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Access to Safe Drinking Water in Developing Countries: A Comparative Analysis of the Urban and Rural Areas of Zaria, Kaduna State, Nigeria

[1]*IDUSERI, EO; [2]ABBAS, II; [3]IZUNOBI, JU; [4]OGEDEGBE, SO; [5]OGBONNA, DO

[1]*Department of Environmental Science, National Open University of Nigeria, Abuja, Nigeria*
[2]*Department of Geography, Kaduna State University, Kaduna, Nigeria*
[3]*Department of Chemistry, University of Lagos, Akoka-Yaba, Lagos, Nigeria*
[4]*Department of Geography, College of Education, Igueben, Edo State, Nigeria*
[5]*Department of Geography & Environmental Management, Ahmadu Bello University, Zaria, Kaduna State, Nigeria*
**Corresponding Author Email: iemily@noun.edu.ng*

ABSTRACT: Water is a "*sin qua non*" for virtually all human activities; a pre-requisite for sustainable development as the consequences of safe water for health, productivity and quality of life as well as implications for economic development are enormous. This study investigated the sources of water supply and challenges faced by inhabitants in accessing these water sources in three districts each of urban and rural Zaria, Nigeria, and compared the results. Descriptive statistics and average mean score (AMS) technique was applied, and requisite data presented in frequency and percentage tables. The results revealed that the urban dwellers had to travel longer distances, than the rural dwellers, to source water and that the sources of water supply varied with the season. Whilst the urban areas accessed wells and water vendors in the wet and dry seasons, respectively, for non-domestic water supply and water vendors for domestic water supply; all year round, residents of the rural areas sourced non-domestic water supply from rainfall in the rainy season and streams in the dry season. Conversely, wells and water vendors were accessed in the wet and dry seasons, respectively, for rural domestic water supply. The corollary is that water vendors and wells are the predominant sources of water in Zaria, Nigeria. The methods of water purification employed by the communities sampled and their challenges to safe and adequate water supply are discussed; and plausible solutions are proffered. In addition, some recommendations to mitigate poor access to water are also volunteered.

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Water is, undoubtedly, the *sine qua non* of life and has, from time immemorial, been a decisive factor in man's survival in terms of economic and social activities, including farming and animal husbandry, domestic consumption and, to some extent, transportation, etc. (Ahile *et al.*, 2015). Water can be also described as the lifeline of the biosphere but it is not uniformly distributed and demand for it remains greater than the available supply in many regions of the world (Falkenmark and Rockstrom, 2004). Nevertheless, an adequate, reliable, clean, accessible, acceptable and safe source of water supply should be available (Bos *et al.*, 2016). In the developing world, water infrastructure is poor and many people do not have access to potable water and where available, clean and safe drinking water is inadequate for human consumption and other uses, such as for domestic and agricultural purposes (Cosgrove and Loucks, 2015). Consequently, in as much as water is an essential component of the planetary life support system, water deficiency constitutes an insecurity that has to be overcome in the process of socio-economic development (Falkenmark, 2013). The problem of potable water shortage has become a source of concern in the world; locally and globally, underpinned by the United Nations Sustainable Development Goals 6 (SDG-6) geared at providing access to clean drinking water for all and highlighting its importance to hygiene and the prevention of diseases (www.un.org). Despite these, inequalities remain in accessing safe drinking water in the world (Schyns *et al.*, 2015). In some countries, sufficient freshwater is not available (physical scarcity) whereas in other countries, abundant freshwater is available but expensive to use (economic scarcity). According to the World Bank (1996), about 80 countries suffer water shortages and this is reflected in their health and economies whereas more than two billion people have no access to clean water (UNESCO, 2016). Water is necessary to support socio-economic activities and maintain healthy ecosystems. In Nigeria, water scarcity existed as far back as the pre-colonial period when people had to

