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ORIGINAL ARTICLE

Water resources endowment and the challenge of underutilization in a tropical community in Nigeria

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Abstract

The success of achieving global water accessibility is contingent upon the sustainable management of water sources. This study aimed to identify and comprehend the sources of water for household use in Iwo, Osun State, Nigeria, by surveying 458 households. Both descriptive and inferential analyses were employed to examine the collected data. The findings revealed that 76% of households primarily relied on groundwater as their water source, while only 19% had access to both pipe-borne and groundwater. Significance at $p < 0.05$ was established, prompting factor analysis (FA) extraction from the 13 variables analyzed. The results identified three key factors that accounted for 79.563% of the reasons behind the underutilization of pipe-borne water (PBW) sources: proximity to the pipe network facility, preference for a specific water source, and reasons for non-connectivity of PBW to homes. Another FA was conducted on 12 factors, exposing two significant factors that explained 66.496% of the reasons for the neglect of surface water. These factors included the usability/quality of urban streams and the impact of seasonal changes. The study highlighted a considerable underutilization of PBW due to various reasons, suggesting the need for policies aimed at maximizing surface water sources through PBW.

Keywords Multiple water sources · Resource underutilization · Resource neglect · Climate change · Household water use

Introduction

The success of the global target of access to potable water for all by 2030 is partly and significantly dependent on the sustainable development and management of various water sources found in different locations around the world (Aguilar and de Fuentes 2007; Mugagga, and Nabaasa 2016; Weststrate et al. 2019; Sarkar and Bharat 2021). The water access situation in many developing countries is intertwined with broader issues of poverty and inequality (Graham et al. 2016; Angoua et al. 2018; Valero et al. 2023). Marginalized communities often bear the brunt of inadequate water infrastructure and services. Lack of financial resources and political will can lead to insufficient investments in water projects, leaving these communities with limited access to a basic necessity for life (Biswas 1979; Angoua et al. 2018; Valero et al. 2023).

In addition, the privatization of water resources in some cases can exacerbate disparities, as those with economic means may gain preferential access, leaving others struggling to secure even the most basic water needs (Angoua et al. 2018; Ogunbode et al. 2022). Climate change further compounds the challenges faced by developing countries in ensuring water access (Ogunbode et al. 2023a, b; Valero et al. 2023). Shifts in precipitation patterns and the increased frequency of extreme weather events, such as hurricanes and prolonged droughts, threaten water sources and strain existing infrastructure (Bayu et al. 2020; Valero et al. 2023). Vulnerable populations in developing nations often find themselves on the front lines of these climate-induced water crises, amplifying the urgency of addressing both immediate water access issues and the longer term impacts of climate change (Bayu et al. 2020). International collaboration is essential in addressing the global water crisis (Krzymowski 2021; Schmidt 2021). Support from developed nations, international organizations, and non-governmental entities is crucial for funding and implementing sustainable water projects. Implementing innovative technologies, improving water management practices, and fostering community engagement are vital

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components of a comprehensive strategy to enhance water access in developing countries (Bayu et al. 2020; Schmidt 2021). Rayu et al. were of the opinion that by addressing the root causes of water inequality and prioritizing sustainable solutions, the global community can make significant strides toward ensuring that all individuals, regardless of their economic status or geographical location, have access to clean and safe water.

The United Nations' Sustainable Development Goal (SDG) 6 focuses on ensuring access to clean water and sanitation for all by 2030 (Biswas et al. 2022; Küfeoğlu 2022). According to Biswas et al. (2022), this goal acknowledges the critical role of water in eradicating poverty, promoting health, and supporting sustainable development. It was further stressed that SDG 6 target is to achieve universal and equitable access to safe and affordable drinking water and adequate sanitation, with a specific emphasis on improving water quality, reducing water scarcity, and addressing the needs of marginalized populations. To achieve this goal, collaborative efforts are required on a global scale, involving governments, international organizations, communities, and the private sector (Schmidt 2021; Küfeoğlu 2022). Sustainable water management practices, efficient water use, and the development of resilient water infrastructure are essential components in realizing SDG 6 and ensuring a water-secure future for the entire global population (Biswas et al. 2022; Our World in Data team 2023).

Research on water accessibility in developing countries is driven by a combination of humanitarian, environmental, and socio-economic factors, reflecting the urgency and complexity of addressing water-related challenges in these regions (DuChanois et al. 2019; Gomez et al. 2019). First, the fundamental human right to access clean and safe water motivates researchers to develop innovative solutions that can improve water quality and availability, reducing the burden of waterborne diseases and enhancing overall public health. Second, the environmental imperative emphasizes the need to sustainably manage water resources, protecting ecosystems and biodiversity (Gebremichael et al. 2021). As water scarcity and pollution escalate, understanding and mitigating these issues become critical for ecological balance. In addition, water research in developing countries is motivated by the socio-economic impact (Biswas 1979; Armah et al. 2018; Gomez et al. 2019). Improved water access contributes directly to poverty alleviation, as communities can better engage in productive activities when they are not burdened by the time-consuming and arduous task of fetching water over long distances. Furthermore, enhancing water infrastructure and management systems can foster economic development by supporting agriculture, industry, and overall societal resilience (Armah et al. 2018; Gebremichael et al. 2021). In essence, the motivation for research in water accessibility in developing countries lies in the aspiration to create a more equitable, healthy, and sustainable future for vulnerable communities while addressing interconnected environmental and socio-economic challenges.

