Sources and Functionality of Rural Water Supply in Communities from three Senatorial Zones of Imo State, Nigeria

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ABSTRACT: Sustainability of domestic water access in communities is essential for good health, society's dignity and progress. This study investigated the sources and functionality of rural water supply in nine communities of three local government area (LGA) in three senatorial zones of Imo State, Nigeria using structured questionnaires. The questionnaires were administered on 100 women in each community. Data obtained were analysed using multivariate analysis of variance (MANOVA) to reveal the frequency of using the various sources of rural water supply, and Wilcoxon's test for matched pairs to reveal the functionality status of the most frequently used water source. The findings indicate the importance of borehole water facilities in these rural communities and the necessity for intervention programs to strengthen their functionality in tandem with the State's aspirations in achieving sustainable development goals.

The availability of water in any environment is usually used as one of the indicators in assessing the possibility of the presence of life. In human settlements, availability and access to this indispensable resource is interconnected to a family's health, society's dignity and the economy of a nation (OPHI and UNDP, 2019; UN Water , 2014; SIDA, 2015). This link between water and wellbeing is based on the premise that clean water, sanitation services and sustainable water management open windows of opportunities for the poor, reduce deprivations and is a progressive strategy for economic development. However, the sources of water to sustain domestic activities vary in time and space, and is related to geology, level of development, culture among others (Nnanji *et al*., 2013; Olawade *et al*., 2020; Onyenechere *et al*., 2012; WHO/UNICEF, 2010). These sources include dug wells, springs, river, dam, lake, pond, stream, borehole, piped borne water and public taps. The functionality status of these domestic water sources, measured as proportion of functional facilities to the total available facilities, has been facing sustainability challenges across regions, especially in developing countries (Machado *et al.,* 2019; Khan *et al.,* 2018; WHO, 2011). This has been associated with inefficient management and lack of integration of all stakeholders in the water management system, such as relegating the opinion of women, the major water users (Geere and Cortobius, 2017; Juliette, 2013; Nguyen, 2018; SIDA, 2015). In Swaziland, Peter and Nkambule (2015) maintained that 33.3% of water supply facilities were found to be unsustainable. In Ghana, Fisher *et al*., (2015) posited that 21 to 39% of water supply systems were either abandoned or non-functional. In Zimbabwe, 38 and 60-70% of water suppy facilities in Darwin and Gwanda were respectively unsustainable (Dube, 2012; Hoko *et al*., 2009). The functionality challenges of the domestic water system faced in these countries are similar to those in Kenya, Mozambique, Nigeria, other Sub-Saharan African countries and developing economies (Andres *et al.*, 2018; Janz, 2011; Khan *et*

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al., 2018; Koehler *et al.*, 2015). Following variations in the proportion of functionality among them, the severity of the challenge could be captured in regions with lower funtionality proportion. This could assist in restructuring policies and intervention programs on domestic water access. The deficiency in sustainability of these facilities and its interconnectedness to human wellbeing has been opined to be a development challenge in many rural communities of the globe, including Sub-Saharan Africa (SIDA, 2015; United Nations, 2017). Consequently, addressing achievement of sustainable developments goals will require a consideration of this tenet in human goals and aspirations. In Nigeria, though there was progress in improving household access to safe drinking water from 40% in 1990 to 69% in 2015, the number of people not having access to safe potable and domestic water remains a challenge (OSSAP-MDG, 2015; UNICEF, 2015). Rural communities of Imo State, Nigeria are not exempted in this development challenge, and studies that have captured the sources of these rural water supply for domestic purposes and within the confines of the opinion of women (closest to the resource), with a view of addressing the functionality status of the most important source (the source with the largest frequency of use) has not been addressed. Their closeness and necessity of their voices on water sources and challenges is central to health, sanitation and hygiene, and is a tenet in addressing achievement of sustainable development goals. Identifying the most important source of domestic water supply in communities from the opinion of women and determining its functionality could provide the fundamental tools to assist in facilitating investment planning and tackling the challenges facing the source of water supply. Therefore, the objective of this study was to investigate the sources and functionality of rural water supply in nine communities of three local government area (LGA) in three senatorial zones of Imo State, Nigeria.