**Corresponding Author Email: iemily@noun.edu.ng*

migrate from one part of the country to another in search of water. It is notable that only 27.4% of the total population of the country had access to improved water supply in 1974; with the rural population accounting for not more than 0.30% (Nura and Sabo, 2011). Water shortages are due to a mismatch between demand for water and its availability. Throughout history, many communities have adapted to water shortages by transforming terrestrial water systems (L'Vovich *et al.*, 1990). In many places, water scarcity increases as water systems are subjected to rises in pollution and exploitations (Postel *et al.*, 1996; Postel, 2000). People in the slums of developing countries are reported to, typically, pay 5–10 times more per unit of water than people, in the urban areas, with access to pipe-borne water (Xu and Usher, 2006). Water scarcity is a relative concept and can occur at any level of supply or demand (UN-Water, 2006). For an individual to be water secure, for instance, the individual needs about 1200 m^3 of water per annum (Allan, 2010). Scarcity may also be a social construct (a product of affluence, expectations and customary behaviour) or the consequence of altered supply patterns, stemming from climate change (UN, 2011). Ahile *et al.* (2015) conducted a study on the coping strategies of residents with water scarcity in Makurdi town, Nigeria and their data revealed an estimated total household water demand of 127,600 litres per day relative to the available supply of 40,520 litres per day; with a shortfall of 87,080 litres per day translating to about 68.2% of the water demand remaining unsupplied. Bello and Tuna (2014) also evaluated the demand and supply of portable water in Kano, Nigeria by collecting secondary data from several water supply-related institutions and determined that water supply in Kano did not meet demand due to insufficient numbers of water treatment plants, power failure and shortage of funds, amongst others.

This study assesses the sources, spatial distribution and water availability as well as quantifies the demand, supply and consumption per household in the urban and rural areas of Zaria, Kaduna State, Nigeria.

MATERIALS AND METHODS

Description of the study area: Zaria (Zazzau) in Kaduna State is located on the vast undulating plains of Northern Nigeria (Figure 1). It presently cuts across four local government areas, viz: Sabon-Gari, Zaria, Giwa and Soba, and it is located at latitude 11º 5' 82" N and longitude 7º 43' 12" E. Zaria experiences two distinct (wet and dry) seasons, which are caused by the movement of the Inter-Tropical Discontinuity (ITD) under the influence of two major air masses namely the tropical continental (cT) and tropical maritime (mT). It has a mean annual rainfall of about 800 mm, mainly witnessed in the wet season (April–October), with temperatures ranging between 21–29 ºC throughout the year (Yakubu, 2013). Zaria is drained majorly by the Galma River with three other rivers as its tributaries: Rivers Kubanni, Shika and Saye.

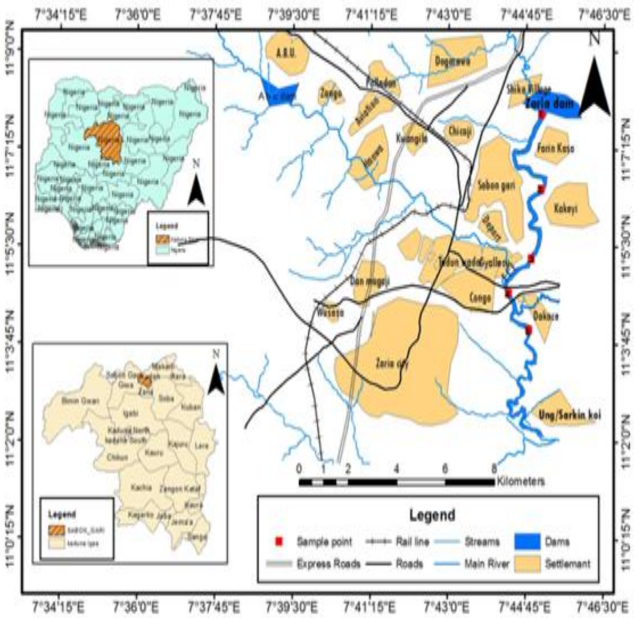

Fig 1: Map of Zaria (Adapted from the Administrative Map of Kaduna State, 2019)

