Analysis of borehole water accessibility in Samaru Community, Zaria Metropolis, Kaduna State, Nigeria

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Abstract
Purpose: This study is aimed at analyzing the water accessibility in Samaru Community, Zaria Metropolis, in Nigeria with a borehole as the center for attraction.
Research methodology: Questionnaires, interview, and observation methods were applied in data collection and systematic sampling was adopted in selecting the respondents. The questionnaires were administered from January 2021 to August 2021.
Results: The results revealed that the hand pump borehole was the major source of water supply in the study area with 71%. The consumption of water per capita of the majority of respondents, 61%, was less than 30 liters against WHO standards. Then, 59% of respondents cover a distance of between 1-2 km to get access to their water supply. Findings further revealed that cooking use of borehole water was 38% against drinking that is 24%. Additionally, some water-borne diseases like typhoid fever and cholera were reported in some cases.
Limitation: The issue at hand virtually affects the whole of the metropolis but eight researchers could not cover all sections because of the limitation of time.
Contribution: Research on the provision of clean water and sanitation cannot be overemphasized as they are objective six of the Sustainable Development Goals (SDGs) because of their importance in life.
Keywords: Accessibility, Borehole, Water, Samaru Community, Zaria Metropolis
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1. Introduction

Undoubtedly, after air, water is the most important substance for our existence on earth (Osunkiyesi, 2012). The domestic use of water cannot be quantified as it cuts across all areas. It is used for cooking, it is used for washing, it is used for drinking and outside the home, water is used for industrial activities (Akpoborie et al, 2008). Chemically, water contains two molecules of Hydrogen and one molecule of Oxygen (H_2O). There are two major sources of water used domestically or industrially. These two sources are surface water such as streams, rivers, ponds, and lakes, and groundwaters such as wells, boreholes. Both types are used domestically and industrially, but it was reported that groundwater is safer for domestic use and less susceptible to contamination (Okeola, Kolawole, & Ameen, 2010). It is used not only for domestic purposes, but also for irrigation farming

(Haruna, Uzaini, & Harrison, 2008; Okeola, Kolawole, & Ameen, 2010; Shymala, Shanthi, & Lalitha 2008). To substantiate this point, it was revealed that well water is the major source of water for domestic use in Akure, the capital of Ondo State in South Western Nigeria (Ogundele, 2010).
The scarcity of potable water is not only peculiar to rural areas in Nigeria, but also urban. In rural areas, people resort to using streams and rivers for their domestic uses (Shittu, Olaitan, and Amusa, 2008). While in urban areas, wells and boreholes are the major sources (Okeola, Kolawole, & Ameen, 2010). For instance, Wukari town is the second most important town in Taraba State, North Eastern Nigeria, it was reported that the people in the town use different water sources and the breakdown is as follows: boreholes constitute 14.6%, hand-dug wells constitute 46.6%, streams constitute 1.80% and water vending which the vendors mostly source from boreholes constitutes 37% (Ishaku, Hussain, Dama, Zemba, & Peters, 2010).

A resolution by the United Nations General Assembly put access to drinking water and sanitation both as human rights and a major requirement for the fulfillment of several other human rights (United Nations, 2010). The supply of water must be physically accessible, sufficient in quantity, safe in terms of quality, available when needed, acceptable in color, taste, and odor, and price-friendly for everyone. This was achieved a long time ago in developed countries, water easy accessibility is still a challenge in developing countries including Nigeria especially in rural areas (World Health Organization, 2017).

As a short time or long time solution to water inaccessibility in developing countries, the public, private and individuals develop the use of boreholes. Most of these boreholes are hand pumps drilled manually. This manual drilling approach to water supply has been there for tens and hundreds of years and is a forgotten method of water supply in developed countries of the world, and automated methods of the water supply have taken over. In developing countries, however, manual drilling has experienced a revolution in which can be attributed to projects going on in Africa, Asia, and Latin America (Danert, 2015). It was reported that over 100,000 hand boreholes have been drilled in India, 100,000 in Vietnam and Nepal, 30,000 in Nigeria, 16,000 in Niger, and over 1000 in Chad and the Democratic Republic of Congo. According to (Danert, 2019). Hand pump boreholes provide a large percentage of drinking water in Bangladesh, India, and Nepal (Danert, 2015). It was estimated that 650,000 people drink from hand pump boreholes in the Democratic Republic of Congo (Kane & Danert, 2020) and up to 5 million people across the Lagos region, in Nigeria (Danert, 2019). According to (Danert, 2015; Danert, 2019, Weight, Yoder, & Keller, 2013). The hand pump is also relatively widespread in countries like Bolivia, Madagascar, Nicaragua, and Senegal, and has become a flourishing business in areas of Bangladesh, Nigeria, Niger, and Sudan.

Although the hand pump boreholes have their own shortcomings, they have proven the best alternative for the socio-economic role they play. They are likened to affordability, they suit the soil and geology of many places and those without alternative easy tap from this method. The major challenge of these hand pump boreholes in these developing countries is the lack of or inadequate technical experts and equipment in many cases which can be used to repair them whenever there is a fault. Also, the absence of reliable sources of potable water supply in many areas of developing countries makes many wealthier households embrace this method of water supply since the supply is erratic, unreliable, or non-existence at all (Martinez-Santos, Martin-Loeches, Diaz-Alcaide, & Danert, 2020).

Several studies on borehole and water accessibility have been conducted elsewhere. For instance, Ishaku, *et al,* (2010) in Wukari, Nigeria, Martinez-Santos, *et al*, (2020) outside Nigeria, and many more. However, Samaru neighborhood of Zaria metropolis, despite being an important community not only in Zaria, but also Kaduna State because it is the host community of Ahmadu Bello University Zaria, the largest University South of Sahara. The heterogeneity(2 community is home to thousands from students to civil servants and other people that work in both public and private sectors but have not seen a similar study. This study therefore set to bridge that gap by assessing the accessibility of borehole water as the major source of domestic water supply in the community.

The objectives of the Study

Two main objectives set in this study, are to:

i. identify socio-demographic characteristics of the residents of the study area
ii. identify sources, uses, difficulties, and techniques used in accessing potable water in the study area

Limitation

Although eight researchers teamed up for the study, a study of this magnitude and importance can be better handled if the number of researchers is more than eight to cover more space and more time. Spatial attributes and temporal attributes are two attributes that geographical studies are anchored on. Thus subsequent studies should consider the whole of Zaria metropolis or even Kaduna State and instead of eight months, maybe the whole of the year.

