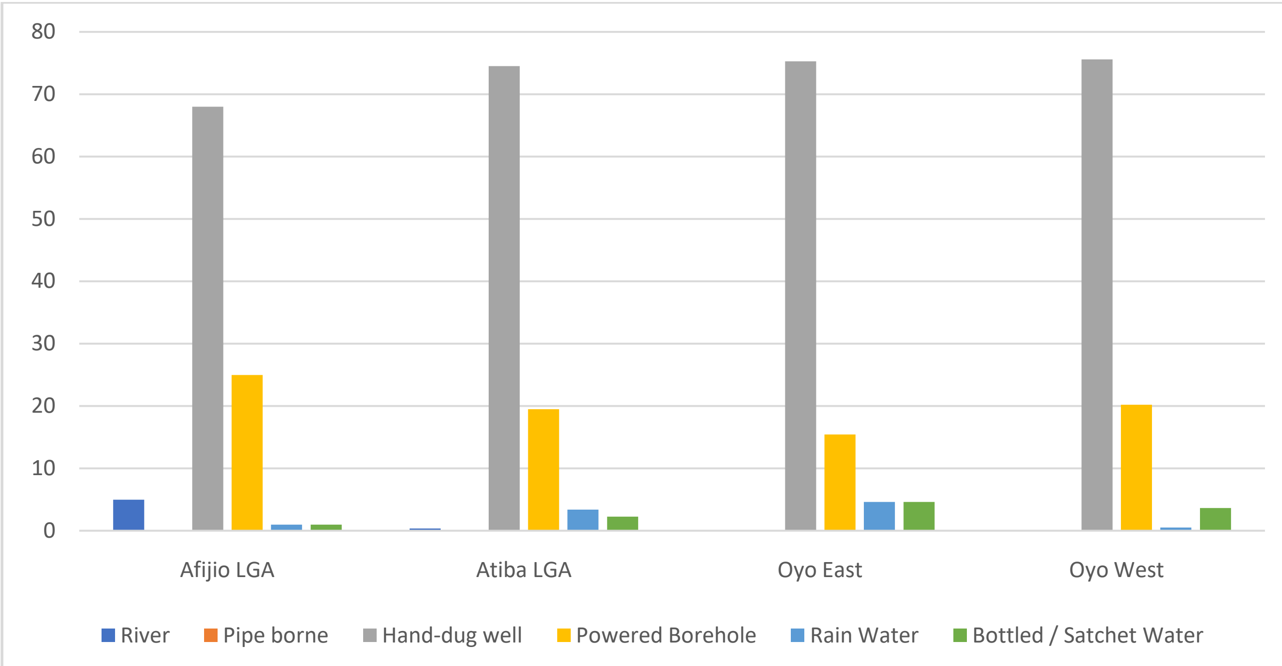

Figure IV: Sources of Cooking Water

Source: Authors fieldwork, 2025

2.4 Source of Bathing Water

Once again, the data clearly show hand-dug wells as the primary source of water for bathing, with 80.56**%** of all responses. These wells are most heavily used in Atiba (83.53%) and Oyo West (87.11%), showing their pivotal role in daily hygiene. The widespread use of hand-dug wells for bathing reflects their practical convenience and accessibility. However, it also indicates that many residents may be using untreated water directly for body hygiene, which, while less dangerous than for drinking, still presents risks such as skin infections if the water is contaminated.

Powered boreholes are the second most used source, with 16.86% of instances. Afijio leads in this category with 24% of households, followed closely by Atiba (16.10%). Boreholes provide a relatively cleaner and more pressurized water source, indicating that a sizable proportion of the population has access to semi-improved bathing water infrastructure. However, the relatively lower use of boreholes for bathing compared to wells could be due to cost, maintenance issues, or household priorities for reserving borehole water for more sensitive uses like drinking or cooking.

River water is used for bathing in 1.52% of cases—primarily in Afijio (5.5%). Rainwater accounted for only 1.05% as a bathing water source, spread thinly across the LGAs. This minimal usage is probably because of urban pollution effects. Interestingly, bottled or sachet water is completely unused for bathing, which is to be expected. The high cost and packaging limitations make this source unsuitable for bulk use like bathing. Most tellingly, pipe-borne water is again absent(see Figure V).

