

Appraisal of Potable Water Supply in Bida Niger State: Implications for Availability and Suitability for Drinking

Wali, S. U.^{1&2*}, Babangida, S. M.² and Gada, M. A.²

¹Department of Geography, Federal University Birnin Kebbi, Kebbi State, Nigeria.

²Department of Geography, Usmanu Danfodiyo University, Sokoto, Nigeria.

*Corresponding Author email: saadu.wali@fubk.edu.ng

ABSTRACT

Portable water supply systems undergo highly dynamic and conflicting societal demands and environmental pressures. Several fundamental and impending water crises are not essentially due to water scarcity or a lack of technical expertise but rather because of poor management and governance of available water resources and infrastructure. In this study, we assessed government effort in providing potable water in Bida. A total of 45 questionnaires were administered randomly, comprising of 12 questions, which are designed to obtain views of people regarding the research topic. Results showed that many people (49%) in Bida do not have potable water supply from a public source. Regardless of the challenges faced by the government, 49% of the residents receive very clean water. While 22% of the residents purify water before use, only 20% are willing to pay for the water supply. This is a terrible situation as it is a poor government/private partnership indicator. In addition, Several Samples ANOVA (Kruskal-Wallis test) was used to test the hypothesis that there is no significant difference between people's opinions regarding government effort in providing potable water in Bida. The result showed no significant difference between sample medians. However, this investigation covers only Bida. Consequently, a full investigation of government effort in potable water provision is suggested over broader spatial and temporal scales.

Keywords: Potable water; Reliability; availability; Adequacy; Billing; Tap; Borehole

1. INTRODUCTION

It is well established that access to drinking water is a precondition for recognising all human rights. The UN Committee on Economic, Social and Cultural Rights approved General Comment No. 15 on the right to water, which elucidates that the right to water means the right of all people to available, reachable, cheap, suitable, and safe water (and sanitation), for personal and for domestic uses (Vučijak, 2018). Some of these requirements are somewhat contradictory, and there is a need for balance. Availability implies that the amount of water supplied per person should be sufficient for all his/her personal and domestic use and is estimated at 50 to 100 litres per person per day (Vučijak, 2018). On the other hand, such a

water supply to be secured implies related costs, where the affordability limits these costs to a selected percentage of the average household income (Vučijak, 2018).

African urban population was projected to rise from 11.3% in 2010 to 20.2% in 2050, making African cities the second-fastest-growing cities in the world after Asian cities (Wessels, 2015; Ramírez et al., 2018). However, at least one-third of the urban inhabitants in the world live in slums (World Watch Institute, 2007; Ramírez et al., 2018). This implies that needy settlements, made up of families, lack one or more of the following conditions: access to improved water, access to improved sanitation facilities, structural quality and durability of

dwellings, and the security of tenure (Swilling and Annecke, 2013; Ramírez et al., 2018). In Nigeria, these disparities rose abruptly with increasing population and urban expansion. These have made it difficult for public water supply agencies to supply the required water.

Water systems are experiencing highly dynamic and conflicting societal demands and environmental pressures (Lieberherr and Ingold, 2019). The prevailing and looming water crises are not necessarily due to water scarcity or a lack of technical expertise but relatively poor management and governance of available water resources and infrastructure (Lieberherr and Ingold, 2019). The inability of current systems to address these issues has led to calls for increased coordination among key actors (Lieberherr and Ingold, 2019). Multiple public and private actors across different institutional levels, from local to international, play a role in water governance. However, typically 'Water Boards' have been delegated

Several studies on water supply were carried out in Nigeria, including Nwagbara et al. (2010), Okereke (2010), Madu (2010), Iliya and Gada (2010), and Wali et al. (2018). Most of these studies centred on problems including effects of climate change on water supply, the performance of water supply schemes and management of water supply schemes. Government agencies generally carry out a comprehensive study evaluating the efforts made by the government on water supply, and findings are often decorated. The actual inventory and functionality of water supply systems remained poorly reported. However, in many fast-growing towns like Bida, water supply is rarely related to population growth, urbanisation, and industrial demands. In addition, politics play an essential role in determining where the water supply system is located or constructed. Therefore, we upscale this study to assess government efforts to provide a potable water supply in Bida, Niger State.

