Journal of Applied Sciences, Information, and Computing
Vol. 2, No. 2 (December 2021)
School of Mathematics and Computing, Kampala International University

ISSN: 1813-3509 https://jasic.kiu.ac.ug

GEOGRAPHIES OF WATER SCARCITY IN THE ERA OF COVID-19 PANDEMIC

M. Baba-Adamu, M.[1]* and Adamu, U.[2]
Department of Geography, Yobe State University, Damaturu, Nigeria
[1]T: +2348032499468 E: babageo001@ysu.edu.ng

Abstract

Background: Water is the most important natural resource that guarantees socio-economic development and quality of man's life, while its consumptive demand increases in response to the geographic diversities of the human population. **Aim:** This study examined the influence of some geographic variables on households' exposure to water scarcity during the COVID-19 pandemic in Potiskum town, Yobe State. **Methods:** Online survey was conducted on the households' water demand and availability, while the data were analyzed with both descriptive and inferential statistical models. **Findings:** It highlighted that about 34% of the households were using unimproved water sources, which increases their spatial distance coverage, time, and energy expenditures for the water fetching. The WSVI demonstrated the exposure of 60.2% of the households to the varying levels of water scarcity, which constitute a threat to the attainment of SDG 6 and compliance with the COVID-19 pandemic's safety measures. Similarly, the geographic determinants were found to statistically correlate with the dynamics of the water supply. Whereas, the linear regression model of the determinants was found to account for 32.7% of the households' susceptibility to the water crisis. **Conclusion:** It affirmed the presence of water scarcity, attributed to the geographic factors, and prompted by the emergence of the COVID-19 pandemic. Thus, it suggests increased investments in the urban water sector, towards improving affordable access to the water supply and enhanced WASH service, which reduces the vulnerability of the households to water crisis and transmission of contagious diseases such as the COVID-19 pandemic.

Keywords: COVID-19, Household, Scarcity, Vulnerability, Water

1. INTRODUCTION

The access to adequate water supply guarantees socio-economic development and improved living conditions, while the consumptive demand for the resource is a response to the increase in the human population and changing consumption patterns. The water resource is an essential natural endowment for human well-being, hence its access has been recognized as a human right and emphasized in the ambitious United Nations Sustainable Development Goals (SDGs). The adequate supply of the limited freshwater resource is paramount for diverse aspects of social and economic development. Lukman et al. (2016) opined that access to water is measured by the number of people w ho have reasonable means of getting an adequate (quality and quantity) amount of water that is safe for domestic activities. Thus, adequate access to the water supply is a key determinant for the control and prevention of infectious disease transmission, while limited access creates a challenge (WHO, 2019 as cited by Animi & Afori-Asenso, 2020). The global pursuit of water access, including developing nations, at the end of 2015 deadline of Millennium Development Goals (MDGs) led to the improvements in the access to improved water service (United Nations, 2015, 2017 as cited by Ogunbode, Nejo & Kehinde, 2020). They added that though a considerable population is now accessing water supply from improved water sources for domestic uses, the emergence COVID-19 pandemic and the attendant ravaging effects could endanger the water supply service, most especially in the developing nations, whose sustainability plans for the water supply are weak, particularly in the low and middle-income communities. Additionally, the water sources on which households depend to meet up their daily demands have been classified into improved and unimproved groups. For instance, the 2017 Joint Monitoring Programme of the World Health Organization and United Nations International Children's Emergency Fund (WHO/UNICEF) reviewed the classification of the water sources and sanitation facilities as cited by Armah et al. (2018) that improved drinking water sources are those that have the potential to deliver safe water supplies by nature of their design and construction. It added that the improved water sources should meet these three criteria: (i) it should be accessible on-premises (ii) water should be available when needed (iii) the water supplied should be free from contamination. Similarly, the bottled and sachet waters as well as the delivered water are now classified as improved sources, though they were previously considered as unimproved as a result of lack of data on accessibility, availability, and quality. Whereas, the unimproved water sources are the direct opposite of the improved described, which clearly shows that reliance on the unimproved water sources relates to the disadvantaged conditions of the household's socioeconomic status.