Study Area

Samaru is located between Latitudes 11°09'30'' to 11^{0}20'6'' and Longitudes 7°38'15'' to 7°39'20''E at an altitude of 550-700m (Abor, Giwa, & Giwa, 2015). Samaru is located in SabonGari Local Government Area of Zaria Metropolis, Kaduna State. The Local Government has a total of eleven (11) Political wards; Anguwan-Gabas, Basawa, Bomo, Chikaji, Dogarawa, Hanwa, Jama'a, Jushi, Muciya, Samaru, and Zabi (Abor, Giwa, & Giwa, 2015). Sabon Gari LGA, the LGA of the study area is predominantly heterogeneous in nature with various tribes with nationalities, i.e. all tribes are found in the Local Government. Foreigners like Malians, Nigeriens, and Chadian have been assimilated, into the community and as well trade together. Sabon Gari had a population of 322,874 (NPC, 2006), while as Samaru community (Study Area) has a projected population of about 31, 501.41 by 2020 which make up 3% of the entire population (NPC, 1991) using a growth rate of 3% conservative for Kaduna State.

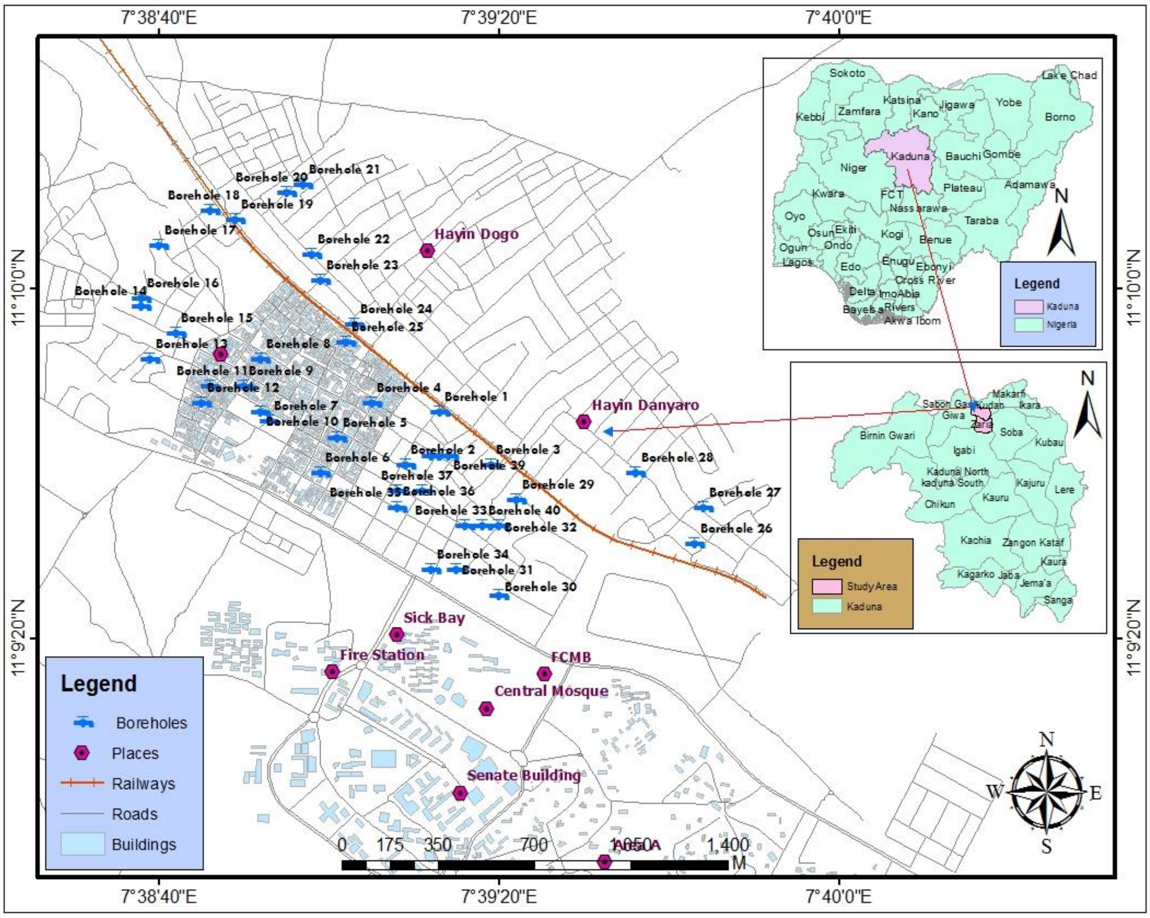

Figure 1. Study Area

Source: Authors, 2021. Adopted from Administrative Map of Kaduna State, Nigeria

Climate

Samaru climate is classified under the tropical continental climate and according to Thorawaits moisture index, dry humid. The continentality of its climate is pronounced during the dry season especially in December and January (Mortimore, 1970). The seasonality of the climate is assured by the movement of the intertropical discontinuity (ITD). The oscillation of the dry and rainy seasons is controlled by tropical continental and tropical maritime air masses. The mean daily maximum temperature rises gradually from January (6^{o}C) showing a major peak in April (39^{o}C) and a minor one in October. The mean daily minimum temperature rose from its lowest value 7^{o}C between December and January reaching the highest of about 11^{o}C in July and August. The dry season is particularly rainless between November and April.

The mean annual rainfall of Samaru is about 1100mm with an average intensity of 80mm/hr. However, the rate is in excess of 100mm/hr. With a peak intensity recorded in the past on the basis of the relative importance of the dry continental worth. Easterly or westerly air and the consequent weather. The year in Samaru can be divided into the cool, dry, and dusty period (harmattan season) which lasts from November to February and sometimes reaches March as the case may be. The hot season or thunderstorms and squalls are usually in May, the wet season is usually hot and humid beginning from the third week of July to October (Mortimore, 1970).