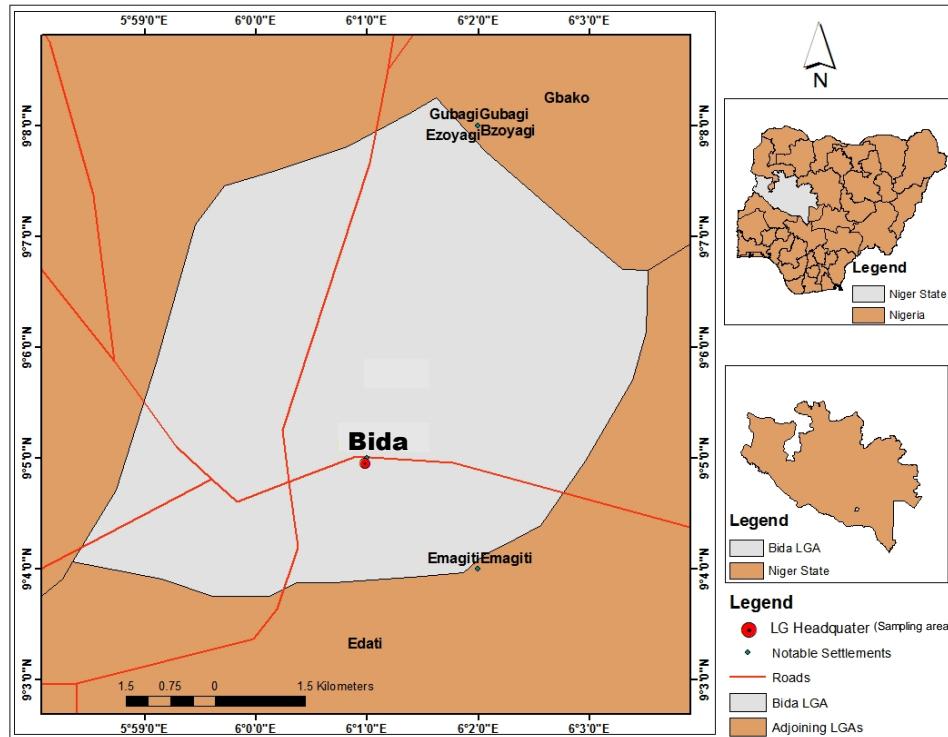


Figure 1: The study area.

the responsibility to provide water services in cities (Lieberherr and Ingold, 2019). On the other hand, regional, national, international and private actors may play an essential role in oversight, technical knowledge and funding, especially in rural water supply and sanitation.

2. STUDY AREA

Location and climate

Bida local government is in Niger State. It is situated between latitude 9°05'N and 6°01'N. The local government covers 512 km² and is bounded by Gbako local government to the North, Lavun Local Government to the

south, and Katcha Local Government to the west (Figure 1). The climate of the study area is influenced by two seasons, the dry and wet seasons. The annual rainfall is about 1,600mm. The duration of the rainy season ranges from 150-210 days.

Mean maximum temperature remains high throughout the year, hovering about 32A°F, particularly in March and June. However, the lowest minimum temperatures occur usually between December and January when the town come under the influence of the tropical continental air mass, which blows from the north. The dry season in Bida commences in October (Oyebande 1978).

Geology and soil

Geological investigations show that potential source rocks in the Bida Basin are gas prone. Potential reservoir units occur in the fluvial sandstones of the Lokoja Formation and the shelf and flood plain sandstones of the Patti Formation. In addition, the shales and clay stones of the Patti and Agbaja Formations may provide regional seals. Different trap configurations are possible in the basin, ranging from traps within uplifted blocks, traps in drapes, compacted structures over deep horsts to stratigraphic traps and flanks of uplifted blocks. Cross-sections indicate that the area around Bida and the south of Bida around Pategi, Muregi, Baro, Agbaja, Ahoko, Abaji, and Gadabiyu is particularly prospective.