However, 2019 estimates show that 785 million people worldwide are living without access to basic drinking water services and 700 million are likely to be added between now and 2030 – United Nations SDGs report (2020). Affirmatively, Olalekan et al. (2019) posited that due to the increasing climate change events, half of the world could stand at high risk of water stress by 2050, with the potential to increase the water scarcity refugees. This means the prevalence of waterborne disease may increase as more people are exposed to water scarcity conditions. The World Bank (2020) opined that the high rates of infant mortality, under-nutrition, stunting, inflammation, impair cognitive functioning, and physical development, which lowers productivity and wages, have been linked to the prevalence of water-borne diseases. The water and sanitation have driven the Joint Monitoring Programme (JMP) of the World Health Organization and the United Nations International Children Emergency Fund (WHO/UNICEF JMP (2017) reported that one in three globally does not have access to clean drinking water, and vulnerable to high morbidity and mortality among children under five years of age. This access to adequate and safe water supplies is a recognized human right and formed part of the ambitious 2030 sustainable development goals (SDGs), the 2025 African Water Vision, Nigeria National Water Supply Policy, and the 2010 Yobe State Water Supply and Sanitation Policy (YSWSSP) according to Baba-Adamu and Jajere (2020). Additionally, the 2.2 billion people lacking access to safely managed water service and the 4.2 billion falling short of safe sanitation facilities, as demonstrated by Olalekan et al. (2019), maybe a contributing to the increase in the number of confirmed cases of the highly contagious diseases (COVID-19), especially in Nigeria where adherence to the safety measures becomes challenging for the poor households. The adverse effects of the newly emerged coronavirus (COVID-19) pandemic manifest in every nation and region of the world, as it spread to nooks and crannies worldwide. The lack of pharmaceutical drugs for the virus necessitated the immediate acceptance of the universal measures backed by protocols and guidelines of the World Health Organization (WHO), which includes but is not limited to the regular washing of hands and facemasks that are to be used in public places. However, the poor access to water supply and the sanitation service in developing regions such as sub-Saharan Africa presents a huge challenge to the effective containment of the COVI-19 pandemic. This made it critical that the collaborative concerns and efforts from the diverse stakeholders, especially the most relevant, in revamping and improving the service for access to improved water supply during this COVID-19 pandemic, which doubled the other preventable deadly water-borne diseases prevailing in developing countries such as diarrhea, malaria, typhoid fever, cholera, and dysentery.

Furthermore, though considerable progress (69%) in water access was achieved in Nigeria by the 2015 deadline of MDGs, the country still lag behind other countries in the sub-Saharan region, as the country regressed in access to piped water service on-premise in urban areas from three in every ten persons in 1990 to even less than one in 2015 (Water Aid, 2019 as quoted by Ogunbode et al., 2020). The rapid urbanization, lack of investment, and institutional constraints in the expansion of water service may be the factors hindering access to the water supply (World Bank, 2017). This exposes about 69 million Nigerians to lack access to safe water supplies, 19 million of whom walk a long distance to collect the water from surface water bodies such as the lakes, streams, and rivers (NBS, 2017). With the emergence of the COVID-19 pandemic and the confirmation of 54,587 cases as of 4th September 2020, the proportion of the water-scarce population in the most populous black nation may increase, while the dotted water supply facilities could be pressurized. This is why Abdulmalik (2020) posited that for Nigeria to defeat the transmission of the viral disease access to improved water supply and sanitation must be emphasized with an increase in the budgetary allocations and commitments of the population. The urban areas which accommodate the highest human population and the confirmed cases of the deadly virus might be suffering from the shortage of water supplies, sanitation facilities, and hygiene service (WASH). However, studies conducted by Siddiqui and Akbar (2008), Morufu (2017), Olalekan and Sabinus (2017), Olalekan, Odimiji, and Nimisingha (2018) as quoted by Olalekan et al. (2019) positioned that a man requires about 150 to 300 liters of water per day for domestic purposes such as drinking, cooking, washing utensils, bathing, flushing toilet, air-cooling, and gardening. This is against the 90 liters/person/day pegged by the YSWSSP (2010) as revealed by Baba-Adamu and Jajere (2020), for people living in the urban areas of Yobe State. Despite the importance of water for domestic uses, the extent of households' vulnerability to water scarcity has not been sufficiently studied and documented within the period of the COVID-19 pandemic in the Yobe region of Nigeria, which led to critical data gaps for effective planning and development. However, while demographic (Bukar & Daura, 2015), socio-economic (Haddout et al., 2020), and environmental (Baba-Adamu & Jajere, 2020) determinants to domestic water supply were studied, the geographic factors of the domestic water supply were neglected, especially during this global health crisis. As such, this study is limited to the nature of water sources, household-water source spatial distance, modes of water conveyance, and the time expenditure for water provision, relative domestic water supply. It is against this background that the study assessed the influence of the geographical variables on the households' vulnerability to water scarcity in the era of the COVID-19 pandemic in the study area. The specific objectives of the study include the identification and classification of the domestic water sources; measurement of the extent of the households' water scarcity; and valuation of the geographic determinants of the water scarcity. This has the potential to broaden the comprehensive understanding of the households' water supply challenges, increase the realm of knowledge, and create awareness for necessary inputs from people and authorities.