The estimated total population of Zaria in 2019 was 719,000 (WPR, 2021). The growth of the region is attributed partly to history and the establishment of higher educational institutions, such as Ahmadu Bello

University, College of Aviation Technology, Federal College of Education and other research institutes as well as industries, such as the Nigerian Tobacco Company and Nigerian Oil Mills. Zaria is made up of four distinct residential and commercial areas: the old walled city, the Colonial Township or Sabon-Gari, Tudun-Wada and Samaru. It also consists of many rural settlements; with predominant socio-economic activities of farming and cattle rearing. The old city has served as a political, administrative and market centre for several years and the chief expression of these functions are linked with the Emir's palace.

Data collection and analysis: The data required for the study were collected from primary and secondary sources. Questionnaires and interviews were the instruments for eliciting information. The questionnaire was prepared with answer options in a 5-point Likert scale, delineated in Table 1. The questionnaire elicited information on the social and demographic characteristics of respondents as well as the four research questions raised herein. Detailed and guided interviews were also used to get necessary and basic information where necessary. The data was analysed statistically and null hypotheses were tested at the end of the investigation to address the research questions.

Table 1: Likert scale

Option	Code	Point
Strongly Agree	SA	5
Agree	A	4
Disagree	D	3
Strongly Disagree	SD	2
Undecided	UD	1

Data are presented in frequency and percentage tables. The average mean score (AMS) technique was used to test the hypothesis. The derived value (DV) was obtained from the average of all the scale points (1–5) thus:

$$\mathrm{DV} = \frac{5+4+3+2+1}{5} = \frac{15}{5} = 3$$

The computed value was obtained from a summation of the frequency multiplied by the scale point and divided by the summation of the frequency, according to equation 1.

$$\mathrm{CV} = \frac{\sum fx}{\sum f} \qquad (1)$$

where f = frequency and x = scale point

The computed values (CV) were also compared to the derived values (DV) of 3.0. When CV is greater than DV, then the answer was regarded as positive but negative when CV is less than DV. Similarly, null hypotheses were rejected when CV was greater than DV, and accepted when CV was less than DV.

RESULTS AND DISCUSSION

The sample size for the respondents in the selected three urban and rural areas each of Zaria was calculated as 384 at a 95% confidence level and 5% margin of error (Krejcie and Morgan, 1970), based on a total population of 719,000 (WPR, 2021) but was rounded-up to a sample size of 400, for this study. The questionnaires were distributed and retrieved as shown in Table 2. Tudun-Wada got the highest number of respondents of 160 whereas Sakadadi had 12 participants. It is worthy of note that the more populated areas of Tudun-Wada, Sabon-Gari and Samaru are urban settlements while the less densely populated areas of Kuffena, Wusasa and Sakadadi are rural.

Table 2: Distribution of questionnaires based on the population of selected communities in the study area

Community	[a]Total Population	Sample Selection
Samaru	162,519	70
Sabon-Gari	56,175	93
Tudun-Wada	436,811	160
Kuffena	28,886	40
Wusasa	17,737	25
Sakadadi	16,872	12
Total	**719,000**	**400**

[a] Source: www.macrotrends.net (Nigeria Metro Area Population 1950–2020)