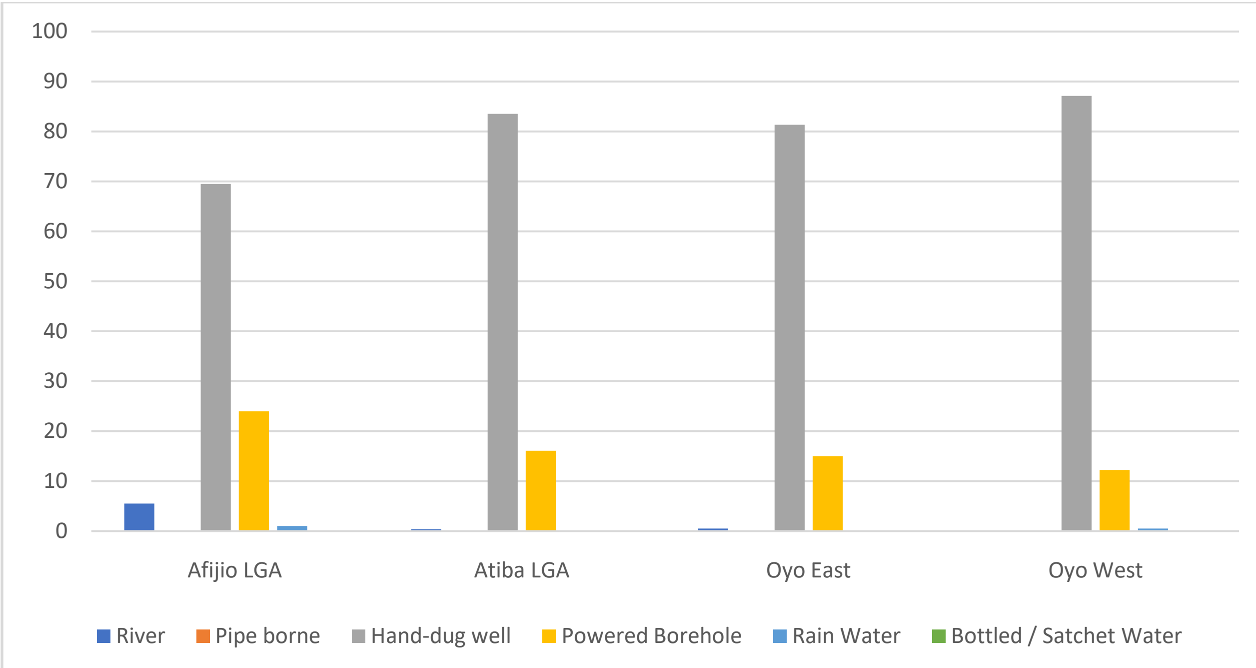

Figure V: Water Sources used for Bathing

Source: Authors fieldwork, 2025

2.5. **Water Source for Cloth Washing**

Unsurprisingly, hand-dug wells dominate once again**,** being used by an overwhelming 81% of the total. The highest numbers come from Atiba (85.77%) and Oyo West (87.11%), indicating that these wells are the household workhorses—not just for cooking or bathing, but also for heavy-duty water needs like laundry. Next in line are powered boreholes (16.47%**).** These appear more evenly spread across the LGAs, with slightly higher use in Afijio (24.50%). Borehole usage for cloth washing—though less than for drinking or bathing—may suggest that while households have access to powered water sources, they reserve these for more critical needs and opt for wells when washing large batches of clothing. This prioritization is likely influenced by considerations like: cost to operate borehole, distance to borehole, and period of borehole operation.

Rain water is used for washing clothes in 1.17% of households in the region, particularly in Oyo East (03.59%). The low usage suggests either poor rainwater harvesting systems or a prioritization of harvested rainwater for drinking and cooking. Notably, river water is used for cloth washing by 1.29% of households in the zone, the majority of which are in Afijio LGA. This points to limited access to clean river sources. Bottled or sachet water is also completely unused for cloth washing, which makes perfect sense given its high cost and low volume—making it unviable for large-volume needs like laundry(see Figure VI)**.**

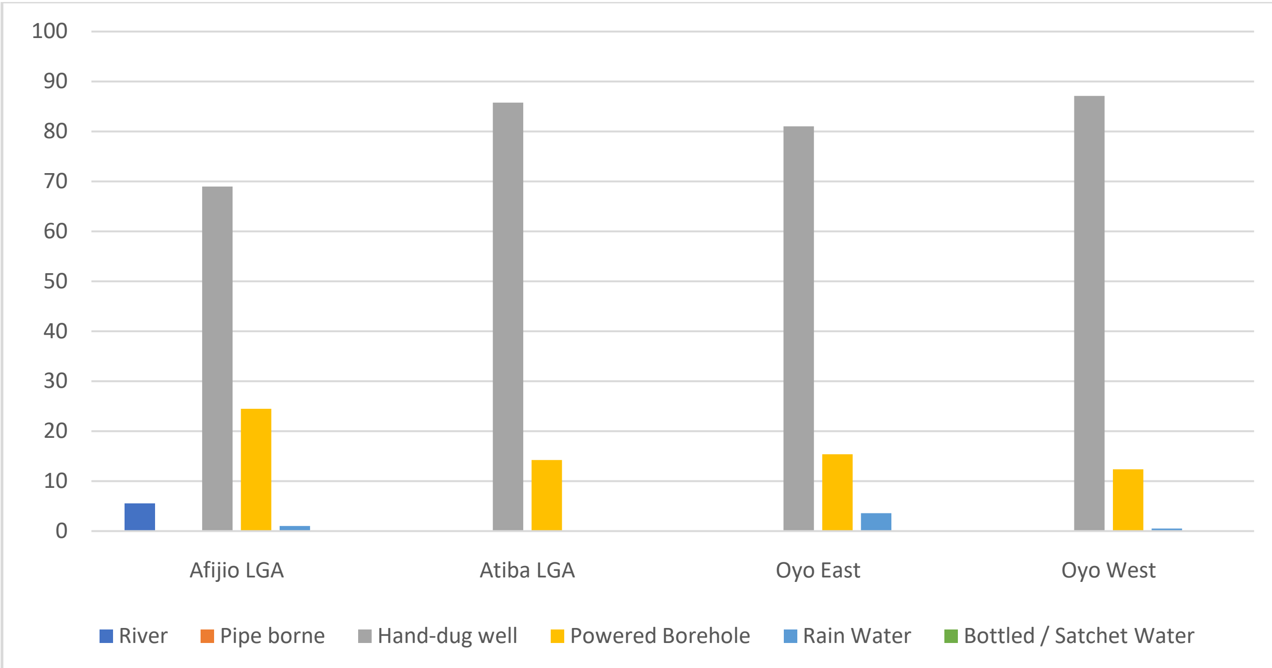

Figure VI: Sources of Water for Cloth Washing

Source: Authors fieldwork, 2025

2.6 Source of Water used for Flushing Toilet

The results again show a dominance of hand-dug wells **(**81%), and the result is relatively uniform across the LGAs. This strong dependence highlights that hand-dug wells are truly multipurpose in these communities. Following hand-dug wells, powered boreholes are the next most common source (16.47%). Afijio and Atiba report higher borehole use for toilet flushing, possibly due to slightly better access to powered systems or water prioritization practices that allow for using borehole water even in less sensitive applications like flushing (see Figure VII).