MATERIALS AND METHODS

Study Area and Data Collection: The study was carried out in rural communities of Imo State, Nigeria. The State is located between latitudes 5°10'N and 5°60'N and longitudes 6°40'E and 7°25'E. A survey design was employed. Following the observed even challenges of water stress in Imo state, a local government area (LGA) was selected from each of the three senatorial zones using simple random sampling. Nine (9) rural communities from a total of 22 communities were sampled in the three LGA from the three Senatorial Zones in the State. The number of communities randomly sampled from each local

government was in accordance with proportional sampling. Thus, two communities (Okwelle and Umuduru) from Onuimo LGA, three communities (Atta, Okwudor and Amucha) from Njaba LGA, and four communities (Enyiogugu, Nguru Nweke, Lagwa and Okwuato) from Aboh Mbaise LGA, respectively in Okigwe, Orlu and Owerri Senatorial Zones. At p=0.1, a sample size of 100 was deduced from each of the nine communities wherein women were sampled from households using systematic random sampling (Yamane, 1967). Interviewer-administered questionnaires were used to collect data that elucidated the five sources (borehole, stream, well, pipe borne water, rain water) of rural water supply that were identified across these nine rural communities, use and functionality as per the opinion of women.

Data Analysis: The frequency of using each source of water (measured on an ordinal scale: rarely, occasionally, daily) was the dependent variable, hence nine dependent variables (including dynamics in seasonal use), while the nine rural communities were the independent variable. The gathered data was analysed using Statistical Package for Social Sciences (SPSS). Data relating the frequency of use of various sources of water with communities was analysed using multivariate analysis of variance (MANOVA) (SAGE Publications, 2019; Taylor, 2011), while the functionality of the major source of water was analysed using Wilcoxon's test for matched pairs.

RESULTS AND DISCUSSION

Principal Source of Rural Water Supply: The overall multivariate analysis of variance shows that the frequency of using the various sources of water (during wet or dry season) significantly varies across the communities: Wilks' Lambda=0.060, F (72, 5378) =44.022, p=0.000 (Table 1). This means that the various sources of rural water supply are not generally utilised equally across the rural communities of Imo State.

Table 1. Proportion of Households using each Water Source across Communities

Effect	Value	F	Hypothesis df	Error df	Sig.
Communities Wilks' Lambda	.060	44.022	72.000	5378.7	.000

However, in-depth analysis of the frequency of utilising each source of water from MANOVA reveals that, while the frequency of use of other sources of water (stream, well, piped borne and rain water) is significantly related to the communities, the frequency of using borehole water is not significantly related to communities in wet and dry seasons (Table 2).

Table 2. MANOVA of Frequency of Using Water Sources across Communities.

Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Adjusted R^2
Frequency of using borehole water during dry season	.009	8	.001	1.000	.434	0.000
Frequency of using stream water during dry season	129.369	8	16.171	68.576	.000	0.376
Frequency of using well water during dry season	36.640	8	4.580	21.955	.000	0.157
Frequency of using pipe borne water dry season	450.200	8	56.275	487.563	.000	0.812
Frequency of using rain water during wet season	29.600	8	3.700	8.831	.000	0.065
Frequency of using borehole water during wet season	.042	8	.005	.679	.711	0.003
Frequency of using stream water during wet season	88.976	8	11.122	79.775	.000	0.412
Frequency of using well water during wet season	15.756	8	1.969	18.750	.000	0.136
Frequency of using pipe borne water during wet season	378.989	8	47.374	317.822	.000	0.738

The variance of the dependent variable explained by the model (Adjusted R^2) is quite small (0.000 and 0.003) for the frequency of using borehole water in both seasons when compared to the other sources of water (Table 2). This implies the communities do not define the frequency of use of borehole water by these women- hence this source is the most important domestic water supply for rural communities of Imo State. For the other sources of rural water supply, the variance of the dependent variable explained by the model range from 0.065 (6.5%) to 0.812 (81.2%), indicating the importance of communities in defining the source of water use. A large proportion of households (99.89% in the dry season and 99.56% in the wet season) in rural communities of Imo State use borehole water daily (Table 3).