2.0 MATERIALS AND METHODS

2.1 Study Area Setting:

Potiskum town is the headquarters of Potiskum Local Government Area of Yobe State, located between latitudes 11º03' to 11º30' north of the Equator and longitudes 10º50' to 11º51' east of the Meridians. The town is 98km to the west of Damaturu (the state capital), falls in the Sudano-Sahelian Savanna vegetation belt, specifically a shrub savanna, and receives an annual rainfall that ranges between 600mm and 800mm in the four-five-months wet season. Studies by Babagana et al. (2018) as well as Bunmi, Nyangnaji, and Mayomi (2016) reported that the mean annual rainy days in the study area revolves around 100+ days, as the onset of the rain varies from May and June and terminates in September-October, and no rain is received in the usually seven-months dry season. They maintained that the soils of the area include the brown and reddish-brown, as well as the leached ferruginous tropical type, which deteriorates due to intense cultivation. The ethnic composition of the study area includes the Chadic languages such as the Ngizims, Kare-Keres, and Bolewas, who are mostly subsistent farmers of millet, sorghum, beans, and groundnut.

2.2 Study Design and Data Sources:

This study explored the geographic determinants of the domestic water scarcity in urban Potiskum, as used by Inkani (2015); Inkani and Mashi (2016) in rural areas of Katsina State, which led to the employment of the mixed methods of research, quantitative and qualitative, to deepen the findings of the research work. The study developed a questionnaire instrument called the "Domestic Water Scarcity in the Era of COVID-19 Pandemic" and shared it to collect household heads' responses. As such, the study used both primary and secondary sources of data, the former collected through an online household survey using social media platforms such as WhatsApp, telegram, and Facebook, whereas the latter involved the review of relevant published research works and reports. The responses of the household heads collected between the 24th April and 5th May 2020, was necessitated by the COVID-19 pandemic which discouraged crowding and encouraged spatial distancing as well as the enforced safety measures by both the state and the federal governments. The questionnaire for the data generation was primarily structured to capture the water sources of the households, the volume of water available for domestic uses, including the washing of hands, and the facemasks in the prevention of contracting the COVID-19, and the water demands in response to the contemporary realities. Whereas, the questions on the instrument were both open and closed-ended.

2.3 Study Variables:

The household access to the improved water supply was the dependent variable used for this study and coded as 1 when the household collects sufficient water supply and 0 if otherwise. The independent variables of the study, which are the potential determinants of access to improved drinking water sources, include the nature of the water sources (improved or unimproved), household-water source spatial distance (> or < 1km), modes of water conveyance (traditional or non-traditional) and time expenditure (> or < 30 minutes per round-trip of water collection).

2.4 Statistical Data Analyses:

The data of the study were analyzed using both descriptive and inferential statistical tools which include the water scarcity vulnerability index (WSVI), simple correlation, and linear regression models. The WSVI was developed by Inkani (2015) and computed as a ratio of water availability to the demand of a household. The computed values of the model could be as low as 0% and as high as 100% - which stands to be the lower the values the lower the vulnerability and the higher the value the greater the susceptibility. The vulnerability system of the WSVI has been classified as shown in Table 1, which assumed that;

$$\mathrm{WSVI} = 1 - \left(\frac{\mathrm{HWA}}{\mathrm{HWD}}\right) \mathrm{X}\ 100$$

Eq. (1)

Where;

- WSVI = Water Scarcity Vulnerability Index
- HWA = Household Water Availability
- HWD = Household Water Demand
- 1 = the value of water sufficiency a household should have if all its water demands are met

However, the simple linear correlation model assumed that:

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{n\sum x^2 - \sum (x)^2}\ \sqrt{n\sum y^2 - \sum (y)^2}}$$

Eq. (2)