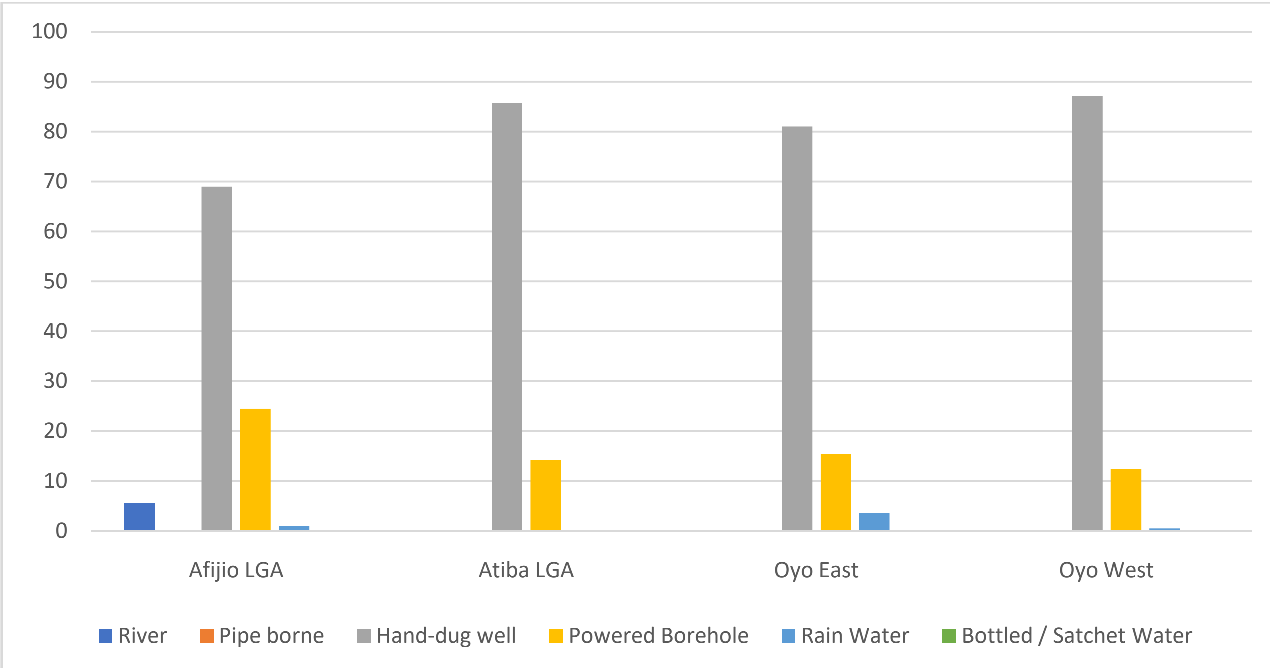

Figure VII: Source of Water for Toilet Flushing

Source: Authors fieldwork, 2025

2.7 Source of Water for Car Washing

As with other household uses, hand-dug wells dominate again**,** accounting for 76.91% of the total in the zone. The usage is consistent across all LGAs, with slight variation—Atiba (79.10%), Oyo East (76.60%), and Oyo West (91.67%) being the highest. The heavy use of hand-dug wells for car washing reveals that these wells are not only relied upon for essential domestic functions but are also versatile enough to support optional and water-intensive tasks. It suggests that in areas where water is abundant and easily accessible via wells, households are willing to extend their use to non-essential needs like car maintenance. The result equally implies that the car wash hand-dug well is more common in the highly urbanized Oyo main town than in the peripheral districts that constitute the Afijio LGA.

Powered boreholes are the second most used source with 18.06% ofinstances, again showing that even higher-quality water sources are being employed for less critical tasks. Afijio leads here with 24.03%, followed by Atiba (20.90%) and Oyo East (16.31%). This may reflect either a surplus of water availability among certain households or a lack of alternative sources convenient enough to use for outdoor car cleaning. Rainwater is used for car washing in 2.05% of cases, again indicating the role of harvested rain as a supplemental water source. Likewise, river water is used by2.79% ofrespondents**,** notably all in Afijio (7.79%) and Oyo East (2.13%). The use of rivers for car washing is common in many peri-urban areas, especially where water conservation is less of a concern, or where rivers are not physically polluted (see figure VIII).