For the other sources of water, the proportion of residents that make use of it daily in the dry season are 8%, 6.22% and 18.33% for streams, wells and piped borne water respectively; while in the wet season, the proportion of residents in these communities that make use of it daily are 2.67%, 1.89%, 16.44% and 58.89% for stream, well, piped borne and rain water respectively. Hence, borehole water is the principal source of rural water supply in Imo State as there is no significant variation in the frequency of using this water source across communities.

Although there is a slight drop in the proportion of residents using borehole water in the rainy season (99.89% in the dry season and 99.56% in the wet season), following available rain water, more than 99% of the residents across the communities depend on borehole water, irrespective of the seasons.

Table 3. Frequency and Proportion of Use of Water Sources in Rural Communities in Imo State

Sources of water/ seasons	Frequency and proportion of using water sources (%)			Total (%)
	Daily	Occasionally	Rarely	
Borehole/dry	99.89	0.11	0	100
Borehole/wet	99.56	0.11	0.33	100
Streams/dry	8	15.89	76.11	100
Well/dry	6.22	1.89	91.89	100
Piped borne/dry	18.33	8.67	73	100
Stream/wet	2.67	18.89	78.44	100
Well/wet	1.89	5.44	92.67	100
Piped borne/wet	16.44	7	76.56	100
Rain/wet	58.89	31.22	9.89	100

The accessibility of water table for borehole water development, relative acceptable quality of the water by residents and the challenges of accessing the other sources of water could be the major reason for borehole water being the principal domestic water source in these communities. Consequently, there is no significant variation of its use across communities. The variation in the frequency of using the other sources of rural water supply across these communities could be attributed to the availability of the sources, variation in the lifestyle of the household and accessibility of the source of water supply. For example, the geographical location of Njaba LGA in Orlu Senatorial Zone permits the availability and accessibility of streams, and some residents at the vicinity of the streams rely on this water source. In Aboh Mbaise LGA in Owerri Senatorial Zone, the streams tend to be distant from human settlements and undermines access and use of this water source. Despite the variation in utilising the different sources of rural water supply, borehole water is still the principal source of water supply in these communities. It is necessary to define the importance (frequency of

use) of a rural water source in view of charting a path on strengthening its availability. Chi-square (X^2) analysis reveals that a significant proportion of these rural residents do not have a borehole water facility in their homes (X^2_{cal}=23.68, X^2_{tab}=6.63, df=1, p=0.000), representing 41.89% of rural residents in Imo State (Table 4).

Table 4. Proportion of Residents without Borehole Water System

Borehole possession by residents (%)		Total (%)	X^2_{cal}	X^2_{tab}	df	P-value
Yes	No					
41.89	58.11	100	23.68	6.63	1	0.000

The proportion of ownership of these boreholes varies across communities, ranging from 25% in Lorji to 64% in Nguru Nweke. Thus, a larger proportion (58.11%) of these rural residents depend on public borehole water or buy water from available commercial borehole sources. Findings from this study on the proportion of residents relying on borehole water is similar to that of Iwuala *et al.,* (2020) who showed that borehole water is the major source (65.4%) of potable water supply for urban residents of Imo State and less than half (33%) of these residents own a borehole water source. In a related study, Onyenechere and Osuji (2012) showed that a larger proportion of residents in Owerri city rely on borehole water, especially from commercial borehole owners. Thus, there is a need to consider and strengthen the availability and access to public rural borehole water facilities in any bid for water development in the State.

Functionality Status of Public Borehole Water Facilities: The study reveals that the public infrastructure of this principal source of rural water supply (borehole water) for residents in Imo State are failing. Using Wilcoxon's test for matched pairs, the difference in the average (median) of the constructed public boreholes and the functional public boreholes is statistically significant (Tcal =0, Ttab=5, N = 9, P=0.046) (Table 5), with only 21.74% of functional public boreholes providing water for these rural residents.