Where: -
n = study population
x = independent variables
y = dependent variable

On the other hand, the assumption of the linear regression model was that:

$$\mathrm{WSV} = \mathrm{NWS} + \mathrm{SDWS} + \mathrm{TWF}$$

Eq. (3)

$$\mathrm{HWSV} = \beta_{\circ} + \beta_1\mathrm{NWS} + \beta_2\mathrm{SDWS} + \beta_3\mathrm{TWF}$$

Eq. (4)

Where: -
WSV = Water Scarcity Vulnerability
NWS = Nature of Water Sources
SDWS = Spatial Distance to Water Sources
TWF = Time for Water Fetching

3. STUDY FINDINGS

The findings of this study were presented below under various headings and sub-headings in response to the objectives sought to be achieved.

3.1 Water Sources

The study area formed part of Kerri-Kerri Formation, which lithologically changes rapidly, both vertically and laterally with a thickness of 49 meters, while the confined or semi-confined aquifers occur mainly underwater table condition and chiefly recharge by precipitation (Okuson, 1995; Oruonye, 2009). Despite the looseness and coarseness of the Formation, it is known to be unpredictable, in terms of availability and depths of groundwater reserves, which Yusuf et al. (2018) described as a zone characterized by deep layer aquifer, water yields, and much of the arenaceous beds are with little or no water. The class of the water sources used for domestic water supply varied from one household to another in Nigeria. For instance, this study found that 34.2%, 31.1%, 30.2%, and 4.5% of the studied households were using open dug-wells, water vendors, boreholes, and others for their daily water supply, as shown in Table 2. The difference in the classification of the water sources contributes to access to a safe and adequate water supply. Based on the WHO/UNICEF JMP (2017) classification, the water sources were classified as either improved such as boreholes, or unimproved in the case of open wells. The proportion of the households depending on water vendors (31.1%) was not surprising, given that the Multiple Indicator Cluster Survey (MICS) conducted by NBS (2017) affirmed the reliance of the most households on such water sources for domestic water supply in the urban areas of Nigeria, while the use of boreholes (as shown by 30.2% of the households) is a noticeable feature of urban communities in the country. However, the households relying on the lowest rung of the drinking water ladder (using unimproved water sources) could be highly vulnerable to water scarcity and water-borne diseases, due to the openness to contaminants. In addition, several kinds of literature, Fair et al. (1971), Tebbutt (1991), Steel and McGhee (1991), Metcalf and Eddy (1991), John De Zuane (1996) as cited by Lukman et al. (2016) described the detailed impurities of such unimproved water sources and the need for treatment before water consumption. The vulnerability to water scarcity may also be worsened by the emergence of the COVID-19 pandemic, which necessitated frequent washing/sanitizing of hands and facemasks. This is particularly because the geologic conditions, specifically the aquifers, of the area may influence the water yields of the unimproved sources and expose the households to fall in supply. The water fetching from the unimproved source connotes socio-economic implications on the households. Moreover, the UNDP (2006) reported the annual loss of 40 billion productive hours and 443 million school days to fetching water, especially from unimproved sources, in sub-Saharan Africa. These losses have the potential to magnify a decline in socio-economic productivity, growth, and development, some of which include exposure of the people to social violence and an increase in school drop-out. The IMF (2020) technical assistance report to Nigeria on five key goals of the SDGs, affirmed that SDG 6 could be attained with increment in the budgetary allocation of the country by more than 2%. The technical guidance may principally improve the access to basic WASH services, which stand to help in the fights against the highly contagious disease.

3.2 Water Scarcity Determinants

Domestic water scarcity could be influenced by several factors, some of which may include distance, transport, and time. The spatial distance of the households from their water sources is an issue that relatively influences water access, especially in developing countries of Africa such as Nigeria. Descriptive analyses, as shown in Table 3.1, affirmed that 21.4% of the studied households covers less than half a kilometer to access water supply, whereas the 27.3%, 47.7%, and 3.6% ranges between 0.5 – 1km, 1 – 1.5km, and 1.5 – 2km, respectively. However, since the average distance for the water supply stood at 1.3km, the study finding out-weighted the mean distance reported by WHO/UNICEF (2017). The long-distance coverage in search of water supply may result in the use of unsafe water sources, which increases exposure to water-borne diseases and poverty. It is also important to note, that while the water access for regular washing of hands and facemasks forms part of the important preventive measures of the COVID-19, the coverage of long-distance reduces the volume of available for usage while increasing susceptibility to the contagious virus through queuing competition, collection, and transport. This is especially that Nigeria's national average of households having access to handwashing facilities with soap and water stood at 11% (NBS, 2016). A study by Kithinji (2015) on extending the work of Madanat and Humplick (1993) found that the distance from the household to the water source impacts negatively on water source choice and supply. Moreover, the proximity to the water source may influence the quantity of water accessibility, while the routine coverage of long distances in search of water is likely to result in the use of unsafe water, with potential health consequences, especially during pandemics.