In Table 3, a breakdown of the social demographics of the respondents involved in the study is enumerated. The analysis showed that there were more females (58%) than males and more indigenes (53%) than non-indigenes. Conversely, 70% of the respondents were married with more than one-third of the households catering for 10–14 persons. Almost 50% of the people sampled had tertiary education whereas close to 80% were in the 29–49-year age bracket. The relatively high numbers of post-primary and tertiary education level respondents were attributed to the university towns of Samaru and Tudun-Wada. This is also a pointer to the robustness of the responses received. Table 4 shows the distances travelled by Zaria residents to access water in the dry and wet seasons, respectively. It indicates that the respondents in the urban areas travelled distances of between 1–5 km, or over, occasionally, to get water in the dry and wet seasons whereas those in the rural areas did not have to travel as far because of nearby natural sources, such as rivers and streams. In rural areas, for instance, the respondents in Kuffena travelled < 4 km in the rainy season but > 4 km in the dry season. The situation is similar across the rural areas, where longer distances were, explicably, travelled in the dry season, to access water. Relatively longer distances were travelled in both rural and urban communities in the dry season. Whilst close to 50% of the residents in the Zaria area travelled less than 1 km in the rainy season, over 50% travelled up to 2 km, in dry season, to access water. This is attributable to the scarcity of water typically experienced in the dry season, where alternative non-natural sources of water do not exist (UN-Water, 2007). Ezenwaji *et al.* (2014) has highlighted a Federal Ministry of Water Resources' 2008 survey, which showed that about 80% of residents in Nigeria lacked access to improved drinking water. The global assessment of water supply and sanitation data describes reasonable access to water as being the availability of at least 20 litres per person per day from a source within 1 km of the user's dwelling (Ward and Robinson, 2000; WHO/UNICEF, 2000).

Table 3: Demographics of the respondents

	Frequency	Percentage (%)		Frequency	Percentage (%)
Sex			**Household Size (persons)**		
Female	230	58	> 5	70	17
Male	170	42	5–9	50	13
Total	400	100	10–14	140	35
Age (years)			15–19	100	25
18–28	60	15	20–29	40	10
29–39	150	38	Total	400	100
40–49	160	40	**Level of Education**		
> 50	30	7	None	30	7.5
Total	400	100	Quran School	40	10
Marital Status			Primary School	30	7.5
Married	280	70	Post-Primary School	120	30
Single	50	13	Tertiary Education	180	45
Divorced	40	10	Total	400	100
Separated	30	7			
Total	400	100			
Habitation Status					
Indigene	212	53			
Migrant	188	47			
Total	400	100			

This however does not mean that 20 litres per person per day is a recommended quantity of water for daily use. Oyebande (2001) has opined that an assured supply of water, both qualitatively and quantitatively, for the purposes of consumption, hygiene and amenity use, greatly improves the social and economic activities of people. As a result, water supply and its efficient use and sustainability are of grave importance to any nation, especially the LMICs. Table 5 shows the daily water demands of the communities in the Zaria study area. As expected, the urban communities made more demands on water than the rural communities. This may be attributable to the larger population in the urban area but it must be recalled that they also travelled longer distances (*cf.* Table 4) and may be, therefore, hoarding. Similarly, the demand was generally higher in the dry season. It is interesting to note that whilst 151–200 litres were the minimum daily water demand in the rural areas, two of the urban communities sampled made a daily demand of less than 50 litres. The different water sources in the Zaria area are collated in Table 6. More residents accessed streams, taps, burrow pits, water trucks and water vendors in the dry season whereas wells, boreholes and rainfall were the main sources of water for the rural and urban communities in the wet season. It is also interesting to note that while more urban dwellers relied most on water vendors for water, most respondents in the rural settlements relied on rainfall. Nonetheless, wells are an important source of water, in the rainy season, in both rural and urban areas. Pertinently, well water was the only source of water available all year around in all the communities sampled. It is also notable that respondents reported that water was not collected from rainfall and burrow pits in the dry and wet seasons, respectively. Furthermore, Sabon-Gari residents accessed boreholes more in the dry season than wet season; contrary to what was observed in the five other settlements. Residents of Wusasa and Sakadadi reported that they lacked boreholes and tap water, with Sakadadi also unable to access water trucks. Surprisingly, Sakadadi, Sabon-Gari and Tudun-Wada residents did not get water from the streams in the rainy season whereas water vendors and trucks did not provide water in Kuffena in the wet season. In addition, Samaru, Kuffena and Wusasa accessed streams in both seasons. In the rural areas, tap water and burrow pits did not deliver water in the wet season whereas streams, wells, burrowed pits and water vendors provided water during the dry season. The data for domestic water supply in the Zaria area is shown in Table 7.