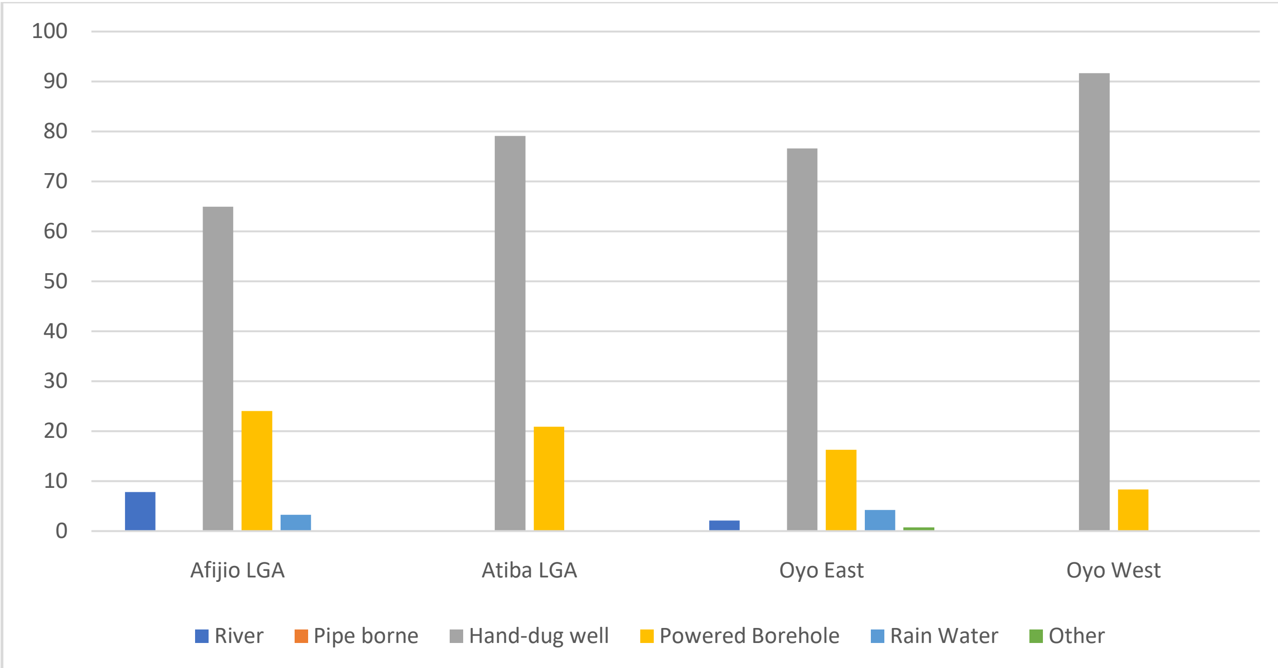

Figure VIII: Sources of Water for Washing Cars

Source: Authors fieldwork, 2025

2.8 Reliability of Household Accessible Water Sources

The most encouraging finding is that 54.61% of households report having water available to both the household and others satisfactorily all year round. This category dominates in all LGAs, particularly in Oyo East (66.50%) and Afijio (56.35%), suggesting that just over half of the surveyed homes enjoy consistent, reliable water access and even have enough to share. This is a strong indicator of water security, likely due to private boreholes and hand-dug wells. It also suggests some degree of social solidarity in resource sharing.14.35% of households reported having water that is always available, but only sufficient for their own household needs—not for sharing or community access. This shows that while some families have invested in or secured adequate personal systems, water may still be limited in quantity. This group is most prominent in Afijio (30.46%), possibly due to individual well ownership or water quality consciousness. The next most common category is water source which yield satisfactory in the rainy season alone (19.60%), with Atiba (30.19%) showing the highest reliance on the rainy season water table. This points to a major vulnerability: households in this group struggle to maintain water access during dry seasons and must either ration use, rely on inconsistent external sources, or walk farther distances. Such dependence on seasonal rainfall reflects both infrastructural gaps, limited resilience, and geological and climate variability.

More troubling are the 9.3% of households who report that their water supply is “not always satisfactory all year.” These families experience significant fluctuation in availability, likely forcing them to supplement from outside or unreliable sources, and increasing their vulnerability to water stress. Atiba again leads in this group (13.96%), reflecting intra-regional disparities in water reliability.

2.10% of households stated they are yet to acquire a private water source. These households must rely entirely on neighbors, public taps (if available), or water vendors. This is most common in Afijio (4.05%), which suggests sufficiency of communal or freely available sources in the area. Although the number is small, the implications are significant—these households are at heightened risk during communal crisis, occasional shortage, price surge, or dry season.

Access reliability is crucial because it goes beyond type and use of water—it measures security, equity, and resilience aspects of water accessibility. The fact that over half of households enjoy reliable access is positive. However, the remaining households face varying degrees of insecurity—ranging from seasonal shortages to complete dependence on others. The reliance on rain in particular highlights the need for better water harvesting and storage technologies, while the 9.3% struggling all year shows a persistent access gap that must be closed through targeted interventions (see Table II).

Table II: Water Source Reliability in Oyo Zone

Water Source Reliability	**Afijio**		**Atiba**		**Oyo East**		**Oyo West**		**Total**	**Percentage**
	No	%	No	%	No	%	No	%		
To the household and others satisfactory all year	111	56.35	128	48.30	135	66.50	94	48.96	468	54.61
Always to the Household alone	60	30.46	15	5.66	28	3.79	20	10.42	123	14.35
To the House satisfactory in the rainy season alone	13	6.60	80	30.19	21	10.34	54	28.13	168	19.60
Quantity not always satisfactory to the household all year	5	2.54	37	13.96	15	7.39	23	11.98	80	9.33
Household yet to acquire private water source	8	4.05	5	1.89	4	1.98	1	0.51	18	2.10
Total	197		265		203		192		857	100.00

Source: Authors' fieldwork, 2025

2.9. **Water Source Most Preferred by Households, provided all Sources are Available**

The water source most preferred by households is borehole water (58.30%). The preference is especially strong in Afijio (65.20%) and Atiba (62.26%), but remains consistently high across all four LGAs. This overwhelming preference shows that people regard boreholes as a relatively clean, reliable, and self-controlled water source based on their exposure and experience. Boreholes offer better water quality than surface sources and are generally viewed as safer for drinking, cooking, and hygiene. Even where boreholes may not be widely available due to cost or technical constraints, they clearly represent the "gold standard" in the eyes of the population.