Furthermore, the modes of water conveyance of the studied households involved the use of foot (43.7%), wheelbarrow (52.5%), and animal carts (3.8%) as Table 3.1 shown. While the water collection activity was mostly shouldered by children, these means of water transport are energy demanding and time-consuming, plus socio-economic implications on the growth and development of the children. Although varied, all the modes of water transport are problematic to the collectors, especially those transporting by foot. This finding is consistent with Ordinioha (2011) and Inkani (2015) who concluded in their studies that the problem of domestic water supply is further confounded by the methods employed to transport the water to the households. In Table 3.1, the time expenditure for water collection was shown as 14.9%, 12.7%, 26.9%, and 45.5% for less than 15 minutes, 16 – 30 minutes, 31 – 45 minutes, and greater than 45 minutes, respectively. However, while only 27.6% of the households were within the 30 minutes pegged by WHO/UNICEF JMP (2017) as the expected time expenditure, the mean time involved in the activity of water fetching was 45 minutes per round-trip of water provision, which includes queuing and transportation. However, studies on factors influencing households' access to domestic water supply by Oyekale and Ogunsanya (2012) as well as Onundi and Ashaolu (2014) as quoted by Kithinji (2015) found that as the time consumption for water supply increases, the likelihood of access to safe drinking water decreases.

3.3 Water Scarcity Measurements

The water scarcity vulnerability index (WSVI) was used for the computations and evaluation of the households' susceptibility, or otherwise, to the water scarcity, using the mean water availability and demand, which is expressed in percentage. This is shown in Table 2, where 39.8% of the households face "No Water Scarcity", 25.1%, and 15.8% were in the "Low Water Scarcity" and "Moderate Water Scarcity" levels, respectively. Other households (14%) were in the "High Water Scarcity" while 5.3% experiences the "Acute Water Scarcity" (see Table 3.2). This model analysis shows a decline in the proportion of the households in water scarcity with an increase in the extent of the problem, which paralleled the findings of Inkani and Mashi (2016) as well as Baba-Adamu and Jajere (2020). Though the households in the study area that are connected to the public water system could be very negligible, the WSVI findings demonstrated that 39.8% of the households, who might be the economically active folk of the population, experiences zero water scarcity. However, the households in the low and moderate levels of scarcity (40.9%) might have been transited to the problem by their compliance with the COVID-19 measures of regular washing of hands and facemasks, which adds to the usual water consumption. Additionally, these water scarcities may increase the vulnerability of the households to water-borne diseases such as diarrhea, cholera, and dysentery, as the unsafe water sources increases. Generally, while the NBS (2016) report on the SDGs progress in Nigeria shows 69.6% of the households with access to safely managed water service, these findings contradict the report though might have been prompted by the pandemic. Thus, it stands to constitute a huge challenge to the attainment of the SDGs, especially the sixth goal and other relevant local policies. The demonstration that 19.3% of the households in the high and acute water scarcities may not be distanced from their socio-economic and demographic characteristics, principally poverty and low literacy levels, which were further confounded by the emergence of the respiratory disease. In essence, these WSVI findings exposed the poor condition of public water service in the area, despite being a human right, and threaten the achievement of the decade-old Yobe State Water Supply and Sanitation Policy, planned to have 100% coverage in the next three years. Invariably, the vulnerabilities of the households to the water scarcity, as the WSVI has shown, constitute another set of socio-economic challenges to the authorities and the population. The potential challenges may include the growth in poverty level and exposure to diseases, as the unimproved water sources are likely to be more used. The water scarcity, in the era of the COVID-19 pandemic, also could not be delinked from inequalities that characterized the provision of water services as well as the weak purchasing of the population, who are mostly rain-fed farmers, small-scale businessmen, and technicians.