Hydrology and Drainage

The topography and climate of the region have a significant impact on the hydrology and the amount of water that is available at any given time within the year. Both surface and underground water are available in the hydrological zones. The more humidity in the microclimate the more water was available. The water on the plains of Zaria was drained in the River Saye to the South, River Kubanni to the North, and River Galma to the east. These rivers in turn empty their waters in River Kaduna. The drainage consists of the Kubanni River which has its source from the Kampagi hill in Shika Zaria. It flows in a South-East direction through the premises of Ahmadu Bello University. The Samaru stream which is one of the tributaries of Kubanni River has a stream length of 1.05km within an area of 2.28km^2 and has a drainage density of 0.4605 km/km^2. The drainage system focuses on River Galma and Kubanni River. River Galma is a major tributary of River Kaduna and Kubanni River on which Ahmadu Bello University Dam is situated, is seasonal and supply water to Ahmadu Bello University and its environs. Samaru stream flows in North-South direction through the main campus of Ahmadu Bello University Zaria, situated along a valley West of Samaru village into the Kubanni River.

Vegetation

The region generally falls within the Guinea Savannah vegetation. The climax climatic vegetation of the area ought to be Northern Guinea Savanna, but because nearly all vegetation within the stream system has been degraded due to man's activities such as intense cultivation, fuel wool felling, the real climax vegetation is almost absent. What is seen presently are a few scattered trees interspaced with tall tree grasses about 1-15m and 2-5m respectively. Trees found here include Isorberlina Doka, grass type includes *Adropogonaea spp*, *Schizachiriumsemiberbe,* and *Monocynbiumceresti* (www.abu.edu.ng).

Population

Samaru is a major district in Sabon Gari LGA of Zaria metropolis, Kaduna State in Northern Nigeria. It is known for housing arguably the largest university sub-Sahara Africa, Ahmadu Bello University, as well as being home to a number of prominent Nigerians. According to the 1991 population census, Samaru had 12,978 people. Based on the 3% annual growth rate of the 1991 census, Samaru population growth was projected to be about 31, 501.41 by 2021 (Abor, Giwa, & Giwa, 2015).

Land Use and Human Activities

Samaru is characterized by leached ferruginous tropical soil types. Most of the soil in Samaru is weakly developed particularly those found very close to the residual hills. The soil also contains pieces of quartz and mica. The upper part is a mixture of some materials blown by the wind that is

Aeolian deposits. Samaru soil can be summarized majorly into Fadama soil; soil formed on met sediments and developed on granite www.abu.edu.ng.

2. Literature Review

Water

Potable water is not only significant but also necessary to sustaining life; it must be adequate, safe, and accessible year-round (WHO, 2006). Water is the most essential substance that cannot be replaced for the survival of human because it is part and parcel of all body functions that makes up to about 60% (Sissons, 2020). Thus, life is built, nurtured, and sustained by water as about 60 percent of the human body is water. Although people understand its importance, ensuring its quality is still a big challenge among developing countries (WHO, 2017).

No amount of effort was made to ensure quality, accessibility would be too much (WHO, 2006). Although governments at various levels in Nigeria make efforts to provide potable water, a large number of Nigerians still face inadequacy in water provisions (Emerenini, 2020). Additionally, WHO (2006) has set a guideline for safe drinking water. The guidelines, put all water users in the right direction with the caveat on certain categories of people who are at risk if their water is contaminated. The guideline place under-age children, old people, weak people, and those surrounded by unhygienic condition and the environment at the greatest risk of being affected by waterborne diseases. The guideline further stated that safe drinking water is suitable for normal domestic activities, including personal hygiene. The guidelines are also applicable to bottled water, packaged water, and ice water intended for human use. However, the water of higher quality required for treatment of illnesses like renal dialysis and other related is beyond the scope of the guideline for they are not general requirements, but specific. In this case, the guideline proposes boiling the water to neutralize any microorganism or contaminant that might affect the safety of the water. As communities struggle to cope with the scarcity of safe drinking water, industrial sectors compete with domestic consumption for the industrial water uses include among others: transporting products, diluting products, cooling products, fabricating and processing products, sanitation USGS (Undated).

Borehole in Nigeria

A borehole is a water source drilled down the earth to reach water level, it uses a pipe to get to the ground which is normally narrow (Daniel & Daodu, 2016). In most parts of Nigeria, access to safe drinking water is seriously inhibited by cost, availability, distance, and other factors indicating that consumers are compelled to accept what they can afford or what is available. The government at all levels strives to provide water for its people. This can be attributed to the importance of water in our lives. Water sustains life and is needed in all developmental projects whether permanent or temporary. Although the human body is more than 70% water (Popkin, Anci, and Rosenberg, 2010), clean water is not adequate with many water-borne diseases contaminating them (Safe drinking water, 2016). A shocking revelation from the World Bank (2015) estimated that only 12% of the global population consumes 86% of the available water, while a whopping 1.1 billion people have no access to adequate water supplies.

Drinking water, irrespective of its source, in developed countries is normally place to safety and quality tests. But these safety tests are often lacking in many areas of developing countries especially the rural areas. Rural areas in Nigeria suffer public health problems owing to inaccessible clean and potable water as about 70% of them are underwater shortages or unclean water (Ishaku, *et al.*, 2011). According to Gregory and Victor (2018), there is the need to test the increased boreholes dug in Nigeria to find out issues linked to boreholes that might contaminate the groundwater of which borehole is one of them. Supporting the argument put forward by Gregory and Victor (2018), EPA (2021) frowns at the violations of international water quality standards often generated from boreholes.

Ideally, the borehole is meant to provide wider, cheaper, and more access to potable water but this sole aim is somehow abused going by the practices done in its provision and usage. Although thousands were dug across Nigeria, many people have no access to potable water (UN-Water, 2021).

Concept of Spatial Accessibility

Accessibility has many perceptions. According to the Approaches to Measuring Potential Spatial Access (2017), spatial access measures distance from houses and it depends on aggregation and disaggregation. WHO (2006) defines water accessibility as the source of water that does not exceed one kilometer or a distance of 20 minutes away from the house and is capable of having at least 20 liters per capita of a family member.