The second most preferred source is the hand-dug well (19.43%). While this may seem counterintuitive—given the associated risks of contamination—hand-dug wells are likely favored because of their proximity, familiarity, and cost-effectiveness. In some cases, residents may trust their privately constructed wells more than community boreholes. Oyo East (27.45%) and Oyo West (20.77%) show higher preference levels for this source, possibly indicating either historical success with these wells or a cultural attachment to them. Interestingly, rainwater ranks third with 12.84% of residents. This reflects an environmentally adaptive outlook among some households—especially those that may not have reliable access to a borehole or public system. The fact that it ranks this high is promising, and could justify investment in better rainwater collection and storage systems.

Public piped water, despite being absent in actual usage, is preferred by 8.07% of households. This preference highlights aspiration demand: people want piped water, even though it's not available to them. The centralized and pressurized delivery it offers is associated with convenience and quality assurance. Oyo West (16.91%) and Oyo East (15.69%) show the most interest in piped systems, which could guide future infrastructure projects and policy priorities. Finally, river water is the least preferred, with just 1.36% of respondents choosing it, mostly from Afijio (2.94%). This is no surprise—despite its availability, river water is widely seen as dirty, unreliable, and exposed to contamination. The low preference confirms that its use is mostly a last resort, not a choice.

Summarily, the water source preferred by households reveals a gap between reality and desire. Most people want borehole or piped water, but due to financial, infrastructural, or environmental limitations, they often rely on hand-dug wells or even rivers. The relatively strong interest in rainwater systems presents an opportunity for low-cost, sustainable interventions. The low preference for rivers shows people are aware of risks and value water quality, even when limited by circumstances (see Figure IX).

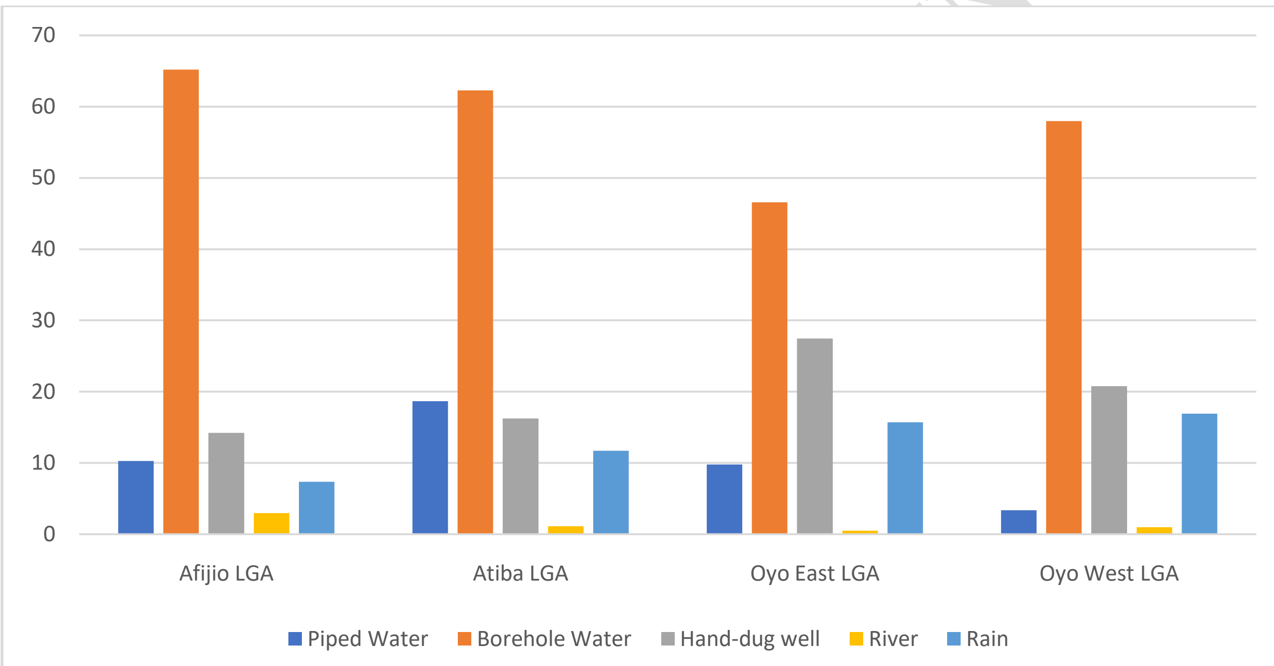

Figure IX: Water Source most Preferred by Households

Source: Authors' fieldwork, 2025

2.10 Reasons for the Choice of the Most Preferred Water Source

By far, the most important factor influencing household preference is water quality, cited by 52.93% of households. This trend is consistent across all local areas, with Oyo West (60.87%) and Oyo East (59.07%) leading. This overwhelming emphasis on quality reflects a growing awareness of waterborne diseases, taste, clarity, and trust in certain sources over others. The prominence of quality consideration suggests that any future interventions must not just improve access, but also enhance and guarantee water quality.

The second most common reason is water availability, as mentioned by 28.14% of respondents**.** In regions like Afijio (35.86%) and Atiba (34.23%), availability is just as important as purity. This reflects a pragmatic view: households want water that is readily accessible year-round**,** not just theoretically clean. For many, a source's reliability during dry seasons, or its proximity, matters just as much—if not more—than purity. This could explain why some continue to use hand-dug wells despite preferring boreholes: availability overrides concern in the face of necessity.