3.4 The Correlates of the Water Scarcity

The simple linear correlation analyses of the water supply dynamics and the geographic determinants (nature of water sources, spatial distance, modes of water conveyance, and time expenditure for water collection) were computed using SPSS version 21.0, and the results presented in Table 4. It shows that the households' nature of water sources has statistically significant relationships with the water demand ($n = 171$, $\alpha = 0.01$, p-value = .009, $r = .136$) and vulnerability to water scarcity ($n = 171$, $\alpha = 0.01$, p-value = .000, $r = -.634$) both at 99% level of confidence (see Table 3.3). The correlation coefficients of the findings suggest that access to improved water sources has enough evidence to prove an increase in the households' water availability by 13.6 liters daily, whereas the unimproved water sources increase the vulnerability to water scarcity by 63.4 liters per day (see Table 3.3). These findings were not surprising since the proportion of the households relying on unimproved water sources and those depending on water vendors for the daily supplies constitute the overwhelming majority (65.3%) of the studied population. Table 3.3 also revealed that while the modes of water conveyance do not have a statistical influence on either of the dynamics of water supply in the study area, the spatial distance of the water sources from the households has a significant statistical relationship with the households' water demand at 95% confidence limit ($n = 171$, $\alpha = 0.05$, p-value = .020, $r = .121$). This implied that the households' water demand is positively influenced by 12.1 liters due to the employment of the said modes of water transport, which are usually traditional and demand high human energy and time. The expenditure of the time for the water sourcing demonstrated enough statistical evidence to prove its influence on the water availability at 95% confidence ($n = 171$, $\alpha = 0.01$, p-value = .003, $r = .623$) and the vulnerability to water scarcity at 99% confidence level ($n = 171$, $\alpha = 0.01$, p-value = .000, $r = .232$). These findings, as supported by the correlation coefficients, posited that the water availability increase by 62.3 liters every day with an increase in time allocation for the activity, while the susceptibility to the scarcity of the 23.2 liters evolves with the decrease in the time expenditure for fetching water daily. Generally, however, these findings suggest that in compliance with the safety measures of the COVID-19 pandemic, particularly the regular washing/sanitizing of hands and facemasks, the water scarcity may be confounded to implicate various aspects of livelihoods.

3.5 Regression of the Water Scarcity Determinants

The linear regression model was computed using SPSS to determine the general influence of the variables. The significantly related geographic variables with the dynamics of domestic water supply, as the simple correlation analyses have shown, were regressed and found to have accounted for 32.7% of the households' vulnerability to the incidence of water scarcity (see Table 5). The regression was significant at all levels, as the ANOVA revealed (see Table 6). The finding implied that explaining the susceptibility of the households to water scarcity, during the ongoing pandemic, can be better made by holding the geographic variables constant.

4. CONCLUSION AND RECOMMENDATIONS

The study found that reliance on unimproved water sources was common in the study area, which led to high energy and time expenditure besides diseases. For instance, the water collection involves the coverage of an average distance of 1.3km per round trip, while the modes of the water conveyance were culturally common among the population, which leads to a time expenditure of about 45 minutes per head per trip. It suggests that the water fetching for domestic services, including compliance to COVID-19 safety measures, stands to be adversely affected by the time, energy, and distance involvement. The WSVI analyses show that 60.2% of the households were in varying levels of water scarcities – 25.1%, 15.8%, 14%, and 5.3% in the low, moderate, high, and acute levels of scarcity, respectively. While the higher vulnerabilities might be immediately reduced with additional investments, the findings pose a challenge to the attainment of the SDG 6.1, African Water Vision, and other local water policies, which does not predict the occurrence of such a pandemic. These highlighted the ability of the Yobe State Water Corporation to substantially reduce the inequality in access to improved water supplies, as the COVID-19 pandemic increases. The statistical analyses show that water scarcity is influenced by the nature of the water sources, the spatial distance, and the water collection time. This calls for an increase in access to water supply particularly and the WASH service generally, to reduce the transmission of the virus and other diseases. Thus, the study concluded that the contagious disease disrupts not only the health system but also the water supply system of the study area as explained by the studied geographic variables.