Geophysical investigations have shown that Bida Basin is circumscribed by an NW-SE trending arrangement of linear faults and central positive anomalies bordered by negative incongruities (Olabode et al., 2012; 2016). This physical outline is consistent with rift-associated assemblies as detected in the next to Benue Trough. The Bida sandstone is the basal deposit of the Middle Niger Basin, and it generally contains acceptable to coarse-grained sandstones, conglomerates, siltstones, and clay stones (Olabode et al., 2012; 2016). The sandstone which lies beneath the Mokwa and Kontagora plains are usually angular to sub-angular, finely arranged to arrange and very fine to very coarse and gravelly poorly. The existence of the Sakpe ironstone unit is restricted to the slopes of the mesas belt flanked by Bida town and River Niger. The unit overlies the beds of Bida Sandstone conformably. It comprises coarse-grained Oolitic ironstones,

dark brown to dark yellow (Olabode et al., 2012; 2016). The most predominant soil type is the ferruginous tropical soils derived from the Basement Complex rocks and old sedimentary rocks. Such ferruginous tropical soils are ideal for cultivating guinea Corn, maize, millet and groundnut (Oyebande 1978). Hydromorphic or waterlogged soils are found mainly in the extensive flood plain of the Niger River. The soils are poorly drained and generally greyish or sometimes whitish due to the high content of silt. Ferrosols, which developed on sandstone formations, can be found within the Niger trough. (Oyebande 1978). Their characteristic red colour enriched with a clay subsoil is noticeable in the landscape. Termite hills dot the landscape; these can be seen along the major highways in the area. The Southern Guinea Savannah vegetation covers the entire landscape of the area like in other states of similar vegetation, it is characterised by woodlands and tall grasses interspersed with tall, dense species. However, within the Niger trough and flood plains occurs taller trees and a few oil palms trees. In some areas, traces of rain forest species can be seen (Oyebande 1978).

3. Materials and Method

A total of 45 questionnaires were administered, comprising 12 questions. The first four (4) questions focused on general information (age, sex, marital status and occupation of the respondents). The questions raised are as follows:

1. Sex: Male Female ;
2. Age category: a. 20-30 b. 31-40 c. 41-50 d. 50 and above ;
3. Marital status: a. married b. single ;
4. What is your occupation: a. farming b. public service c. Trading d. Other ;
5. Is there any water supply system in your house: Yes No ;
6. if yes what types: a. Pipe borne , b. well c. others ;
7. Is the water supply system meeting up with the increased population: a. Yes b. No ;
8. Is the water supply system suitable: a. Yes b. No ;
8. How portable is the water you

drink: a. very clean { } b. clean { } c. Dirty { } d. others { };

9. Do you use any means to purify your water:
 a. Yes { } b. No { };

10. What is the position of the water supply: a. Regular { } b. Irregular { }, c. Others { };

11. Who is been responsible for the supply of water: a. Government { }, b. self { }, c. community { }, d. Non-governmental organization { }; and

12. If the supply is from the government do you pay Tax: a. Yes { } b. No { }.

Data generated from the fieldwork is summarised and standardised using basic statistics (frequency and percentage). Further, the several samples test ANOVA (Kruskal-Wallis) was used to measure the variability of groundwater composition between the three sampling locations. This method allows for comparing several independent random samples and can be used as a nonparametric substitute to the one way ANOVA (Critchlow and Fligner, 1991; Conover, 1999). The Kruskal-Wallis test statistic for k samples, each of size n_i is defined viz:

$$T = \frac{1}{s^2} \left[\sum_{i=1}^k \frac{R_i}{n_i} - N \frac{(N+1)^2}{4} \right] \quad \text{Eq. 1.}$$

where N is the total number (all n_i) and R_i is the sum of the ranks (from all samples drawn) for the i th sample and:

$$S^2 \frac{1}{N-1} = \left[\sum_{all} R_{ij}^2 - N \frac{(N+1)^2}{4} \right] \quad \text{Eq. 2.}$$

The null hypothesis of the test is that all k distribution functions are equal. The alternative hypothesis is that at least one of the populations tends to yield larger values than at least one of the other populations (Critchlow and Fligner, 1991; Conover, 1999).

4. RESULT AND DISCUSSION

Table 1summarizes general information on respondents in the study area. More males (60%) than females (31%) respondents, whereas 49% are aged between 20-30 years, and only 5% of the respondents are above 41 and 50 years old. Most of the respondents (58%) are married. In terms of occupation, 51%

are traders, and 18% are engaged in public service. The variability of general information about the respondents is further illustrated in Figure 2. Overall, the respondents' composition comprises men and women of different age brackets, married and single, engaged in different occupation types. This is especially required because their composition will reflect the expected responses towards government efforts to provide potable water in the study area.