Water as A Human Right

Access to safe drinking water is a fundamental human right globally. However, it is estimated that about 1.1 billion people mostly in developing countries have no access to potable water. As if it is not enough, the majority of the domestic water supply burden lies on women and children who trek and hunt for water for their households daily (UN, 2010). According to WHO, the basic requirements for water include drinking, personal hygiene, but the limit cannot be set as it has to do with accessibility. It has been estimated that in order to ensure basic human needs, every individual needs 20 to 50 liters of water, free from harmful elements, each day (UNDP, 2006). This right to water was implicitly endorsed in the 1948 Universal Declaration of Human Rights. The right to water applies primarily to the water of acceptable quality and quantity for personal and domestic uses, implying an emphasis on affordable water supply. The need for access to water for farming and other productive uses is recognized, but while water is required for a range of different purposes, for example, to secure economic production and livelihoods, priority in the allocation of water must be given to the right to water for personal and domestic uses to facilitate a reduction in poverty levels in rural communities (UNDP, 2010; World Bank, 2010).

Water is quite important, it is an asset to rural communities in sub-Saharan Africa. Therefore striving to achieve continual potable water availability to build stable rural people is quintessential for advancing water infrastructure development for poverty reduction. Also, water as an asset has long been recognized as a factor for achieving good education development globally. (World Bank, 2010).

Groundwater Quality

The quality of water is not only important but is directly linked with human existence. In his work, Ranjan (2010), perceives or considers human life existence when there is quality water in place. It is a universal fact that, groundwater quality is presumed to be better than surface water, because its quality is the sum of environmental elements such as the geology of the area, and the nature of activities carried out in the area by man (Chapman, 2006). There are certain parameters that indicate the suitability for water use. These parameters indicate contaminated or safe groundwater; such water needs to be colorless, tasteless, and odorless (Suthra, Bishori, Singh, Mutiyar, & Pathil, 2009).

Table 1. Safe distance between boreholes/wells and source of contaminants

Source of Pollution	**Distance (M)**
Septic tank	15
Latrines	45
Cemetery	250
Sewage farms	30
Infiltration ditches hi	30
Percolation zone	30
Pipes with watertight joints	3
Other pipes	15
Dry wells	15

Source: WHO 2006

Access to Domestic Water

According to the World Health Organization (WHO), access to potable water is measured by the number of people who have a reasonable means of getting an adequate amount of water that is safe for drinking, and all other essential household activities which include personal hygiene practices

(WHO, 2017). However, it is estimated that more than one billion people in low and middle-income countries lack access to safe water for drinking, personal hygiene, and domestic use, and it is estimated that these numbers represent more than 20% of the world's population (UNDP, 2015; World Bank, 2010).

Table 2. WHO Standards – Indicators of Access to Water

Time spent to fetch water	Distance travel to fetch water	Water supply accessibility	Level of Health Concern
More than 30 minutes	More than 1000m	No access	Very high
5 to 30 Minutes	Between 100 and 1000m	Basic access	High
Within 5 minutes	Within 100m	Intermediate access	Low
Water supplied through multiple taps continuously	Water supplied through multiple taps continuously	Optimal access	Very low

Source: WHO 2006**.**

Previous Studies

In a study conducted outside Nigeria, William (2014) assessed the spatial distribution of physical, chemical, and microbiological elements in water in rural and urban regions of Yei Country in South Sudan. Both dry season between February to March 2011 and the rainy season between June and July 2011 were used in collecting water samples. After the water samples were collected, they were analyzed. Additionally, factors affecting daily water consumption were also assessed. The results revealed that physical and chemical parameters of pH scale range from acidic 6.0 through neutral 7.0 to alkaline 8.1 in the dry season was experienced. But the result was a bit different in the rainy season as it was 5.5 acidic to 7.5 neutral. Factors affecting daily per capita borehole water consumption were also assessed and were found to be distance and season variation. The results also revealed that urban boreholes have slightly higher acidic content than rural boreholes. The study further revealed that although physical and chemical parameters were affected, they did not seriously affect changing seasons. The study also revealed that distance from borehole, the size of the household, and of course season seriously affected daily per capita consumption of water. The study further revealed that a World Health Organization standard was not observed in many areas where boreholes were provided. The study also revealed that rural areas consume less water than urban areas and the results finally revealed that per capita daily consumption of borehole water is higher in areas that are clustered around 500 meters away from boreholes than areas clustered 1 km and above from boreholes. The study recommended that World Health Organization standards should be observed when providing boreholes.

Supporting William's findings, Emerenini (2020) applied a quantitative sectional study to examine whether the level of contamination of potable water generated from borehole used in the production of sachet water otherwise called pure water in most parts of Nigeria is in compliance with World Health Organization standards. The relationship of Physico-chemical and bacteria was also examined in the study. The study was carried out in Owerri, the capital of Imo state. Data were collected from 68 water samples from 17 different sections or areas of Owerri city. The results revealed that 65% of the samples tested were polluted. The hypothesis testing revealed that null hypothesis was retained because there was poor compliance with the World Health Organization standards. The turbidity of the water samples had also increased although not significant when tested against physical and chemical parameters to predict bacterial influence.

Additionally, in one of the Nigerian universities campus, Amoo, Adeleye, Bate, Okunola, & Hambali, (2018) assessed the physical, chemical, and microbiological (bacterial) quality of water which was sampled in six different boreholes at the Federal University, Dutse, Jigawa State, Nigeria. The results revealed that pH level was found to be between 6.53 less acidic to 7.80 less neutral. The results also revealed that the electric conductivity of the borehole waters was found to be 422.0 to 690 microve/cm, while the temperature was found to be between 31.0^0c to 33.0^0c. All the variables were measured in place. The study further revealed that the water turbidity, water hardness, and nitrate content were found to be in the range of 0.01 to 41.2NTU, 51.3 to 102.6mg/L, and 0.001 to 0.06mg/L respectively. The study finally revealed that some of the sampled water was beyond the World Health Organization and Nigeria Standard for Drinking Water Quality (NSDWQ). The study, therefore, recommended that stakeholders saddled with the responsibility of managing boreholes should ensure strict adherence to the standards to ensure that only quality water is consumed. It was also recommended that inspectors should be sent to tertiary institutions to check water quality on regular basis.

Research Hypothesis

For the purpose of this study, this hypothesis was formulated:

Hypothesis: There is no significant impact of borehole water in accessing potable water in Samaru Community of Zaria Metropolis, Kaduna State, Nigeria.