Table 4: Distances to sources of water supply

Distance (Km)	**Urban Communities**								**Rural Communities**								**Total**	
	Samaru		**Sabon-Gari**		**Tudun-Wada**		**Sub-Total**		**Kuffena**		**Wusasa**		**Sakadadi**		**Sub-Total**			
	DS	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**
≤ 1.0	10	30	33	40	52	84	95	154	4	20	2	14	0	6	6	40	101	194
1.1–2.0	20	22	20	23	24	38	64	83	6	9	3	3	0	3	9	15	73	98
2.1–3.0	10	10	11	16	36	25	57	51	13	7	3	2	2	3	18	12	75	63
3.1–4.0	12	4	15	8	35	6	62	18	7	4	4	2	2	0	13	6	75	24
4.1–5.0	10	2	8	4	9	3	27	9	2	0	6	2	4	0	12	2	39	11
≥ 5.0	8	2	6	2	4	4	18	8	8	0	7	2	4	0	19	2	37	10

*DS = Dry season, WS = Wet season

Table 5: Water demand per day in the study area

Capacity (Litres)	**Urban Communities**								**Rural Communities**								**Total**	
	Samaru		**Sabon-Gari**		**Tudun-Wada**		**Sub-Total**		**Kuffena**		**Wusasa**		**Sakadadi**		**Sub-Total**			
	DS	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**
< 50	0	0	2	1	1	3	3	4	0	0	0	0	0	0	0	0	3	4
51–100	5	10	12	18	4	10	21	38	0	0	0	0	0	0	0	0	21	38
101–150	15	20	20	20	13	15	48	55	0	0	0	0	0	0	0	0	48	55
151–200	12	19	26	25	16	34	54	78	4	8	3	3	0	0	7	11	61	89
201–250	26	11	31	23	73	50	130	84	20	18	4	8	2	4	26	30	156	114
251–300	9	8	2	6	39	38	50	52	14	12	16	12	10	8	40	32	90	84
> 300	3	2	0	0	14	10	17	12	2	2	2	2	0	0	4	4	21	16
Total	**70**		**93**		**160**		**323**		**40**		**25**		**12**		**77**		**400**	

*DS = Dry season, WS = Wet season

Table 6: Sources of water supply

Communities	**Streams**		**Well**		**Bore Hole**		**Rain**		**Tap**		**Burrow Pits**		**Water Trucks**		**Water Vendor**		**Total**	
	DS	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**
Urban																		
Samaru	10	3	10	3	10	20	0	8	5	5	3	0	12	11	20	20	70	70
Sabon-Gari	8	0	8	50	7	4	0	18	5	5	0	0	30	7	34	9	93	93
Tudun-Wada	12	0	20	70	10	30	0	20	8	8	0	0	25	18	85	14	160	160
Sub-Total	30	3	38	123	27	54	0	46	18	18	3	0	67	36	139	43	323	323
Rural																		
Kuffena	8	4	5	10	6	12	0	14	2	0	4	0	6	0	9	0	40	40
Wusasa	8	3	3	8	0	0	0	10	0	0	5	0	3	2	6	2	25	25
Sakadadi	6	0	2	6	0	0	0	6	0	0	2	0	0	0	2	0	12	12
Sub-Total	22	3	10	24	6	12	0	30	2	0	11	0	9	2	17	2	77	77
Total	**52**	**10**	**48**	**147**	**33**	**66**	**0**	**76**	**20**	**18**	**14**	**0**	**76**	**38**	**156**	**45**	**400**	**400**

*DS = Dry season, WS = Wet season

Table 7: Sources of domestic water supply (Cooking and Drinking)