The third factor is private ownership/control**,** noted by 16.53% of households**,** with Oyo West leading at 21.20%. This underscores a desire for autonomy and reliability. When water is privately controlled, people don't have to deal with queuing, conflict, rationing, or unpredictable disruptions. This reason may explain the relatively strong preference for boreholes and wells over piped water or shared community taps. Control over one's water source offers not only convenience but also security**.**

Cultural attachment accounts for just 1.80% of responses. This is a minor but interesting factor, suggesting that in a few cases, traditional or ancestral ties influence water preference. It might apply to those who still favor river water or specific family-owned wells passed down through generations. While it doesn't drive the majority's decision-making, it highlights that identity and heritage still play a role for a small subset of the population.(see table III)

Table III: Reason for the Choice of the Most Preferred Water Source

Reason for Choice	**Afijio**		**Atiba**		**Oyo East**		**Oyo West**		**Total**	**Percentage**
	No	%	No	%	No	%	No	%		
Quality	95	47.98	121	46.54	114	59.07	112	60.87	442	52.93
Private Ownership/control	28	14.14	45	17.31	26	13.48	39	21.20	138	16.53
Avaliability	71	35.86	89	34.23	47	24.35	28	15.22	235	28.14
Cultural attachment	4	2.02	5	1.92	3	1.55	3	1.63	15	1.80
Others	0		0		3	1.55	2	1.00	5	0.60
Total	198		260		193		184		835	100.00
Percentage	23.71		31.14		23.11		22.04		100.00	

Source: Authors' fieldwork, 2025

Summarily, the patterns seen in Erelu water zone reaffirm the central role of hand-dug wells and, to a lesser extent, powered boreholes, in meeting both essential and non-essential water demands in the community. The insignificance of river water use signals potential environmental degradation. The absence of piped water continues to reflect a systemic infrastructural void. Taken together, these facts illustrate how the water system, driven primarily by informal or private sources, functions beyond basic necessity and supports the broader lifestyle of residents.

3.1 Establishing the Predominance of Hand-Dug Wells as the Primary Water Source in the Erelu Waterworks Zone

Empirical data from the study area demonstrates that Hand-Dug Wells (HDWs) constitute the primary water infrastructure for domestic consumption, accounting for 74.66% of all-time available water sources. Despite a stated household preference for borehole water (58.30%) due to perceived quality, HDWs remain the de facto standard for high-volume domestic activities (bathing, washing, flushing), serving over 80% of households in these categories. This dominance is driven by the complete absence of functional municipal piped water (0.00% usage) and the economic accessibility of HDWs compared to powered boreholes.

The foundational statistic for HDW dominance is its overwhelming market share compared to all other water sources combined (see table IV).

Table 1V: Distribution of Household All-Time Available Water Sources

Water Source	**Frequency (n)**	**Percentage (%)**	**Cumulative %**
Hand-Dug Well (HDW)	601	74.66	74.66
Powered Borehole	157	19.50	94.16
Bottled/Sachet Water	24	2.98	97.14
Rainwater	14	1.74	98.88
River Water	9	1.12	100.00
Piped Water	0	0.00	100.00
Total	**805**	**100.00**	

Source: Authors' Fieldwork, 2025

HDWs account for nearly three-quarters of all water sources. The complete absence of piped water (0.00%) creates an infrastructural vacuum that HDWs have filled as the default municipal alternative.

3.2 Cross-Tabulation Analysis: Dominance by Domestic Activity

To prove that HDW dominance extends beyond general availability to specific high-volume domestic uses, we analyze the cross-tabulation of water sources against household activities (see table V).

Table V: Cross-Tabulation of Water Sources by Domestic Activity (Percentage Distribution)

Activity	**Hand-Dug Well (%)**	**Powered Borehole (%)**	**Other Sources (%)**	**Total Responses (N)**
Drinking	49.82	21.39	28.79	851

Cooking	73.42	20.02	6.56	854
Bathing	80.56	16.86	2.58	854
Cloth Washing	81.07	16.47	2.46	856
Toilet Flushing	81.07	16.47	2.46	856
Car Washing	76.91	18.06	5.03	537

Source: Derived from Tables II–VII

For activities requiring large volumes of water (Bathing, Washing, Flushing), HDW usage exceeds 80%. While HDWs are still the primary source for drinking (49.82%), their share drops due to safety concerns, leading to a rise in bottled/sachet water (18.68%). However, even in drinking, HDWs remain the single largest source, outperforming boreholes by more than double.

Dominance must be consistent across geographic units to be considered a zone-wide phenomenon. The following cross-tabulation demonstrates HDW prevalence across the four Local Government Areas (LGAs) (See table VI).

Table VI: Cross-Tabulation of Hand-Dug Well Usage by LGA

LGA	**HDW Count (n)**	**HDW Percentage (%)**	**Rank in LGA**
Oyo West	146	80.22	1st
Atiba	191	74.61	1st
Oyo East	131	72.38	1st
Afijio	133	71.51	1st
Total	**601**	**74.66**	

Source: Table I

The variance in HDW usage across LGAs is low (Range: 71.51% – 80.22%). This uniformity confirms that HDW dominance is a structural reality of the Erelu Waterworks Zone, not a localized anomaly.

To establish statistical significance, a One-Sample T-Test was conducted to determine if the mean frequency of HDW usage differs significantly from other water source types. The null hypothesis (H_0) posits that there is no significant difference in the utilization rates of various water sources (See Table VII & VIII).