Tropical regions have often been identified as rich in water resources, both surface and subsurface sources (Ogunbode et al. 2017, 2019). Despite this endowment, most countries in the tropics have been found to face water poverty (Ogunbode et al. 2017). The concept of water poverty, in its actual sense, is not about the absence or lack of water resources in a given area; rather, it describes a situation of poor access to potable water resources. Ogunbode et al. (2016a, b, 2020) noted that water resources are present in Oyo State, Nigeria, but accessibility across the study areas was found to be below 50 out of the 100-maximum obtainable. Moreover, the resource section of the survey revealed that the state is appreciably endowed with rainfall for not less than 8 months in a year, sufficient groundwater, and surface sources such as rivers, streams, and lakes. However, the dams built across some of the rivers in many local government areas notwithstanding, many developing countries still struggle with poor access to potable water for household use despite their vast water resources. Mugagga and Nabaasa (2016) and Ogunbode et al. (2023b) identified factors militating against appreciable access to water resources for home use, including the abandonment of water resources development to private individuals, cultural and religious organizations, government's lackadaisical attitude towards continuous maintenance of existing water works, and increasing urban expansion in developing nations. The multiple water sources in tropical regions have become a challenge rather than a blessing due to neglect and poor maintenance. This has led to the underutilization of some water resources while others are being overutilized, with the environmental implications often overlooked. For instance, the report indicated that most rural and urban communities in developing countries depend on groundwater. According to Ogunbode et al. (2017), groundwater forms the major source of water for all their respondents across the 25 local government areas studied. However, rainwater, which provides water for 8 months from March through October yearly, is often underutilized in homes due to the non-availability of large collectors like underground tanks. In addition, water dams and reservoirs built do not receive adequate attention, often attributed to corrupt practices and misappropriation of funds, supporting and promoting groundwater exploitation by the government at different levels at the expense of a pipe-borne water network. In some instances, water sources have been observed to be highly polluted for human consumption, with streams and rivers becoming refuse dump sites, defecating zones, and locations for local industries, such as cassava processing factories and oil palm processing sites. This situation has left subsurface sources as the only safer option for water for

human varied uses, reached through borehole drilling and hand-dug wells.

However, the SDG 6 aims at attaining access to potable water globally by 2030. The realization of this objective might not be feasible if the issue of resource underutilization and abandonment is not tackled at different levels. Investigation into the status of each water resource access in tropical regions is still insufficient, especially in developing countries. In this era of climate change, much is expected to be done to ensure access to potable water for domestic purposes, considering cases of water pollution, unreliable rainfall, extreme heat, and their potential negative impacts on water supply to humans (Ogunbode et al. 2016a). This work is especially desirable in the era of the climate change scenario, which is exerting its impact on water resources worldwide (Ogunbode and Ifabiyi 2019; Bello et al. 2021; Manes et al. 2021). While some locations are experiencing water scarcity, others are grappling with excessive rainfall resulting in flooding, water pollution, and the destruction of watersheds (Bharat and McCornick 2006). Effective exploitation and utilization of water resources are demanded to check inefficient water uses in homes (Ogunbode et al. 2023a). This work aims to complement existing literature on the access status of water resources in Iwo, a growing tropical community in Nigeria. The objectives of the investigation are to: (1) identify various water resources in Iwo, Osun State, Nigeria; (2) describe the access status of each of the sources identified; and (3) explore the factors contributing to the access status of the sources. The accomplishment of these objectives is expected to enhance knowledge of improving the accessibility of water sources and the conservation needs in the sector.

Method of study

Study area

Iwo serves as the headquarters of Iwo Local Government Area (LGA) in Osun State, Nigeria (Fig. 1). It is among the LGAs blessed with abundant water resources, both surface and subsurface. Aiba Water Works (AWW) was established in 1957 to oversee the Aiba Reservoir, commissioned in 1959. The Aiba Reservoir, situated on Aiba River, was designed to supply potable water to Iwo residents and its suburbs. Presently, the reservoir primarily caters to the