3. Methodology

Reconnaissance Survey

A reconnaissance survey was conducted by eight researchers to get acquainted with the study area. Boreholes were visited and inspected to understand how they are used in the study area.

Source of Data, Type of Data, and Purpose for Data

There were three major sources and types of data used in the study. The data information is summarized in Table 3.

Table 3. Source, Type, and Purpose of Data

Type	Source	Purpose
Socio-demographic	Questionnaire	Determination of their social backgrounds
Buildings/Structures Affected	Observation	See boreholes and usage
Secondary	Past Literature	To complement data demand

Source: Author's Compilation, 2021

Population and Sampling Technique

One hundred and forty-four (144) questionnaires were administered to respondents affected. In administering the questionnaires, eight researchers went to the field with eighteen (18) pieces of the questionnaires which were administered in eight months (January-August, 2021). Each researcher went alone from researcher one to the eighth as they appear on the title of the article. This provides a basis for comparison on the months the demand for water was higher and the months' accessibility was harder. The head of the household was issued with the questionnaire or their representative where they were unavailable. In selecting the households (respondents), systematic sampling was applied with the first element taken randomly and subsequent elements chosen at the interval of one. Thus, element one was taken, two was skipped and three was chosen, and so on. (Bello and Ajayi, 2006). Affected persons' perception of the types of water they use, the safety of the water they use, the distance they cover to get their water among others were the basic questions elicited from the respondents besides their socioeconomic demographics.

In determining the sample size, which has been asserted that if the population is a few hundred 40 – 50% of the population could be used. If the population is many hundreds, 20% sample could be used and if the population is several thousand, then 10% or less could be used (Mesa, Ghica, Bastos, Bonamigo, & Daquia, 2014). The population was about 31, 501. 41 by 2020 projection using 3% from the 1991 population census which classified the population into wards and neighborhoods. The latest population done in Nigeria was in 2006, but it did not classify or provide the wards and neighborhoods breakdown, but only local government areas and state hence the adoption of the 1991 population census. The data collection was complemented with interviews and observation.

Method of data analysis

Descriptive statistics using tables, percentages, and charts were adopted. Table and percentage present all the information on socioeconomic demographic, while pie chart and percentage were used to present the result on water and surrounded issues. Inferential statistics using Pearson's moment correlation was used to test the hypothesis.

4. Results and Discussion

This section presents the analysis of data and interpretation of findings. It presents and analyzes the data gathered. The analysis and presentation of results are divided into subsections as follows: Respondents' socio-demographic characteristics and accessibility of government-owned handheld boreholes and the private boreholes accessibility.

Section A: Background of Respondents

Table 4. Gender

Option	Frequency	Percentage
Female	89	61.8
Male	55	38.2
Total	144	100.0

Source: Author's Analysis, 2021

Table 4 revealed that the majority of the respondents were female while few were male due to the domestic and personal use of water by women. The right to water applies primarily to water of acceptable quality and quantity for personal and domestic uses, such as washing of clothes, toilets, bathroom, cooking, bathing, and cleaning of the house as it is primarily used by the female. According to world division (undated) women and children suffer more than any group or class when there is a scarcity of water. Many see it as discrimination which appears through women's lower status, low income earning, low power in making decisions, low opportunities, and low access to education services/resources when it comes to water and sanitation

Table 5. Age

Option	**Frequency**	**Percentage**
Less than 18 years	**8**	**56.0**
19-28 years	**46**	**31.9**
29-38 years	**58**	**40.3**
39 years above	**32**	**22.2**
Total	**144**	**100.0**

Source: Author's Analysis, 2021

From Table 5, the result revealed that the majority of the respondents were within the age bracket of (29-38 years). This can be likened to the age that is more reproductive and active. A number of the female within that age bracket have children in the study area. Thus, besides female personal need for cleanliness and sanitation, there is also a need for water for children and the rest of households.

Table 6. Marital Status

Option	**Frequency**	**Percentage (%)**
Married	61	42.4
Single	73	50.7
Divorcee	7	4.9
Separated	3	2.1
Total	144	100.0

Source: Author's Analysis, 2021

From Table 6, the majority of the respondents 73, representing 51% were single. This means that a large number of the residents could be students or family members that stay with their parents. There were few divorcees and separated who were sourcing water for themselves.

Table 7. Occupation

Option	Frequency	Percentage
Student	54	37.5
Farmer	24	16.7
Civil servant	56	38.9
Others	10	6.9
Total		100.0

Source: Author's Analysis, 2021

From Table 7, the result revealed that civil servants were the majority among the respondents with 56 representing 39%, civil servants were closely followed by students, 54 representing 38%. This indicates that the Samaru neighborhood or community of Zaria metropolis is dominated by staff and students of Ahmadu Bello University, Zaria. The university is a few meters away from the neighborhood or community.

Table 8. Household Size

Option	Frequency	Percentage
1-2	26	18.1
3-4	43	29.9
5-6	53	36.8
7 and above	22	15.3
Total	144	100.0

Source: Author's Analysis, 2021

From Table 8, the majority of the respondents' household size ranges from 2-6 with few that range from 7 and above. This means that the settlement is urban and against many household sizes in Nigerian communities whether rural or urban that could have a large number of household sizes of 7 and above.

Section B: Accessibility and utilization

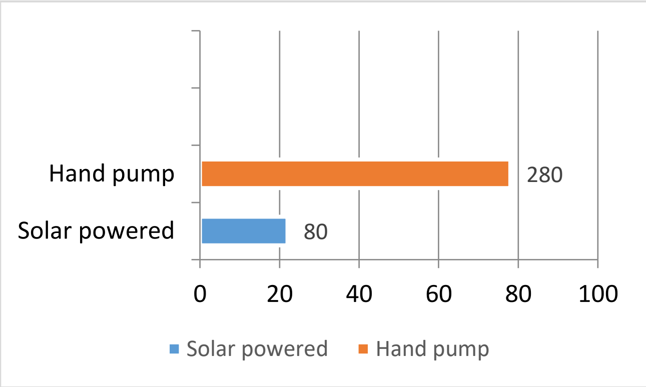

Figure 2. Type of Borehole Used
Source: Author's Analysis, 2021

From Figure 2, the majority of the respondents 112 representing 280 degrees in the chart or 71% use or have access to hand pump borehole as against minority, 32 representing 80 degrees in the chart or 29% that use or have access to solar powered borehole. Hand pump borehole is cheaper and more affordable to people than solar-powered and that is the reason it dominates the community. Although the solar-powered borehole uses sunlight to pump and the study area has a lot of solar radiation or sunlight potential, it is provided is capital intensive. Thus, solar-powered boreholes are provided by the government or politicians to serve communities and they hardly provide enough for people for obvious reasons (scarcity of resources or they might like to return next election period to make promise and campaign for its provision).