Table 2 presents views of respondents regarding government effort in the provision of water supply in Bida. Responses collected on the first question, "Is there any water supply system in your house", indicate that 62% of the households have a water supply, whereas 38% do not have a water supply Figure 3a). Similarly, 62% of households have a water supply from pipe bone, whereas 27% obtained a water supply from wells and 11% of households obtain water from other sources (e.g., vendors)- Figure 3b. Based on the suitability for drinking, 53% of the respondents believe that the water supply they receive is suitable for drinking, whereas 47% are of the same view (Figure 3c).

Responses gathered from the question "Is the water supply system meeting up with the increased population" revealed that 51% of the respondents are of the view that the supply is adequate and is exponential to the growing demand, whereas 49 are of the view that the supply they receive is not adequate owing to the increasing demand for water (Figure 3d). Responses from the question "How portable is the water you drink" revealed that 18% receive very clean water, 49% receive clean water, 22% receive water supply of acceptable quality and 11% receive dirty water supply (Figure 3e). Concerning water treatment, a question was raised, "Do you use any means to purify your water" and responses showed that only 22% of households in Bida purify water before use, whereas 78% of households use water as it is supplied (Figure 3f). Responses obtained on the question "How reliable is the water supply" showed that 58% believe that the water supply is regular and reliable, whereas 42% have issues with the water supply. (Figure 3g).

Concerning the status of water supply, a question "Who is responsible for the supply of water" was raised, and responses showed that

Table 1: General Information of respondents

(a) Sex	Frequency	Percentage
Male	31	69
Female	14	31
Total	45	100
(b) Age of respondent	Frequency	Percentage
20-30	22	49
31-40	11	24
41-50	10	22
50 and above	2	5
Total	45	100
(c) Marital status	Frequency	Percentage
Single	26	58
Married	19	42
Total	45	100
(d) Occupation	Frequency	Percentage (%)
Farming	11	2
Public service	8	18
Trading	23	51
Others	3	7
Total	45	100

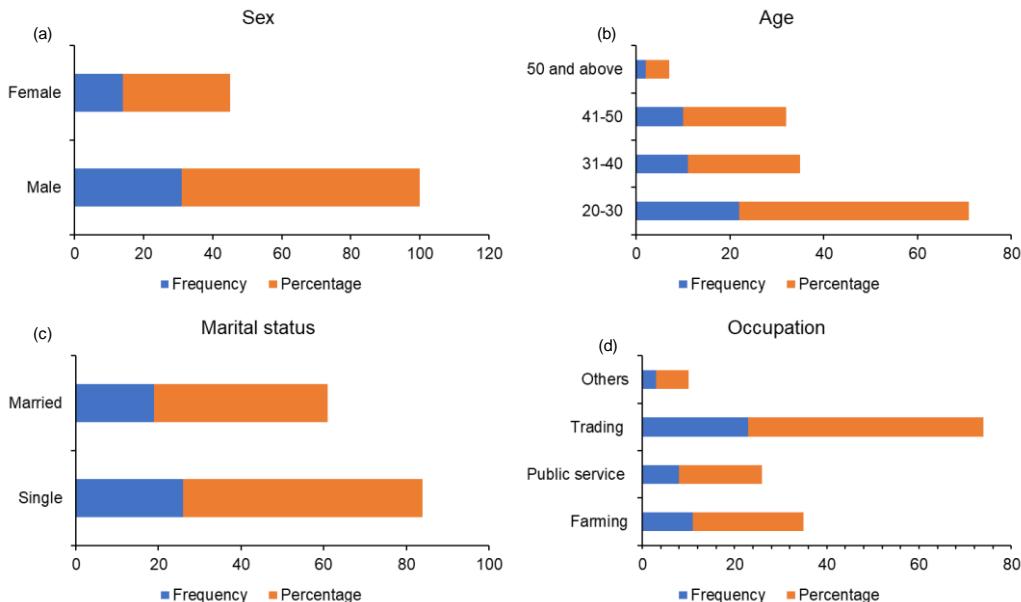


Figure 2: The variability of general information about the respondents.