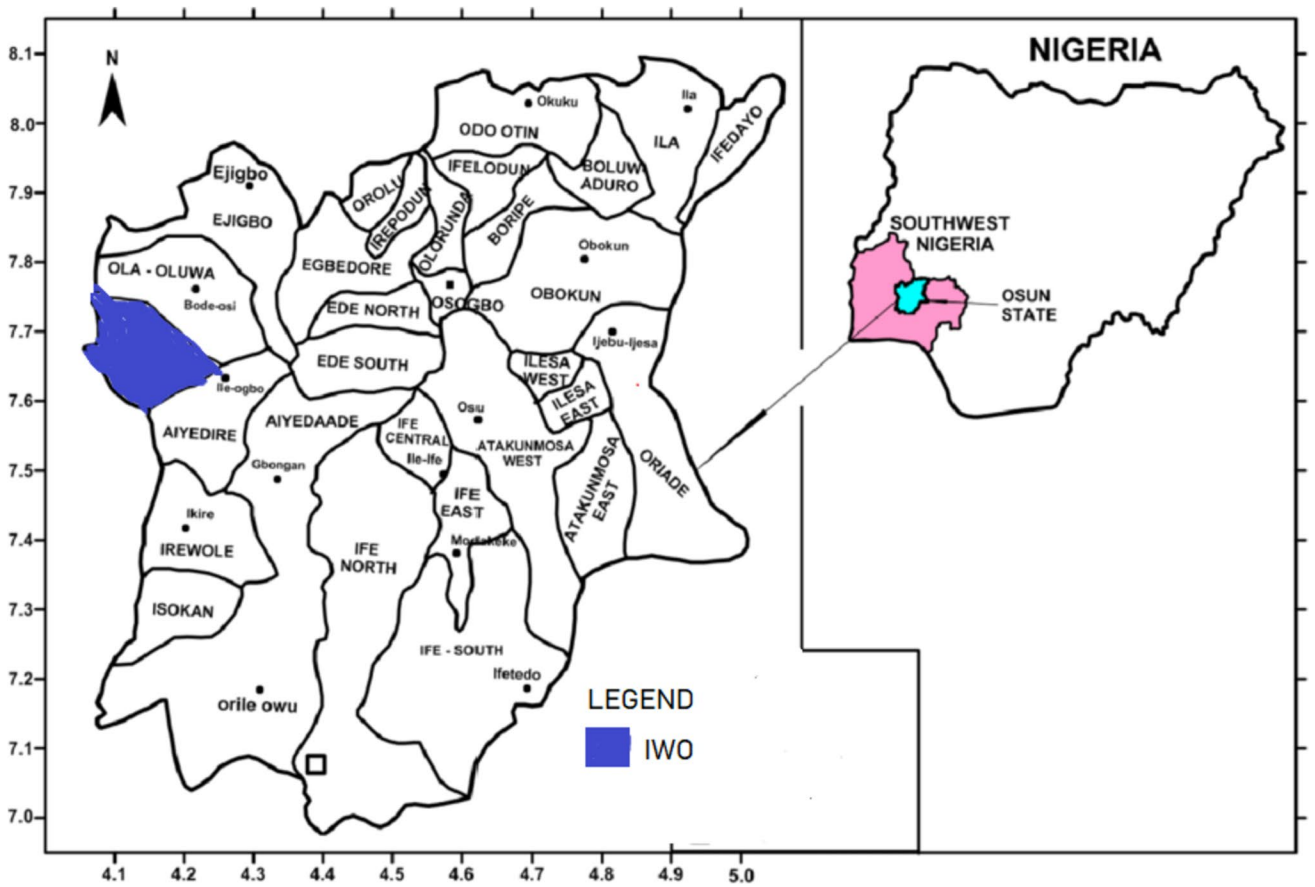

Fig. 1 Map showing Iwo LGA in Osun State (Inset: Map of Nigeria showing Osun State)

town's water needs, with limited supply to the surrounding rural communities. In light of this challenge, a significant portion of the town's population now heavily relies on groundwater extraction through borehole drilling and hand-dug wells. Only a small section of the town, mainly around the dam periphery, receives water directly from the dam. Several challenges contribute to the AWW's inability to reach the majority of inhabitants, including the neglect of the pipe-borne water network in favor of ground sources by the relevant authorities. Groundwater exploitation is actively promoted by both local and state governments, often providing support through the provision of boreholes and hand-dug wells in various locations. Despite Iwo enjoying maritime winds that bring moisture in the form of rainfall for about 8 months each year, this resource has not been effectively utilized. Surface water sources are unattractive for household consumption due to high contamination levels. Consequently, the only safer source for human consumption is groundwater. In conclusion, addressing the neglect of the pipe-borne water network and implementing effective water management strategies are crucial steps to ensure wider access to clean water in Iwo and its surrounding areas.

Data collection process

Sampling technique

In the design of this study, the sampling technique involved the division of the town into six sections, delineated by major roads. Random sampling was then employed within each of the four sections, marking eighty households for subsequent identification every month. Despite the effort to ensure randomness, potential sources of errors in the sampling process are acknowledged. Sampling bias might be introduced if the chosen major roads do not adequately represent the entire population, leading to the exclusion of specific demographics. In addition, there is a possibility of non-response bias, as selected households might choose not to participate, impacting the representativeness of the sample. Geographical variation within each section, not accounted for in the division by major roads, could also introduce errors related to variations in water accessibility.