Communities	Streams		Well		Bore Hole		Rain		Tap		Burrow Pits		Water Trucks		Water Vendor		Total	
	DS	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**	**DS**	**WS**
Urban																		
Samaru	0	0	0	6	16	10	0	8	4	8	0	0	20	20	30	18	70	70
Sabon-Gari	0	0	8	8	18	10	0	28	10	10	0	0	27	17	30	20	93	93
Tudun-Wada	0	0	20	30	50	15	0	25	10	24	0	0	30	30	50	36	160	160
Sub-Total	0	0	28	44	84	35	0	61	24	42	0	0	77	67	110	74	323	323
Rural																		
Kuffena	8	0	12	21	6	3	0	8	0	0	0	0	4	2	10	6	40	40
Wusasa	8	0	4	12	0	0	0	7	0	0	0	0	4	3	9	3	25	25
Sakadadi	2	0	4	9	0	0	0	0	0	0	0	0	3	0	3	3	12	12
Sub-Total	18	0	20	42	6	3	0	15	0	0	0	0	11	5	22	12	77	77
Total	**18**	**0**	**48**	**86**	**90**	**38**	**0**	**76**	**24**	**42**	**0**	**0**	**88**	**72**	**132**	**86**	**400**	**400**

**DS = Dry season, WS = Wet season*

Table 8: Methods of purifying unsafe water

Method	Urban Communities				Rural Communities				Total
	Samaru	**Sabon-Gari**	**Tudun-Wada**	**Sub-Total**	**Kuffena**	**Wusasa**	**Sakadadi**	**Sub-Total**	
Use of Alum	10	15	10	35	3	3	3	9	41
Boiling	28	48	100	176	20	11	5	36	212
Filtration	18	17	37	72	13	9	4	26	98
Decantation	6	9	8	23	4	2	0	6	29
Use of iodine solution/tablets/crystals	0	0	0	0	0	0	0	0	0
Use of chlorine	8	4	5	17	0	0	0	0	17
Use of ultraviolet light	0	0	0	0	0	0	0	0	0
				323				**77**	
Total	**70**	**93**	**160**		**40**	**25**	**12**		**400**

Table 9: Challenges to water supply in the study area

Parameter	Urban Communities								Rural Communities							Remark	Decision
		SA	**A**	**D**	**SD**	**U**	**Σ**	**CV**	**SA**	**A**	**D**	**SD**	**U**	**Σ**	**CV**	**DV = 3**	
Finance	*f*	130	80	60	48	5	323		47	13	7	5	5	77			
	fx	650	320	180	96	5	1251	3.87	235	52	21	10	5	323	4.19	CV > DV	1
Distance	*f*	165	94	40	20	4	323		50	18	4	3	2	77			
	fx	825	376	120	40	4	1365	4.22	250	72	12	6	2	342	4.44	CV > DV	1
Season	*f*	200	70	30	18	5	323		68	5	2	1	1	77			
	fx	1000	280	90	36	5	1411	4.36	340	20	6	2	1	369	4.79	CV > DV	1
Lack of maintenance	*f*	149	99	53	19	3	323		51	12	7	5	2	77			
	fx	745	396	159	38	3	1314	4.15	255	48	21	10	2	336	4.36	CV > DV	1
Inadequate government funding	*f*	230	61	18	8	6	323		51	12	7	5	2	77			
	fx	1150	244	54	16	6	1470	4.55	255	48	21	10	2	336	4.36	CV > DV	1
Unseriousness of Water	*f*	192	80	30	16	5	323		60	10	3	2	2	77			
Cooperation Staff	*fx*	960	320	90	32	5	1407	4.35	300	40	9	4	2	355	4.61	CV > DV	1
Damaged pipes	*f*	67	54	146	48	8	323		30	12	33	3	2	77			
	fx	335	216	438	96	8	1093	3.38	150	48	99	6	2	305	3.96	CV > DV	1
Non-functional boreholes	*f*	183	80	47	13	0	323		52	13	7	5	0	77			
	fx	915	320	141	26	0	1402	4.34	235	52	21	10	0	318	4.12	CV > DV	1
Corruption	*f*	278	45	0	0	0	323		70	7	0	0	0	77			
	fx	1390	180	0	0	0	1570	4.86	350	28	0	0	0	378	4.90	CV > DV	1
Untrained Staff	*f*	187	97	21	10	8	323		45	19	8	4	1	77			
	fx	935	388	63	20	8	1414	4.37	225	76	24	8	1	363	4.71	CV > DV	1
Meeting water demands is easy	*f*	2	5	15	301	0	323		0	0	1	76	0	77			
	fx	10	15	45	602	0	672	2.08	0	0	3	152	0	155	2.01	CV < DV	0