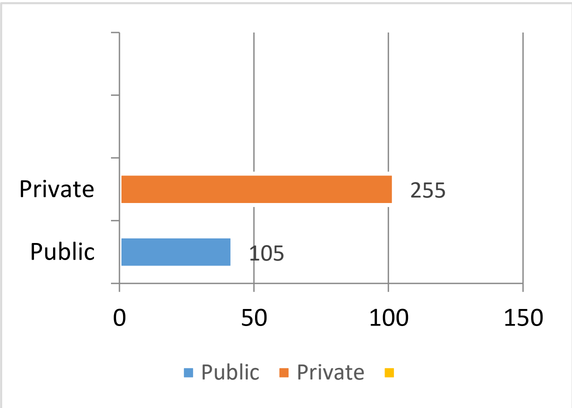

Figure 3: Private or public-owned borehole.
Source: Author's Analysis, 2021

From Figure 3, the majority of the respondents 102, representing 255 degrees in the chart, or 71% were private borehole owners, while 42, representing 105 degrees or 29% were public or government-owned boreholes. This means that a large number of people in the study area have given up hope of getting pipe-borne water supply from the state water board agency and the few people that can afford, have sunk boreholes in their houses.

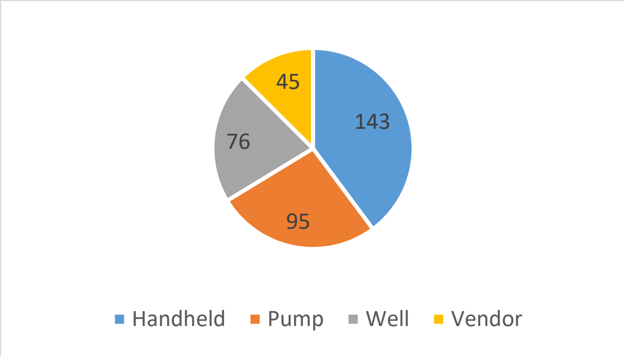

Figure 4: Water access
Source: Author's Analysis, 2021

From Figure 4, the majority of the respondents use the only handheld pump to get their water. This constitutes 143 degrees from the chart or 40%. The more wealthy individuals connect their boreholes to tap some inside the house, while others are inside and outside. This constitutes 95 degrees in the chart or 26%. Those that use or have access to well were 76 degrees in the chart or 21% and those that use other sources like buying from water vendors and harvesting it for free when it rains (during a rainy season) were 45 degrees in the chart or 13%. It can be deduced that, even among the owners of boreholes, some are philanthropists as they connect their boreholes with tap outside to help the general public. This is quite commendable, religious, and African behavior of helping humanity. Additionally, well was also used in the study area which constitutes a large part of the water use 76 representing 21%. This agrees with the introductory part where it was stated the two major sources of safe groundwater are well and borehole.

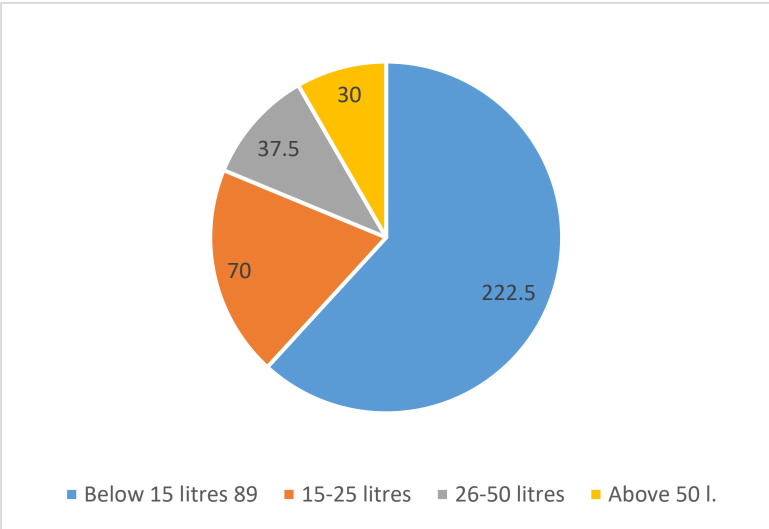

Figure 5: Quantity of water per capita per person
Source: Author's Analysis, 2021

From Figure 5, the majority of the respondents 223 degrees in the chart and representing 61% use less than 30 liters per day. And few respondents 30 degrees in the chart, representing 8% use above 100 liters per day. This indicates that the majority of people manage or use inadequate water for domestic uses. According to Spain National Statistics Institute (2012), the average household water consumption was 137 liters per capita per day. Although this figure might be higher than WHO standard, which requires 100 liters per day, but the water used in Samaru falls far below the WHO recommendation. WHO uses certain yardsticks for estimating water needs. Basic needs according to WHO are: drinking, eating, hand washing, and basic hygiene, but ignoring bathing and laundry have a serious repercussion. And this is often experienced in the study area. Additionally, variation in season affects the water per capita per person. In dry season, the water table is high and water inside boreholes and wells are more available therefore domestic consumption increases. In the dry season, wells get dried up and consumption level does not commensurate with demand, yet people have to manage with the little quantity they get. This corroborates with the findings of Ibrahim, Memon, & Buttler, (2020).