Data collection

The primary dataset for this study was generated through the administration of structured questionnaires conducted between February and July 2023. While the survey focused primarily on female heads of households, with alternative participants considered, when necessary, potential sources of errors in the data collection process are recognized. Response bias is a concern, as respondents may provide inaccurate information, either unintentionally or due to social desirability bias, influencing the reliability of the collected data. The decision to conduct the survey exclusively during the daytime may introduce bias, as it excludes households where members may be more available or willing to participate during evenings. The administration of the survey by the authors and field assistants may also introduce observer bias if there are inconsistencies in how questions are presented or interpreted, potentially affecting the quality of responses. Moreover, the focus on female heads of households may limit the scope of perspectives on water provision responsibilities, potentially overlooking the contributions of other household members. Addressing and acknowledging these potential sources of errors are essential for ensuring the accurate interpretation and reliability of the study's findings.

Data analysis

Both descriptive and inferential statistical analyses were conducted in this study. The data summary included information on respondents' characteristics, distance to the water source, preferred water source, payment of water tariff, views on AWW performance, and reasons for the observed decay or underutilization of a particular water resource. Pie charts were employed using Microsoft Excel software, to visually represent these aspects obtained from the questionnaire. In contrast, inferential statistics, specifically FA, with the use of Statistical Products for Service Solutions (SPSS), was employed to determine and rank the significant factors contributing to the underutilization of a water resource. In the application of FA, the ranking factor, Eigenvalue, was set at a minimum of 1.000. This criterion implied that any variable failing to meet the established standard would be disregarded and described as insignificant in explaining the reasons for the decay and/or underutilization of a given water source. The factors with the highest values in each array of the extracted data in the rotated component matrix (RCM), as generated by FA, were identified as the extracted and significant variables. The contributions of each extracted factor, represented by their respective weights, are computed and presented under the total explained table produced by FA.

Results and discussion

The basic attributes of the respondents are as follows

Gender distribution of the respondents

Figure 2 illustrates that female respondents constituted 83.6% (383) of the survey, while the male gender comprised

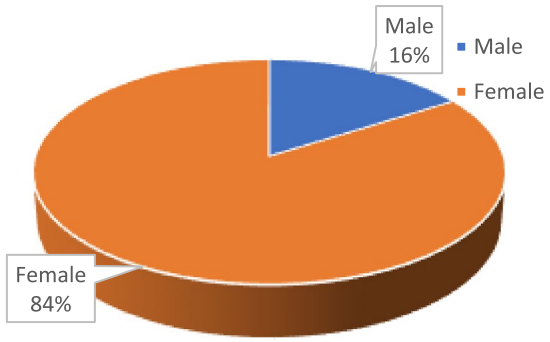

Fig. 2 Gender distribution of the respondents

16.4% (75). The intentional overrepresentation of female respondents aligns with the findings of Ogunbode et al. (2022), which reported that females play a crucial role in providing water for various household purposes in African homes. Consequently, consulting the female gender for water-related information in the region is considered more effective. However, in cases where a female head was not available, the male head was included.

Time spent obtaining water

The results presented in Fig. 3 indicate that 73% of respondents claimed to obtain water for their domestic use in less than 30 min, while 25% spent more than 30 min. The remaining 2% (08) of respondents abstained from answering. The survey observed that most homes have either a dug-out well or a deep borehole within their premises, making water resources easily accessible. This observation is consistent with the findings of Olajuyigbe et al. (2017) and Ogunbode et al. (2017). However, connecting to other sources may pose challenges due to their respective distances from homes, hindering immediate use. Ibrahim et al. (2018) also noted challenges in connecting homes to public water services.

Payment of water tariff

Figure 4 depicts respondents' responses regarding payment for water used in their homes. While 18.4% (84) claimed to pay water tariffs to the government, the majority, 81.4% (373), did not. The payment of water tariffs is essential for supplementing government expenditure on water services, as highlighted by Amoah (2020). Poor tariff payment could contribute to the suboptimal performance of the AWW in Iwo. Tariffs are crucial for maintenance purposes, such as fixing broken pipes, repairing leakages, and minor inputs in water treatment. Amoah (2020) emphasized the impact of high costs on accessing potable water in the Greater Accra region of Ghana. Legislation and granting autonomy to State Water Services (SWS) have been proposed to address corruption issues affecting water supply subsectors in Nigeria.

Water sources and household rate of access

Results from Fig. 5 reveal that groundwater is the dominant source of potable water for 76.2% (349) of households in Iwo. The majority obtain groundwater from hand-dug wells (71.2%), while 12.5% use deep boreholes for their respective household needs. Furthermore, 18.6% (85) of respondents utilize both groundwater and the pipe-borne water network. The remaining 5.2% refrained from responding. Notably, no respondent claimed to source water from the pipe-borne water network or rainwater alone, indicating their supplementary role. This dominance of groundwater aligns with the findings of Ogunbode et al. (2017, 2020) for Oyo State, Nigeria. Poor management of the pipe-borne water network has been reported by Egbinola (2017) and Amoah (2020).