Table 10: Measures to ameliorate the challenges of water supply in study area

Measure	Communities								Remark	Decision
		SA	A	D	SD	U	Σ	CV	DV = 3	
Adequate funding	*f*	192	123	60	23	2	400			
	fx	960	492	180	46	2	1680	4.2	CV > DV	1
Proactive maintenance and preventive	*f*	150	100	80	60	10	400			
measures	*fx*	750	400	240	120	10	1520	3.8	CV > DV	1
Training and retraining of Staff	*f*	111	79	119	63	28	400			
	fx	555	316	357	126	28	1382	3.5	CV > DV	1
Proper security at equipment sites	*f*	187	123	53	27	10	400			
	fx	935	492	159	54	10	1650	4.1	CV > DV	1
Sensitization on how to use provided	*f*	192	123	60	20	5	400			
facility	*fx*	960	492	180	40	5	1677	4.2	CV > DV	1
Provision of pipe-borne water	*f*	250	99	37	10	4	400			
	fx	1250	396	111	20	4	1781	4.5	CV > DV	1
Subsidized water rate	*f*	129	140	67	54	10	400			
	fx	645	560	201	108	10	1524	3.8	CV > DV	1
Provision of clean water	*f*	300	100	0	0	0	400			
	fx	1500	400	0	0	0	1900	4.8	CV > DV	1
Provision of functioning boreholes	*f*	183	169	32	16	0	400			
	fx	915	676	96	32	0	1719	4.3	CV > DV	1
Meeting water demand is easy	*f*	5	10	30	355	0	400			
	fx	25	40	90	710	0	865	2.1	CV < DV	0

SA: Strongly Agree, A: Agree, D: Disagree, SD: Strongly Disagree, U: Undecided, CV: Computed Value, DV: Derived Value; 0 = Measure DOES NOT ameliorate, 1 = Measure ameliorates; ***Σ*** *= summation.*

Table 11: Hypothesis testing table

Subject Matter	Null Hypothesis	CV	Decision	Answer to Research Question
Challenges of regular water supply	There is no significant difference in the challenges to the regular supply of water between urban and rural areas in the study area	4.1	Reject null hypotheses	There are significant challenges to regular supply between urban and rural areas in the study area.
Meeting water demands	There are no significant differences in challenges to meeting the water demands in the study area.	2.1	Accept null hypothesis	There are no significant differences in challenges to meeting the water demands between urban and rural areas in the study area
Measures taken to ameliorate inadequate supply	There is no significant difference in measures to mitigate the challenges to unsafe water supply between urban and rural areas in the study area.	3.8	Reject null hypothesis	There are significant differences in measures employed to mitigate the challenges of unsafe water supply between urban and rural areas in the study area
Seasonality challenges to safe water.	Seasonality did not affect the availability of safe water in the study area.	4.3	Reject null hypothesis	Seasonality affects the availability of safe water between urban and rural areas in the study area

None of the communities sampled used water sourced from burrow pits for domestic purposes but all obtained their water for drinking and cooking from water vendors in both dry and wet seasons. Conversely, water from streams and taps were not accessed domestically in the urban and rural areas, respectively. Wells and water trucks were also reported as good sources of domestic water supply all year round, except in Samaru and Sakadadi, in the dry and wet seasons, respectively. In the three urban communities, bore holes and taps were reliable sources of domestic water in both seasons whereas the same could be said for water sourced from bore holes for Kuffena but not Wusasa and Sakadadi, which lacked bore holes. None of the three rural communities assessed water from streams in the rainy season. Neither could they assess tap water in either of the seasons because taps were not installed. Expectedly, none of the communities were able to access water for domestic purposes from rainfall in the dry season instead water vendors emerged as the prominent source. Remarkably, well water was most used in the rural areas during the wet season while the water vendors prevailed in the urban areas. In view of the unsafe nature of most of the water sources in the communities under study, the different methods of purification employed by the residents were examined and collated in Table 8. The results indicated that both urban and rural settlements in Zaria used similar methods, such as alum coagulation, boiling, filtering and decanting, to purify water for domestic uses. However, the chlorination method was found among the urban dwellers whereas the use of iodine or ultraviolet light was not reported. Boiling was the most common method of purification employed by the residents followed by filtration. The challenges facing the supply of water to the residents in the study area were also examined (Table 9). Salient parameters, such as finance, distance to water sources and corruption, etc., were investigated to determine if they were aiding or abating access to water supply in the area. The results showed that the respondents thought that all the parameters examined were challenging and could therefore affect water supply