Table VII: One-Sample Statistics for Water Source Types

Variable	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
WSTwst (General Source)	6	149.67	228.897	93.447
WSTdrk (Drinking)	8	112.25	144.086	50.942
WSTckg (Cooking)	6	149.67	241.748	98.693
WSTbth (Bathing)	5	179.60	289.390	129.419
WSTcws (Cloth Washing)	5	179.60	292.498	130.809
WSTtsf (Toilet Flush)	5	179.60	286.247	128.014
WSTcar (Car Wash)	6	149.67	187.804	76.671
WSTaws (Availability)	6	149.67	114.729	46.838
WSTppw (Pref. Piped)	6	149.67	116.553	47.583

Source: One-Sample Statistics Table

Table VIII: One-Sample Test Results (Test Value = 0)

Variable	**T**	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval (Lower - Upper)**
WSTwst	1.602	5	.170	149.667	-90.55 to 389.88
WSTdrk	2.203	7	.063	112.250	-8.21 to 232.71

WSTckg	1.516	5	.190	149.667	-104.03 to 403.37
WSTbth	1.388	4	.238	179.600	-179.72 to 538.92
WSTcws	1.373	4	.242	179.600	-183.58 to 542.78
WSTtsf	1.403	4	.233	179.600	-175.82 to 535.02
WSTcar	1.952	5	.108	149.667	-47.42 to 346.75
WSTaws (Availability)	**3.195**	**5**	**.024***	**149.667**	**29.27 to 270.07**
WSTppw (Pref. Piped)	**3.145**	**5**	**.026***	**149.667**	**27.35 to 271.98**

*Significant at $p < 0.05$

The statistical analysis revealed that Water Availability (AWS) was statistically significant, with a t-value of 3.195 and a p-value of 0.024 ($p < 0.05$). This finding indicates that the reliability and availability of water sources within the study area, largely driven by the substantial contribution of Hand-Dug Wells (HDWs) and boreholes, are significant and play a crucial role in meeting household water demands. Although some individual source-type tests, such as WSTwst, did not attain statistical significance at the 5% level due to high standard deviations arising from the marked disparity between the frequency of HDWs ($n = 601$) and minor water sources ($n < 25$), the mean difference values remained considerably high and positive. For instance, the mean difference of 149.67 recorded for general water sources clearly demonstrates that HDWs are not merely slightly more utilized than other sources but are statistically dominant in terms of frequency and dependence.

Furthermore, the significance observed for Preferred Piped Water (PPW) ($t = 3.145$, $p = 0.026$) reflects a strong household preference and aspirational demand for piped water supply. However, this preference contrasts sharply with the complete absence of actual piped water usage (0.00%) in the study area. This disparity between household preference and practical reality further reinforces the position of Hand-Dug Wells as the de facto water supply system, relied upon by residents primarily out of necessity rather than choice..

A critical statistical finding is the discrepancy between what households *use* and what they *prefer*, highlighting that HDW dominance is driven by constraint rather than choice (See table IX).

Table IX: Comparison of Most Used vs. Most Preferred Water Sources

Metric	Hand-Dug Well (%)	Powered Borehole (%)	Piped Water (%)
Actual Usage	74.66%	19.50%	0.00%
Preferred Source	19.43%	58.30%	8.07%

Source: Table I & Table IX

There is a 55.23 percentage point gap between HDW preference (19.43%) and HDW usage (74.66%). This statistically significant disparity confirms that HDWs dominate the landscape not because they are the desired option, but because they are the only affordable and accessible alternative to the non-functional piped system.

4.0 Overview of Water Sources available to Nigerian Households

The dependability of piped water systems in Oyo State remains problematic, with frequent disruptions due to infrastructure failures, power outages, and maintenance issues. Despite the state's 14 water works facilities, the actual water supply coverage is inadequate, with only 17.45% of households having access to piped water supply (Kehinde, 2003). State Water Agencies serve <10% of households directly (World Bank, 2015). Intermittency, aging mains, and billing woes have precipitated user flight to decentralized options (Kumpel & Nelson, 2016).

According to Solihu and Olakunle (2021), groundwater emerges as the predominant water source, with approximately 98% of all Local Government Areas (LGAs) in Oyo State relying on this source. Research conducted by Adebisi et al. (2017) in rural areas of Oyo State demonstrates that 99.2% of households patronize protected dug wells and rainwater collection systems. Only 14% of Nigerians accessed safely managed drinking water in 2019 (UNEP GRID, 2021). Faced with intermittent utilities and quality concerns, households combine four principal source categories—piped schemes, boreholes/tube-wells, dug wells, and packaged water—supplemented by rainwater, surface supplies, and vendors. Source selection shifts with purpose (drinking, cooking, and bathing), season, reliability, affordability, and perceived safety (Abubakar, 2019; Ismaila Rimi, 2019).

In rural areas, Adebisi et al. (2017) found that protected dug wells serve as the primary drinking water source for 99.2% of households, followed by rainwater collection systems. The study reveals that households often resort to river water and streams (64.2%) when improved water sources become inadequate or non-functional. Groundwater remains dominant yet contested. Northern DHS data show 55–69% of households drinking well/borehole water, despite 56% contamination rates (FUDMA JS Sci., 2023).

Cooking water sources in Oyo State households closely align with drinking water preferences, though with some variations based on quantity requirements and cost considerations. Ogunbode and Ifabiyi (2017) report that 100% of households in rural areas source water for cooking from the same sources used for drinking, primarily protected dug wells and rainwater. Studies in Oyo, Kwara, and Cross River reveal a pragmatic split: households reserve scarce sachets/bottles for drinking but revert to boreholes/wells for cooking (Ezenne&Ozor, 2018).