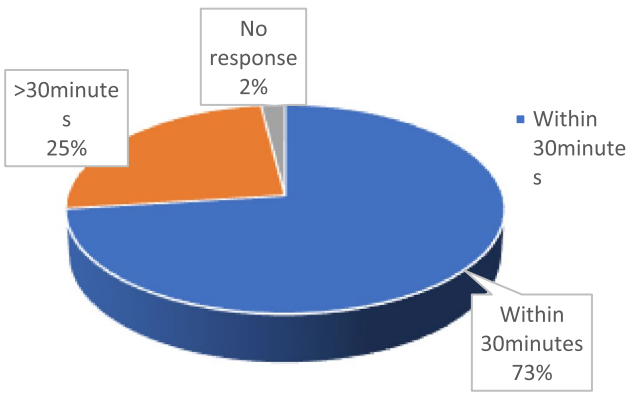

Fig. 3 Respondents' average time spent to obtain water

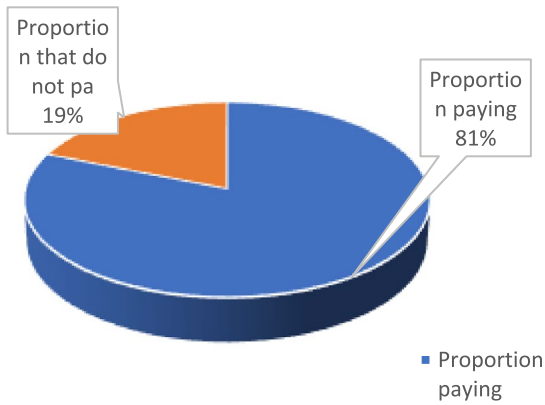

Fig. 4 Payment of water tariff among the respondents

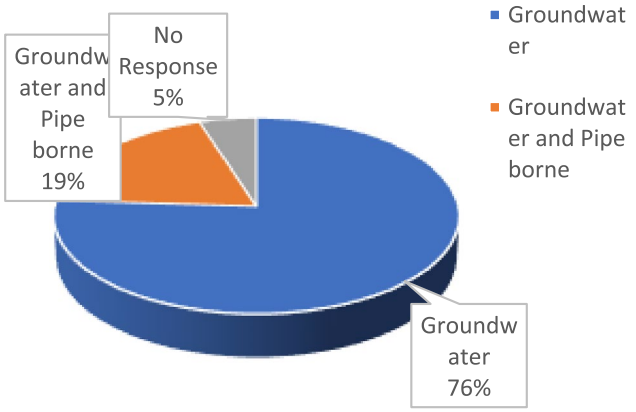

Fig. 5 Respondents' rate of accessing water sources

Water sources and the frequency of use

Figure 6 illustrates that groundwater is the most accessible source of potable water for 81.7% (374) of households in Iwo, while only 18.3% (84) have access to pipe-borne water. Surface water is not used for domestic purposes due to its poor quality, supported by the findings of Ogbuagu et al. (2014), Ogunbode et al. (2017) and Akhtar et al. (2021). Poor urban pipe-borne water network accessibility in developing countries has been noted by Ibrahim et al. (2018). In addition, inadequate attention to surface water development and management in tropical regions is highlighted by Angoua et al. (2018) and Shehu and Nazim (2022). The poor maintenance culture in sub-Saharan countries is also a contributing factor.

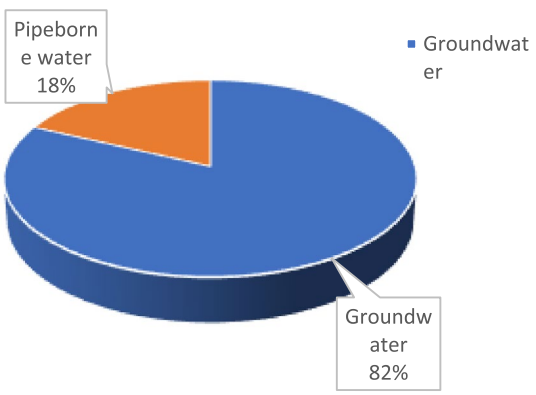

Fig. 6 Water sources and their respective frequency of use

Water sources and their respective management

Figure 7 reveals that 86.8% (397) of groundwater sources are owned and managed by private individuals, with 78.2% being hand-dug wells and 8.6% deep boreholes. Government-provided sources account for 6.5%, managed by the community through a designated committee and religious organizations (6.7%). Ogunbode et al. (2017) emphasized the exploitation of groundwater resources by homes in Oyo State, Nigeria, due to non-connectivity of rural and urban centers. The abandonment of pipe-borne water development in favor of groundwater exploitation in developing nations has been lamented by Shehu and Nazim (2022).