The recommendations of the study include the enhancement of the water governance with responsiveness and clear commitments, and increased budgetary allocations, of providing the service concerning water rights, regulations, and economic attachments. It also put it that the management of public water sources such as boreholes should be sustained as a community responsibility and adequately monitored by an agency of government or development partners. The study further added that compressive result-oriented public-private partnership (PPP) should be initiated and sustained to improve the water service delivery and promote the achievement of the water policies and treaties. The continued efforts of fights against COVID-19 in Nigeria and indeed the world, should be comb and tackle all challenges in the water industry for socio-economic progress and development. Public places such as the markets, motor parks, schools, and worship centers should have WASH facilities, as most of the confirmed cases of the virus were from the urban environments and crowded areas are important to focus units. The exposure of the disadvantaged households in low-income communities should be primarily emphasized in the blueprint, as the findings challenge the attainment of SDG 6, which aimed to ensure availability and sustainable management of water for all by the year 2030. This would substantially reduce the number of people suffering from water scarcity, as access to improved drinking water sources is increased and made affordable.

REFERENCES

Abdulmalik, O. (2020). Nigeria Can Not Defeat COVID-19 Pandemic Without Improved Access to Clean Water and Good Hygiene Practices by Citizens. A Publication of Water Aid Nigeria accessed through https://www.wateraid.org/ng/media/nigeria-cannot-defeat COVID-19 pandemic-without-improved-access-to-clean-water-and-good

Animi, D.O. and Ofori-Asenso, R. (2020). Water scarcity and COVID-19 in sub-Saharan Africa. Journal of Infection 81: e108 – e109. DOI: https://doi.org/10.1016/j.jinf.2020.0 .032

Armah, F.A., Ekumah, B., Yawson, D.O., Odoi, J.O., Afitiri, A.R., and Nyieku, F.E. (2018). Access to Improved Water and Sanitation in Sub-Saharan Africa in a Quarter Century. Heliyon, 4:e00931.

Babagana, M., Umar, I., Liman, Y.M. and Ali, M. (2018). Current Status and Problems of Portable Water Supply in Damagum Township of Fune Local Government Area, Yobe State, Nigeria. International Scientific Journal of Agriculture Innovations and Research, 6(5): 269 – 276.

Baba-Adamu, M. and Jajere, I.A (2020). Geologic Factor and Domestic Water Scarcity in Rural Nigeria. Journal of Applied Science, Information and Computing, 1(1): 89 – 96. Accessed through https://jasic.kiu.ac.ug/article view.php?i=11&t=geologic-factor- and-domestic -water-scarcity-in-rural-Nigeria

Bukar, Y. and Daura, M.M. (2015). Rural Women's Access and Adaptation to Water Scarcity in Semi-Arid Borno State, Nigeria. Academic Research International, 6(3): 273 – 286.

Bunmi, O., Nyanganji, J.K. and Mayomi, I. (2016). Geospatial Surveillance of the Degraded RiverKomadugu Gana Area, Potiskum, Yobe State, Nigeria. Journal of Environmental Issues and Agriculture in Developing Countries, 8(2&3): 37 – 466.

Haddout, S., Priya, K.L., Hoguane, A.M., and Ljubenkov, I. (2020). Water Scarcity: A Big Challenge to Slums in Africa to Fight against COVID-19. Science and Technology Libraries, 39(3): 281 –288. DOI: https://doi.org/10.1080/0194262X.2 20.1765227

Inkani, A.I. (2015). Households' Vulnerability and Adaptation to Water Scarcity in Rural Areas of Katsina State, Nigeria. Unpublished Ph.D. Thesis, University of Nairobi, Kenya.

Inkani, A.I. and Mashi, S.A. (2016). More People Less Water: Assessing Vulnerability to Water Scarcity Among Rural Households in Katsina State, Nigeria. Pesa International Journal of Social Studies. 2(3): 13 – 30.

International Monetary Fund (IMF) (2020). Nigeria: Technical Assistance Report – Additional Spending Towards Sustainable Development Goals. IMF Country Report No. 20/177. Washington DC, United States.

Kithinji, F.K. (2015). Factors Influencing Households' Access to Water: The Case of Communities in Imenti South, Kenya. A Research Proposal Submitted to the Institute for Development Studies, University of Nairobi, Kenya. p. 34 – 68.

Lukman, S., Ismail, A., Asani, M.A., Bolorunduro, K.A., Foghi, P.U. Oke, I. A. (2016). Effects of Selected Factorson Water Supply and Access to Safe Water in Nigeria. Ife Journal of Science, 18(3): 623 – 638.

National Bureau of Statistics (NBS) (2016). National Outcome Routine Mapping of Water, Sanitation and Hygiene Service Level in Nigeria (WASH NORM), Abuja, Nigeria.