The study by Ogunbode and Ifabiyi (2017) also indicates that water supply for bathing contributed 6.41% to rural water supply patterns, with usage influenced by household size, proximity to water sources, and availability of alternative sources. Bathing water typically comes from boreholes, wells, or rainwater in southern regions with higher precipitation (Amaefule et al., 2023). Quality concerns are secondary to quantity and convenience for this purpose.

Water for washing clothes predominantly comes from wells, boreholes, or surface water, given the large volume required (Epundu et al., 2017). Households rarely use sachet or bottled water due to cost.Car washing, a non-potable use, relies almost exclusively on borehole, well, or surface water—sources where quality concerns are least stringent. Flush toilets, more common in urban areas, are often supplied by piped, borehole, or well water. In rural settings, pit latrines are more frequent, requiring less water (Amaefule et al., 2023).Research in Ogbomoso North Local Government Area indicates that 81.0% of households practice open defecation, with only 78.9% of those with toilet facilities using pit latrines (Israel et al., 2023). This finding highlights the limited extent of flush toilet systems across the state.

Water source dependability in Oyo State represents a critical factor influencing household water security and source selection decisions. The reliability of water sources varies significantly across different types of sources, seasonal conditions, and maintenance practices (Ogunbode and Ifabiyi, 2017). Solihu and Olakunle (2021) reveal that groundwater serves as the predominant water source in approximately 98% of LGAs in Oyo State, primarily due to its year-round availability and relative reliability. However, the dependability of groundwater sources is influenced by factors such as seasonal water table fluctuations, pump functionality, and power supply reliability.

The dependability of alternative water sources, including sachet water and water vendors, varies based on market availability and economic factors. Research in Saki town indicates thatsachet water provides a dependable source of drinking water, though at higher costs compared to other sources (Sanni, 2019). Urban households increasingly supplement groundwater with low-cost 50-cl sachets ("pure water"), now Nigeria's fastest-growing packaged food segment (Liddle & Kumpel, 2021). In Lagos, sachets constituted the principal drinking source in 57% of low-income neighborhoods (Nelson et al., 2021). Rising sachet tariffs, however, recently nudged many families back to borehole drinking (NOIPolls, 2025).Water vendors provide dependable services in urban areas, though their reliability depends on their own source water availability and transportation capabilities.

Research in Ijebu Ode Local Government Area by Coster and Otufale (2014) provides insights into household water source preferences, revealing that 64.4% of households prefer public piped water, followed by private piped/borehole water (30.1%) and well water (5.6%).The preference for public piped water reflects households' recognition of its quality, convenience, and reliability when properly functioning. The research also identifies four primary reasons for water source preferences: quality (35.6%), convenience (33.3%), availability (18.5%), and cost (12.5%).

Multiple large-sample surveys concur that self-provided groundwater now eclipses public supply. The 2021 WASH-NORM census counted 2.31 million water points, 75% of them self-supplied boreholes or wells (UNICEF/FMEWR, 2021). Statista's (2020) analysis likewise shows tube-wells/boreholes as the leading main source in both urban (34%) and rural (46%) areas. Musa

&Fumen’s (2013) study recorded 50% reliance on private wells, 16% on boreholes, and just 24% on utility taps in Ilorin.

5.0 Conclusion

The statistical evidence conclusively demonstrates the dominance of Hand-Dug Wells (HDWs) in the Erelu Waterworks Zone. HDWs constitute the largest proportion of water sources, accounting for 74.66% (n = 601) of all available sources within the study area. Their importance is further reflected in household water utilization patterns, as they supply more than 80% of the water used for domestic activities such as bathing, washing, and toilet flushing. The reliance on HDWs is consistent across all the studied Local Government Areas, where they emerge as the primary source of water supply in 100% of the locations investigated. Furthermore, one-sample statistical tests confirmed the significance of water availability patterns largely influenced by groundwater sources, with the availability of water sources showing a statistically significant result ($p < 0.05$). Interestingly, despite only 19.43% of households indicating HDWs as their preferred water source, their overwhelming dominance persists due to the complete absence (0.00%) of piped water supply in the study area. This finding clearly establishes that Hand-Dug Wells are not merely supplementary sources of water but effectively serve as the de facto municipal water infrastructure for residents of the Erelu Waterworks Zone.

6.0 Suggestions for Future Improvement

This disparity underscores the urgent need to address barriers to connectivity and ensure that all households have access to safe, reliable, and affordable pipe-borne water. The solution to unsteady water supply requires technical advancement together with governmental policies and grassroots community programs. Water reliability improvements become possible through the implementation of decentralized systems coupled with renewable energy-powered solutions that technology provides.

The deployment of solar-powered water pumps succeeds in providing rural regions with consistent water extraction since grid electricity fails to reach these remote areas. The technology leverages solar power to draw groundwater, which creates both sustainable and economical methods for maintaining regular water supplies.

Households now use rainwater harvesting systems together with other solutions to collect and store rainwater they can utilize for household needs. Long-term groundwater extraction and rainwater collection led to a 30% decrease in water scarcity among communities, thereby strengthening water volume reliability.

Sustainable water interventions depend on the importance of community involvement. Local stakeholders achieve ownership through participatory approaches where community involvement is involved in water system planning combined with implementation and maintenance duties.

Education programs that explain water conservation strategies together with efficient water use techniques will strengthen initiatives by enabling families to adopt better practices.

Most importantly, Erelu waterworks is in dare need of institutional support on the need to rehabilitate as well as the expansion of the facility. The long years of neglect in an urban environment that expands on daily basis have degraded the beauty, relevance, coverage and the significance of the waterworks in the zone. The best way of securing a healthy urban environment, convenient household welfare and disease free individuals, is the provision of treated water.

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