the government provides 42% of water supply, 40% by individuals, 11% is owned by the community and 7% by the nongovernmental organisation (Figure 3h). Lastly, payment of water rate was evaluated rising a question "If the supply is from the government do you pay water rate". Responses indicate that only 22% of the inhabitants purify water before use in the study area (Figure 3i). In addition, several samples ANOVA (Kruskal-Wallis test) was used to test the hypothesis that there is no significant difference between people's opinion regarding government effort in providing potable water in Bida. Results (Table 3)

revealed that there is no significant difference between sample medians. This is further validated using a normal probability plot of residuals (Figure 4). The normal probability plot of residuals can be used to verify the hypothesis that residuals are normally distributed. The normal probability plot of the residuals should approximately follow a straight line, as indicated in Figure 4.

Table 3: Kruskal-Wallis test for equal medians

H (chi2):	0.2725
Hc (tie corrected):	0.2729
p (same):	0.6014

Table 2: Views of respondents on government effort in providing potable water

(a)Source of water supply	Frequency	Percentage	(f)Purification	Frequency	Percentage
Yes	28	62	Yes	10	22
No	17	38	No	35	78
Total	45	100	Total	45	100
(b)Type of water supply	Frequency	Percentage	(g)Reliability	Frequency	Percentage
Pipe born	28	62	Regular	26	58
Well	12	27	Irregular	19	42
Others	5	11	Total	45	100
Total	45	100			
(c)Suitability of water supply	Frequency	Percentage	(h)Status	Frequency	Percentage
Yes	24	53	Government	19	42
No	21	47	Self	18	40
Total	45	100	Community	5	11
			Nongovernmental organization	3	7
(d)Adequacy of water supply	Frequency	Percentage	Total	Frequency	Percentage
Yes	23	51		45	100
No	22	49			
Total	45	100			
(e)Potability	Frequency	Percentage	(i)Billing	Frequency	Percentage
Very clean	8	18	Yes	9	20
Clean	22	49	No	36	80
Fair	10	22			
Dirty	5	11			
Total	45	100			