Respondents' rating of water sources

Figure 8 indicates that 78.6% (360) of respondents rated groundwater resources higher than any other source. The use of surface water for domestic purposes was unanimously rejected. In addition, 66.2% rated deep boreholes higher, while 12.4% preferred hand-dug wells or motorized sources. The preference for groundwater is attributed to proximity, control over the facility, and constant access to water (Ogunbode and Akinola 2019b). Respondents express dissatisfaction with the stagnant growth of the pipe-borne water network in Iwo, as highlighted by Ogunbode and Ifabiyi (2022).

Respondents' views on the underutilization of pipe-borne water facility

Figure 9 reveals respondents' reasons for neglecting pipe-borne water services in Iwo. These reasons include administrative bottlenecks (12%), the availability of other water resources (57%), poor network quality (9%), erratic supply

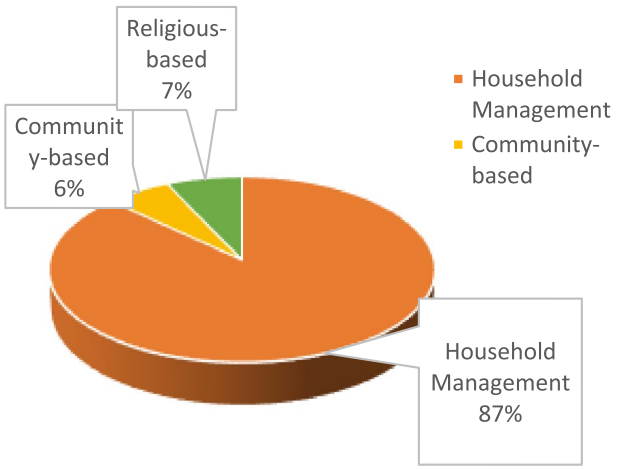

Fig. 7 Water sources and their respective management

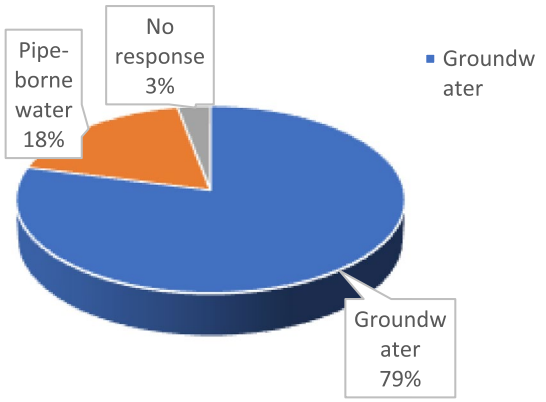

Fig. 8 Respondents' evaluation of water sources

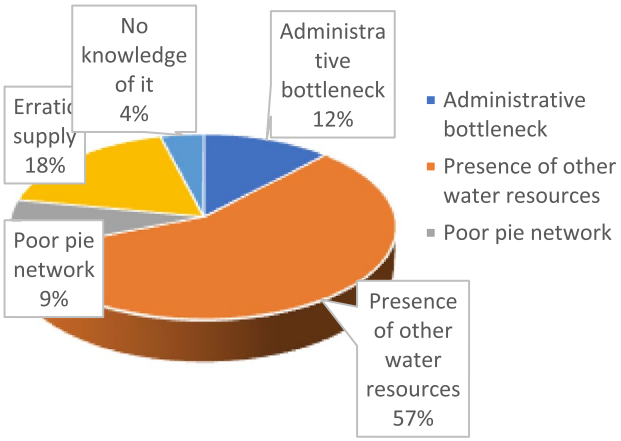

Fig. 9 Respondents' reasons for the underutilization of pipe-borne water

(18%), and lack of awareness of pipe-borne water services (4%). These views have implications for the underutilization of the Aiba water reservoir and may hinder the achievement of SDG targets on water for all by 2030, as noted by Angoua et al. (2018) and Shehu and Nazim (2022).

Analysis of water sources underutilization/decay contributory variables

Factor analyses (FA) were conducted to identify significant reasons for the underutilization of pipe-borne water services, as well as surface streams and rivers in Iwo. The dataset on pipe-borne water inventory underwent testing for factorability. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's tests yielded a significant value of 93.1%, with $p < 0.05$, indicating that the data are suitable for factor analysis.

The results of FA analysis revealed 3 variables out of the 13 analyzed to be significant in explaining the underutilization of pipe-borne water services (Table 1). While all 13 variables proved valuable, the 3 identified by factor analysis as crucial are: (1) proximity of the pipe-borne network to the respondents' residence; (2) respondents' preference for a specific water source; and (3) reasons cited by respondents for not connecting their houses to the pipe-borne water system. Together, these three variables explained 79.563% of the underutilization and potential decay in pipe-borne water services in Iwo.