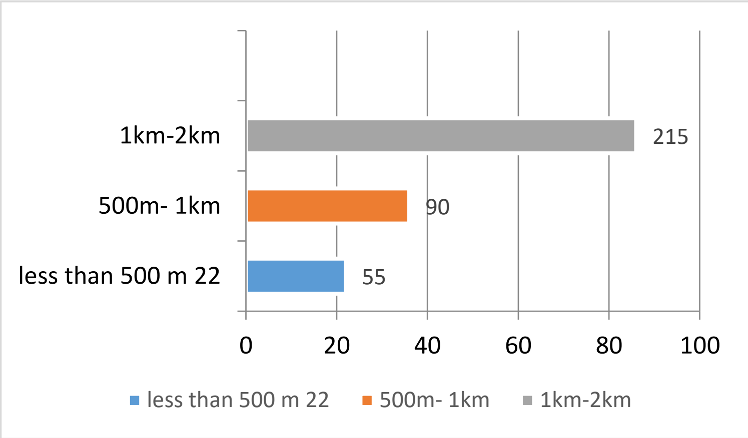

Figure 6. Distance from house to a water source
Source: Author's Analysis, 2021

From Figure 6, the result revealed that the majority of the respondents 215 degrees in the chart or 59% cover a distance of between 1-2 km to get water for domestic use. Only 55 degrees representing a paltry 15% cover a distance of fewer than 500 meters to get their water. This is grossly problematic as it falls too short beyond the WHO standard. The WHO standard recommends that basic access that includes: drinking, eating, hand washing, and personal hygiene should be within the distance of 1000 meters or 1 km or 20 minutes away from the house to find water and the water must reach at least 20 liters. Intermediate access is where people should have at least 50 liters within a distance of 100 meters or five (5) minutes. This covers laundry and bathing. And basic access allows the consumption of 100 liters per capita per day.

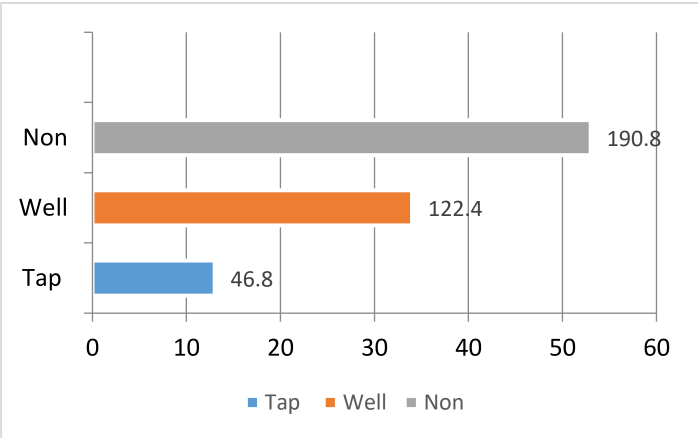

Figure 7. borehole and alternative sources
Source: Author's Analysis, 2021

From Figure 7, the result revealed that the majority of the respondents 191 degrees representing 53% use hand pump borehole without tap in it. 47 degrees representing 13% have their boreholes connected to boreholes or get their water from Ahmadu Bello University's tap. 122 degrees or 34% of the respondents use well water. This means that, although borehole is the major source of water supply in the study area and despite that well get dried up in dry season as seen during data collection, well water is still a force to be reckoned with in the study area.

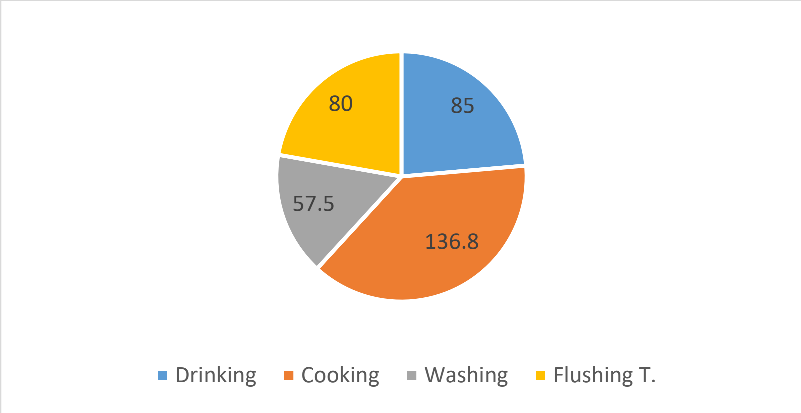

Figure 8. Uses of water
Source: Author's Analysis, 2021

From Figure 8, 137 degrees in the chart represent 38%, and the majority, use water for cooking, while 58 degrees in the chart represent 16%, the minority was used for washing. Flushing was 80 degrees representing 22% while drinking was 85 degrees, representing 24%. This means that although the water used in the study area was to a large extent safe, not everybody used it for drinking as the number of responses on cooking recorded the highest responses. It is understandable that cooking can get the highest responses because in cooking, boiling of the water is involved that kills any germ or any contaminant that might be in contact with the water. Water sources like this were reported to have caused water-borne diseases (Bezuidenhout, 2013; UNICEF, 2009).

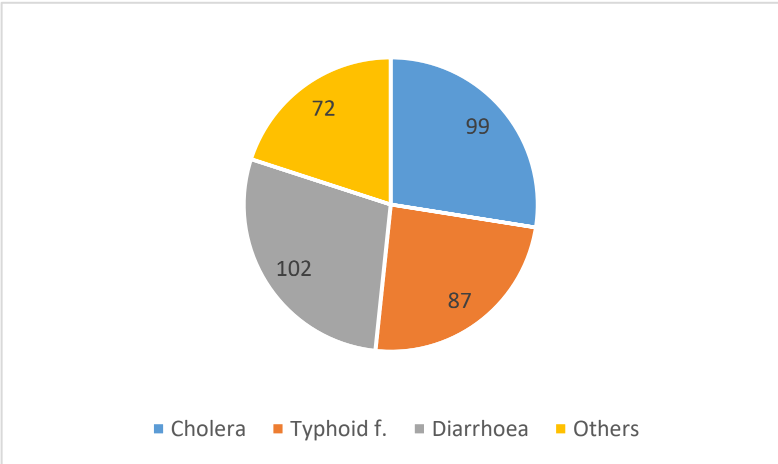

Figure 9. Uses of water
Source: Author's Analysis, 2021

From Figure 9, 102 degrees representing 28%, said the most common borehole disease was diarrhea, 99 degrees representing 27% said the most common disease in borehole water was cholera, 87 degrees representing 24% attributed the borehole disease to typhoid fever and 72 degrees representing 20% of the responses said, there were other diseases caused by borehole water. This corroborates the findings of Bezuidenhout (2013).