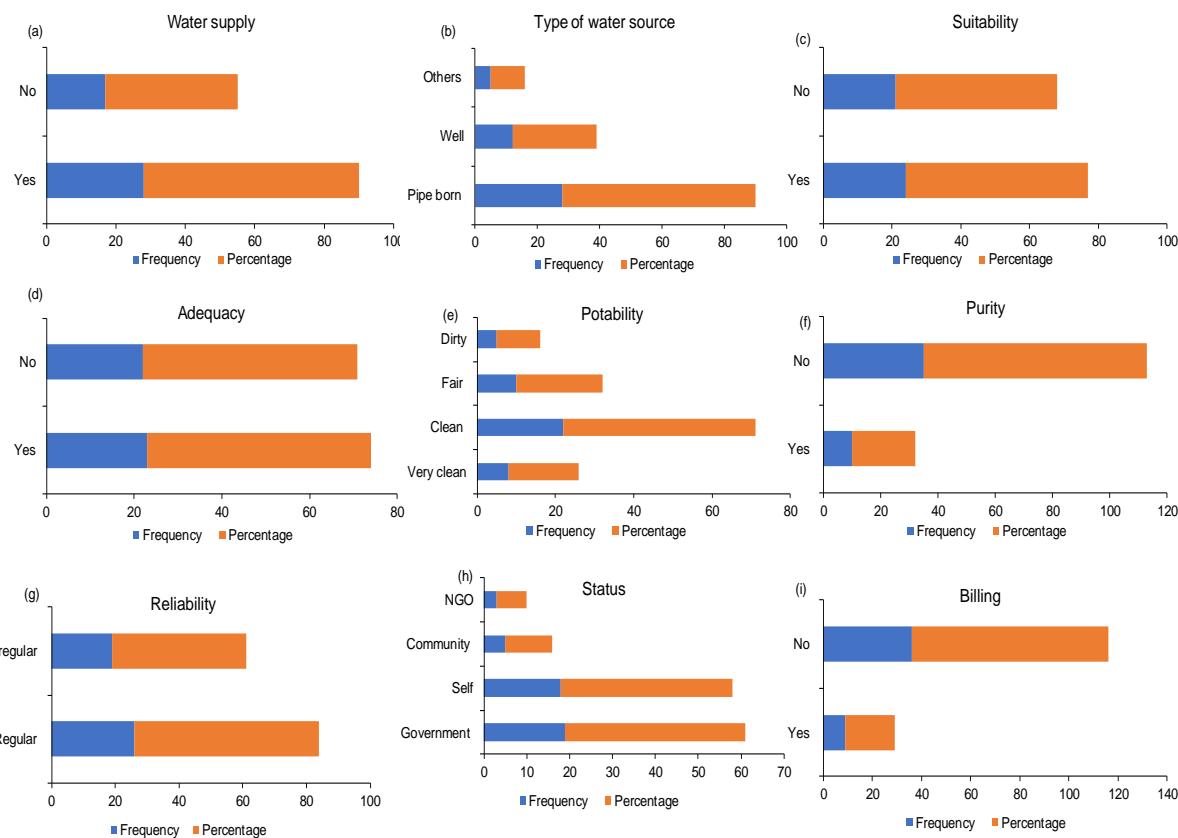


Figure 3: Variability of respondent's views on government effort in providing potable water

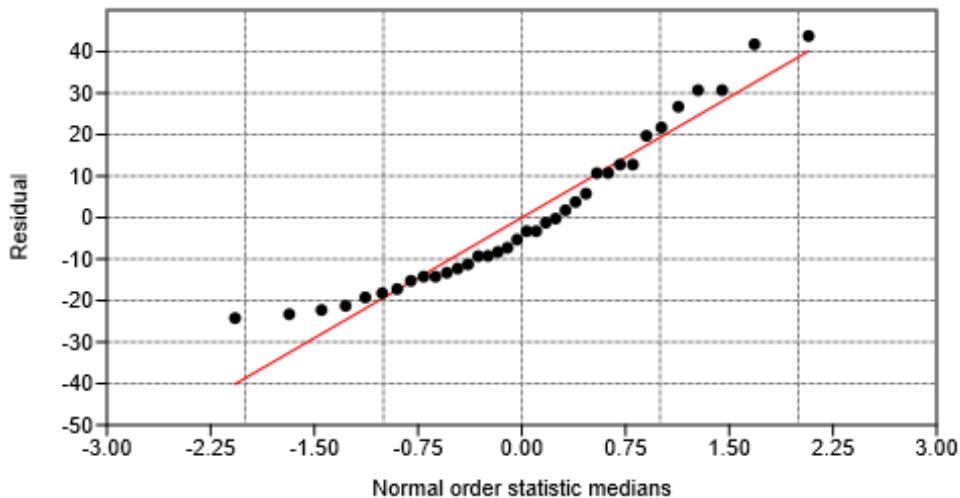


Figure 4: Residuals plot for homogeneity of respondent's views

When a residual plot displays a non-normal pattern, other residual plots can check for other problems with the model, such as missing terms or a time order effect. Prediction intervals can be inaccurate if the residuals do not follow a normal distribution. If the residuals do not follow a normal distribution and the statistics have a smaller number of observations (<15), confidence intervals for predictions and p-values for coefficients can be inaccurate. The observed normality in this analysis confirms the accuracy of the data used in this study.

5. CONCLUSION

The importance of the provision of potable water is well articulated in the literature. This study has reported our novel effort to assess the efforts made by the government in the provision of potable water in Bida. Although portable water supply is one of the fundamental human rights, this study found that:

1. In Bida, as much as 38% of households do not have a potable water supply and obtain water from non-public sources.
2. Similarly, portable water supply cannot reach 49% of people in dire need of water; thus, they must resort to individual boreholes, wells, and other water supply sources, perhaps, vendors.
3. Despite the above challenges, 49% of the inhabitants receive very clean water in the study area, but only 22% of the inhabitants purify water before drinking.
4. Most of the people in Bida rely on public water supply system owing to its

regularity, as only 42% of inhabitants have issues with public water system; and

5. Lastly, only 20% are willing to pay for the water supply, and this is a regrettable development as it provides a poor signal to government/private partnership.

Nevertheless, this investigation covers only Bida. Therefore, a comprehensive study on government effort in the provision of potable water is suggested over broader spatial and temporal scales.

Acknowledgements This study was supported by Usmanu Danfodiyo University, Sokoto, Nigeria.

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