(i) The closeness of pipe-borne water service to the respondents

How close the PBN to different homes accounted for 43.894% (55.169% of the absolute value) of the total explanation offered by the extracted variables. It is ranked first with the weighted value (otherwise called *eigen value*), of 6.145 and the RCM of 83.0, the highest in the first array of variables analyzed. This is expected in the first instance, the closer the main pipe is to a residence, the less is the cost of connection to that home. On the other hand, the interest to connect a residence to PBN is aroused when there is awareness that it is requires less time to connect it. One of the observations during the survey was the restricted connectivity only to the neighborhood of less a kilometer to the AWW. The periphery of the town is almost absolutely cut off from the PBN. Ngben and Yakubu (2023) in support of this finding reiterated that in view of the cost of connecting homes to PBN, residents of Kpanvo and Katariga communities in Tamale, Ghana have resorted to groundwater exploitation.

Table 1 Factors contributing to the underutilization of PBWN as extracted by FA

Component	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1. Closeness to the PBN	7.111	59.261	59.261	5.107	42.557	42.557
2. Preference for other sources	1.370	11.420	70.681	2.673	22.275	64.832
3. Personal reason for not connecting to PBN	1.036	8.630	79.311	1.738	14.480	79.311

In the same vein, Omole (2013), Akinola et al. (2018) and Gao et al. (2018) lamented on the promotion of groundwater exploitation in lieu of pipe-borne water services which has been adjudged to be the leanest and safest of all water sources by the United Nation.

(ii) Respondents' preference for other sources of water

Far next to the first variable is the respondents' respective preference for a particular source of water accounting 23.693% (29.779% of the absolute value) of the total explanation for the underutilization of PBW facility in Iwo. It is second in the rank of the identified and extracted variables with the weighted value of 3.317 and the variable with the highest value of 79.8 in second array of the RCM. The reason for the significance of the respondents' preferences for a particular source could be attributed to the immediate point discussed above in the first instance. In another instance, the underutilization of PBWN could be explained by the respondents' affordability and the desire to be independent in water supply for their home use. Another reason for the neglect of PBWN could be because of the freedom enjoyed in water supply subsector as no license is required from any authority or any management put in place to exercise control over groundwater exploitation, especially hand-dug wells. The seemingly determinant of groundwater mining and/or hand-dug wells are majorly authorized space and financial capacity (Martínez-Santos et al. 2020). According to Ogunbode et al (2016a; 2016b), hand-dug wells are the main source of water in the rural areas of Oyo state because no adequate attention was paid by the authorities to exploit surface water through pipe-borne water network.

(iii) Respondents' reasons for not connecting PBW network to their residents

The reasons for the underutilization of PBWN by the respondents in lieu of other sources were the third variable extracted by the analysis. It has weighted value of 1.667 and gave 11.976% of the total explanation to support the underutilization. The variable was ranked highest in value with 95.7 in third array of the RCM. To buttress this result, several reasons were given by the respondents for their desire to abandon PBWN in Iwo. Such reasons include availability of other alternative sources, poor performance of AWW, the body in charge Aiba water reservoir management, erratic supply of water, poor network of the pipes, restricted to only those areas in the vicinity of the Water Works. According to Ibrahim et al. (2018), pipe-borne connection to homes in their study area was poor in view of the steps to be taken described by the respondents as being too bureaucratic and tasking. Dharmaratnaa and Parasnisb (2014) had submitted to the payment of water tariff by the users in other to benefit from good supply of potable water.

The **surface water resource inventory** dataset underwent rigorous analysis through FA revealing compelling insights into the factors influencing the underutilization and decay of stream/river water in Iwo. The robustness of the dataset was confirmed by the Kaiser–Meyer–Olkin (KMO) and Bartlett's tests, indicating a high factorability of 89.5%, significant at a 95% confidence level. From the comprehensive analysis, FA successfully identified and extracted two pivotal variables, representing the only valuable factors among the 12 variables studied (refer to Table 2). The first factor revolves around the respondents' perspectives on the home usability and drinkability of water sourced from urban streams and rivers. The second factor pertains to the unguaranteed water supply from streams and rivers throughout the year. Remarkably, these two variables collectively contribute to a substantial 66.496% of the total explanation for the decay and underutilization of stream/river water in Iwo. This underscores the significance of both public perceptions regarding water quality and the reliability of water supply sources, emphasizing the need for targeted interventions and policies to address these key factors in enhancing water resource utilization in the region.