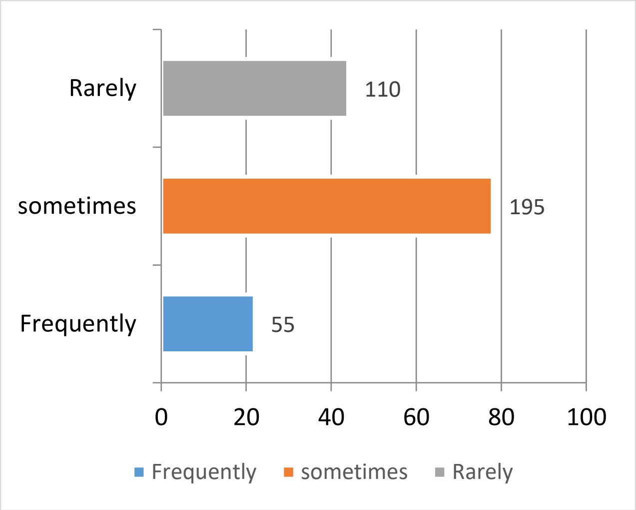

Figure 10. Uses of water
Source: Author's Analysis, 2021

From Figure 10, the result revealed that majority of the respondents 195 degrees representing 54% said mechanical fault occur sometimes, the minatory of the respondents 15% said mechanical fault frequently occur. This means that it occur and need repairs from time to time. This agrees with the findings of Cuss and Holloway (2003).

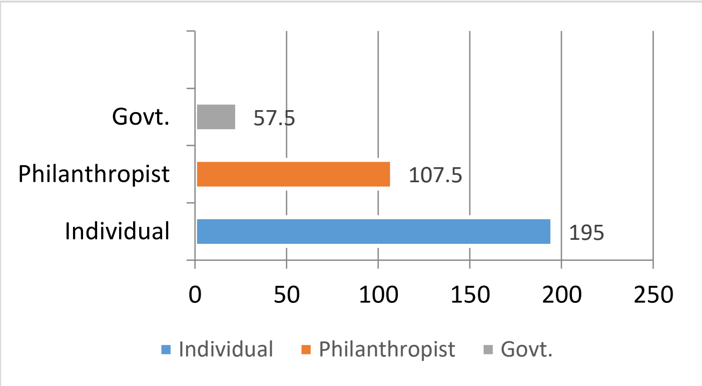

Figure 11. Borehole Managers

From Figure 11, the result revealed that the majority of the borehole management or repairs are handled by the individual owners as represented by 195 degrees (54%). Philanthropists and community leaders play a big role in maintaining government-built boreholes according to the respondents. They represent about 30% or 107 degrees responses. Where the level of damage or fault is beyond the community, government plays its part as recorded by 57.5 degrees which is equivalent to 16%.

Hypothesis Testing

Table 9. Pearson Product Moment Correlation Coefficient on Impact of Borehole on Water Accessibility in Samaru Community

Variables	**N**	Mean	SD	r	P
Borehole water	144	11.8	3.1	-.671	.0001
water accessibility	144	7.4	3.4		

Table 9 reveals that a significant inverse relationship exists between borehole presence or provision and water accessibility in Samaru Community. r=-.671 and p=.0001. This is because the p-value .0001 is less than 0.05 level of significance. The correlation coefficient reveals that the lower the number of boreholes, the higher the inaccessibility of water in Samaru Community and vice-versa. Thus, the hypothesis which states that there is no significant impact of borehole water in Samaru Community of Zaria metropolis, Kaduna State, Nigeria, is hereby rejected.

5. Conclusion

Handheld boreholes are one of the most common water supply techniques used not only in rural areas but also in urban areas in Nigeria and beyond. However, most of the boreholes usage do not comply with World Health Organization standards. Additionally, there are mechanical problems encountered with some of the boreholes due to overstretching. When the boreholes develop any fault, many users suffer especially in the dry season when there are few or no alternative sources. Samaru neighborhood of Zaria metropolis is not exempted. Additional findings in the study revealed that there are many individual borehole ownership owing to the persistent water scarcity and lack of regular pipe-borne water supply from the state government water providers. Distance to the borehole reduces per capita water consumption, likewise household size in addition to variation in seasons. Although borehole water is the major source, well water is still an alternative source in the area, especially during the rainy season. The study also found that some water-borne diseases like cholera, typhoid fever, and diarrhea were found to be affecting some consumers. There are philanthropists and good Samaritans in the study area that connected tap with their boreholes and place them outside for public use. Some residents do not use it for drinking but for other domestic purposes.

Recommendations

1. There is the need of engaging professional repairs to address technical and mechanical faults whenever there is a fault. Using repairs with low experience only addresses short time problems.
2. There is the need for government to provide more boreholes to reduce the distance of those consumers that cover a distance of up to a kilometer or beyond to get water. This is called safe distance. In doing so, solar-powered boreholes should be provided because they are easier to operate and have the capacity to produce a higher amount of water at once than hand pump boreholes. Samaru community has a vast solar potential, a similar Dubai/UAE technology that provides 1.5 million liters of water per day could be adopted. This is a massive project that can provide water beyond Samaru community with huge storage facilities. Government(s) can partner with international donors, World Health Organizations, and so on. A smaller one than that of Dubai could be provided. This capital-intensive project requires intensive solar paneling or solar energy but is the best and most appropriate technology with little or no-fault.
3. The frequent vandalization and theft of borehole water scheme components have been militating against the smooth operation and maintenance of water supply facilities. Thus, there is the need to provide extra security measures and components to the borehole facility in order to ensure the safety and sustainability of the water scheme. A community can do this through a self-support mechanism.
4. The most plausible causes of these borehole failures can be attributed to (i) Design, Location, and Construction (ii) Groundwater potential/hydrogeological consideration, and (iii) Operational and maintenance factors. It is possible for one factor to lead to the other. For example, a borehole poorly designed, constructed, and completed could result in sand/clay pumping and eventually affect the rubber seals in the hand pumps or the impellers in the case of submersible pumps.
5. Since there are some cases of reported water-borne diseases, there is the need to send inspectors to ensure that the anthropogenic activities unhealthy to the water provision are stopped at boreholes sites. That could be the location of septic tanks, soak ways, gutters, and a host of others that could contaminate the water. Regular water quality assessments and treatment of water contaminants should also be conducted by health experts.

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