Both urban and rural settlements were in agreement that meeting water demands was not easy (CV = 2.08 & 2.01) and that corruption was a big challenge (CV = 4.86 & 4.90). This is exemplified by the unavailability of government bore holes in bore hole designated areas. The urban and rural communities opined that inadequate government funding and seasonal fluctuations were the next challenging parameters to water supply, respectively; next to corruption. Ocheri (2006) found that, in Nigeria, water scarcity was common, and attributed it to an unreliable, intermittent and, in most cases, inaccessible public water supply. This results in a high dependency on unsafe supplementary sources of water supply, which are susceptible to water-borne diseases, such as dysentery and cholera. Finance posed a challenge to water supply in urban and rural areas sampled because most of the respondents were not financially empowered to sink personal boreholes and therefore resorted to water hawkers, popularly known as "*Mai Ruwa*", who peddled their wares in 20-litre containers. Equally challenging to all the communities was the distance to and from the sources of water as many of them surpassed the WHO's (2014) maximum benchmark of 1 km as well as the 30-minute prescribed benchmark. The seasonality of water supplies also proved challenging to both urban and rural dwellers as the shortage of water was typically more pronounced in the dry season.

It is instructive that both rural and urban respondents thought that damaged pipes were the least challenging of the parameters evaluated. Damaged pipes restrict water supply, which can lead to shortages and wastes. Nonetheless, burst pipes can serve as sources of water supply to some residents who converge at the sites of damage to collect water from such pipes. When the pipes go dry; without water, however, they typically collect debris and dirt, which block these pipes, causing further damage. Other concurrences between the urban and rural communities sampled included untrained staff, distance and lack of maintenance.

Respondents were also asked to agree or disagree with a selected number of measures geared towards ameliorating the challenges posed by inadequate water supply in the communities sampled. Their responses were weighed using the Likert scale and enumerated in Table 10. With all the computed values (CV) greater than the derived value (DV) of 3, it is logical to conclude that the measures outlined, if implemented, would improve water supply in the area under study. All the respondents agreed that the provision of clean water (CV = 4.8) was the best solution but, surprisingly, suggested that retraining staff (CV = 3.5) would not ameliorate the challenges of water supply in the study area.

In Table 11, the null hypotheses and answers to the research questions are tabulated. Three of the four null hypotheses were rejected based on their CV scores, which were > 3 and, therefore, significant. The null hypothesis on meeting water demands was the only one accepted, with a CV of 2.1; concluding that there were no significant differences in challenges to meeting the water demands between urban and rural areas in the study area. The data generated agrees that there were significant challenges to regular water supply and differences in the measures employed to mitigate the challenges of unsafe water supply between urban and rural areas in the study area. Seasonality was also shown to affect the availability of safe water between the urban and rural communities sampled in the study.

Conclusion

It has been shown that access to safe, potable water is fraught with many but similar challenges in both rural and urban communities of Zaria. The inadequate access to safe supply sources has led to residents seeking easy ways of purifying their water for domestic use. The adoption of proactive maintenance and preventive measures, proper security at water equipment sites and subsidized water rates to disadvantaged communities as well as the provision of adequate sensitization on facility usage, mechanism for the regular monitoring of water quality and a nationwide water quality database should augur well for access to safe and potable water.

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