(i) Respondents' view on the home usability/drinkability of water from urban streams and rivers

The comprehensive findings from the FA shed light on the intricate web of variables influencing the underutilization and decay of surface water in homes. Among the twelve variables under scrutiny, the respondents' perspectives on the home usability of urban streams and river water emerge as pivotal. The strong significance attached to this factor is evident through its substantial eigenvalue of 7.111, contributing significantly to the overall explanation for the decline in surface water utilization. Remarkably, the views expressed by respondents on the usability of urban streams

Table 2 Total variance explained

Component	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.546	58.046	58.046	7.111	54.703	54.703
2	1.099	8.450	66.496	1.533	11.793	66.496

Extraction method: principal component analysis. Source: Statistical Package for Social Scientists (SPSS)

and river water play a dominant role, accounting for a substantial 54.703% of the total explanation provided by the two extracted variables. This translates to a significant 82.27% of the absolute value, emphasizing the centrality of this factor in elucidating the factors contributing to the underutilization and decay of surface water in homes. Building on these quantitative insights, Ogungbile et al. (2023) add qualitative depth by identifying the poor quality of the River Niger at Ajaokuta as a hindrance to its use for domestic purposes. This finding underscores the real-world implications of the statistical analysis, highlighting that water quality issues directly impact the willingness and ability of individuals to use surface water in their homes. Expanding the scope of the discussion, broader studies have corroborated these findings. For instance, research indicates that streams and rivers, including the downstream area of Aiba River, face challenges in being utilized for various domestic chores due to their pervasive filthiness (Ogunbode and Ifabiyi 2014). The multifaceted nature of the pollution is underscored by the fact that these water bodies often serve as dumping grounds for refuse, sites for open defecation, and are laden with effluents from cassava and oil mill processing factories as well as slaughter slabs. The interconnectedness of these factors becomes evident as they collectively contribute to the overall decay of water resources in the studied area of Iwo (Ogunbode and Ifabiyi 2022). The intricate interplay between water quality, societal attitudes, and industrial activities underscores the need for a holistic approach to address the challenges associated with the underutilization and decay of surface water in homes. Effective interventions and policies must take into account not only the quantitative findings from factor analysis but also the qualitative nuances derived from on-the-ground observations and specific case studies.

(ii) Unreliable year-round water availability from streams/rivers

The ebb and flow of urban streams and rivers, influenced by seasonal patterns, pose a considerable challenge to the unimpeded accessibility of these water sources for domestic use. This factor, accounting for a notable 11.793%, contributes significantly to the overall neglect of surface water resources for household purposes within the study area. The specific variable associated with this phenomenon holds an eigenvalue of 1.533. In the scholarly works of Umar et al. (2019) and Ogunbode (2021), a poignant reflection emerges on the detrimental consequences of the braided pattern observed in urban streams, a manifestation attributed to seasonal shifts. This intricate pattern not only impedes the consistent access to water for homes but also exacerbates the misuse of these resources, transforming them into receptacles for refuse disposal and areas for open defecation, affecting both the young and elderly populations. Extending this line of inquiry, Gershom et al. (2019) and Umar et al. (2019) further delve into the repercussions of seasonal variations on the overall quality of rivers within their respective study areas. Their findings underscore a pervasive limitation on the year-round utility of these water bodies, reinforcing the notion that the adverse impacts of seasonality extend beyond mere accessibility concerns to encompass broader issues related to the environmental and public health aspects of urban water resources. The results of the FA showed that only two factors that were identified and extracted were significant for the decay observed in the utilization of surface water in Iwo for domestic purposes. The remaining ten variables were declared valueless and so insignificant to the explanation.

Conclusion and recommendation

An investigation was conducted to delve into the factors contributing to the underutilization of surface and pipe-borne water resources, despite their availability in the tropical environment, using Iwo as a case study. The primary data indicated a predominant representation of the female gender at 84%, with 73% of respondents spending less than 30 min to obtain water for domestic use. Groundwater emerged as the primary source for 82% of respondents, while pipe-borne water (PBW) constituted 18%. The study further revealed that 79% of the groundwater points in the area were judged to be managed by 87% of respondents, while 87% attributed the underutilization of the PBW network to the availability and accessibility of sources. Results from FA disclosed that three variables explained 79.563% of the reasons for the underutilization of PBW in the study area, namely: (1) proximity to the pipe network facility; (2) respondents' preference for a specific water source; and (3) reasons for non-connectivity of the PBW network to their respective homes. Notably, all 13 variables analyzed were deemed valuable in this context. Another FA, conducted to comprehend the reasons for neglect and associated decay in the utilization of surface water resources for homes, revealed that two factors strongly accounted for 66.496% of the explanation. These factors included: (1) respondents' perception of the usability of urban streams and rivers leading to the decay in surface resources; and (2) seasonal changes, which do not guarantee year-round water access from surface sources. The results underscored the underutilization of PBW and decay in surface water sources for various reasons. As a recommendation, stakeholders are urged to formulate policies and regulations to govern the ongoing exploitation of groundwater resources, promoting environmental harmony and stability. Moreover, the maximization of surface sources, especially through PBW networks, should be facilitated through the

enactment of executable policies, accompanied by substantial financial support and capacity building.

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Data availability The datasets during and/or analyzed during the current study available from the corresponding author on reasonable request.

Declarations

Competing interest The authors declare that they have no competing interests.

Ethical approval and consent to participate All experiments were performed in accordance with relevant guidelines and regulations. All experimental protocols were approved by Bowen University Research Ethical Committee with the approval number BUREC/COAES/AGR/003. Informed consent was obtained from all subjects that participated in the survey.

Consent for publication Not applicable.

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