Table 5. Functionality of the Public Borehole Water Facilities

Tcal	Ttab	N	p-value
0	5	9	0.046

The failing of the functionality of these public infrastructures indicates a relative severity of the problem for rural communities of the state when compared with studies by Khan *et al.,* (2018) who estimated that at any given time, about 50% of public rural hand pumps in Nigeria are non-functional. In a related study, Andres *et al.,* (2018) posit that about

46% of water schemes in Nigeria are non-functional, with 30% of these schemes likely to fail in the first year of commissioning. Following the non-functionality of a larger proportion (78.26%) of these public schemes (with some communities having no functional borehole), these rural residents purchase water daily from commercial borehole owners, and are inclusive in the 10.10% of rural residents who spend more than 30 minutes away from their homes to fetch water (except rain water in the wet season) (Table 6).

Table 6. Residents' Time Taken to Access Domestic Water Sources

Time taken to access domestic water source	Percentage	Cumulative frequency
Less than 30 minutes	89.9	89.9
More than 30 minutes	10.1	100

According to OPHI and UNDP (2019), when a household spends at least 30 minutes walk from home roundtrip in order to access domestic water, such a household is considered deprived in accessing domestic water supply, a limitation which undermines their ability to combat multidimensional poverty. The time spent and distance roundtrip does not only stress the individual in walking and conveying the water, but could degenerate to reluctance in fetching water. This is interconnected to underusing the resource and degenerates to problems of poor sanitation and human health, while increasing vulnerability to poverty. Following endemic povery in rural communities in Nigeria, these rural residents in Imo State could be facing limited availability of funds to continously purchase water from commercial borehole owners (Mba *et al.,* 2018; Nmadu *et al.,* 2016). Besides this challenge, the long distances covered to access water by some residents could lead to underusing this vital resource in their households. In this regard, sanitation could be undermined and this exercerbates the existing poor conditions of these residents. The links between affordable water, sanitation and poverty have been widely established and cannot be relegated by any society with a quest to achieve sustainable development (World Bank Group, 2018). Ensuring that everyone has access to safe and affordable water constitutes a tenet of the sustainable development goals (United Nations, 2017). With only 21.74% of the major public water schemes functioning, and a larger proportion of residents (58.11%) without boreholes in their homes, these residents are vulnerable to the interconnected poverty challenges associated with water scheme failure and limited water access. For example, a mother spending long distances to purchase water adds to the stress of existing unpaid workload and reduce ability to achieve her full human

potential (USAID, 2015). Similarly, such distances could make a girl child more vulnerable to sexual abuse and its interconnected risks which impede achievement of her full human potential. Therefore, this study suggests that ensuring the functionality of this principal water supply scheme in rural communities of Imo State could be achieved through privatization of the schemes without undermining inclusive participation and job creation for community residents. The need to align to this approach is related to the success story and sustainability of commercial borehole owners (Iwuala *et al.,* 2020; Onyenechere and Osuji, 2012). These commercial borehole water facilities are owned by individuals and act as a means of livelihood for them. Consequently, they are properly catered for using the income generated from the facility and on the basis that it constitutes a tenet of their survival network. This sustainable approach is as opposed to the challenges faced with a common resource such as the public borehole water facilities, which reflect some of the trappings of the concept of " Tragedy of the Commons" (Hardin, 1968). Hardin argues that when individuals have access to a common resource, they act in ways that diminishes other people's enjoyment, while maximising their benefits. Consequently, there is lack of individual concern to sustain these public borehole water facilities. Privatization of the water scheme and inclusive participation of the community will diminish the challenges associated with using a common resource, generate income for the management authority while strengthening the sustainability of the resource for the common good of the residents. This will assist immensely to guarantee water affordability, health security, create descent jobs, reduce deprivations and foster economic progress.

Conclusion: In any community, identifying the most important domestic water source and its functionality status from the opinion of women, the major water users, are essential tenets in sustaining the resource. Consequently, location-specific data are essential in assessing the status of governance performance on sanitation, health and hygiene and its interconnected impacts to residents' deprivation and poverty. The findings provide useful tools to facilitate intervention programs and policy restructuring in strengthening domestic water access in the area.

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