National Bureau of Statistics (NBS) (2017). Demographic Statistics Bulletin. NBS National Headquarters, Abuja, Nigeria.

Okosun, E.A (1995). Review of the Geologyof Bornu Basin. Journal of Mining and Geology. 31(1): 113 – 114.

Olalekan, R.M., Adedoyin, O.O., Ayibatonbira, A.A., Anu, B., Emanuel, O.O., and Sanchez,N.D. (2019). "Digging Deeper" Evidence on Water Crisis and its Solutions in Nigeria for Bayelsa State: A Study of Current Scenario. International Journal of Hydrology, 3(4): 244 257. DOI: 10.15406/ijh.2019.03.00187

Ogunbode, T., Nejo, Y. and Kehinde, O. (2020). COVID-19 Pandemic and the Sustenance of Global Target on Water Accessibility in the Developing World An Example of Iwo, Nigeria. The Proceedings of the Special Virtual Conference on COVID-19 of the Association of Nigerian Geographers (Southwest Zone), Held via Zoom, June 29 - 30, p. 148 – 160.

Ordinioha, B. (2011). A Survey of the Community Water Supply of Some Rural Riverine Communities in the Niger Delta region, Nigeria: Health Implications and Literature Search for Suitable Interventions. Nigerian Medical Journal, 52: 8 – 13.

Oruenye, E.D (2009). Geographical Aspects of Yobe State Nigeria. Fab Educational Books, Jos, Nigeria. p. 13 – 17.

United Nations Development Programme (UNDP) (2006). Human Development Report 2006: Beyond Scarcity:Power, Poverty and the Global Water Crisis, New York, Palgrave Macmillan, p. 47. http://hdr.undp.org/en/content/huma -development- report-2006

United Nations (2020). The Sustainable Development Goals Report, New York, United State. Accessed via unstats.un.org/sdgs/indicators on May 28th.

World Bank (2017). Human Development Report. The World Bank, Washington DC.

World Bank (2020). Nigeria Biannual Economic Update: Water Supply, Sanitation and Hygiene – A Wake-up Call.

World Health Organization/United Nations International Children's Emergency Fund, Joint Monitoring Programme (WHO/UNICEF JMP) (2017). Progress on Sanitation and Drinking Water Assessment, World Health Organization, Geneva, Switzerland.

Yusuf A., Olasehinde A., Mboringong M.N.,Tabale R.P., and Daniel, E.P. (2018). Evaluation of Heavy Metals Concentration in Groundwater Around Kashere and its Environs, Upper Benue Trough, Northeastern Nigeria. Global Journal ofGeological Sciences, 16(1): 25-36.

APPENDICES:

Table 1 WSVI Interpretation

Vulnerability Class	Range of Values for HWSVI	Class Definitions
I	0%	No Water Scarcity
II	0 – 5%	Low Water Scarcity
III	6 – 15%	Moderate Water Scarcity
IV	16 – 35%	High Water Scarcity
V	Above 35%	Acute Water Scarcity

Source: Adopted from Inkani (2015)

Table 1 Water Scarcity Determinants

Study Variables	Proportional Distribution (%)			
Water Sources	Boreholes	Open-Wells	Water vendors	Others
	30.2	34.2	31.1	4.5
Spatial Distance (in km)	0 – 0.5km	0.5 – 1km	1 – 1.5km	1.5 – 2km
	21.4	27.3	47.7	3.6
Modes of Water Conveyance	Foot	Wheelbarrow	Animals	Others
	43.7	52.5	3.8	0.0
Time Expenditure for Water Collection (in minutes)	0 – 15 mins	16 – 30 mins	30 – 45 mins	>45 mins
	14.9	12.7	26.9	45.5

Source: Fieldwork, 2020

Table 3 WSVI Measurements

Class Definitions	Range of Values of the WSVI	Findings of the WSVI
No Water Scarcity	0%	68 (39.8%)
Low Water scarcity	0 – 5%	43 (25.1%)
Moderate Water scarcity	6 – 15%	27 (15.8%)
High Water Scarcity	16 – 35%	24 (14%)
Acute Water Scarcity	Above 35%	9 (5.3%)

Source: Fieldwork, 2020

Table 4 Correlation Matrix

		Domestic Availability	Water Domestic Demand	Water Vulnerability to Water Scarcity
Nature of Water Sources	Pearson Correlation	-.057	.136**	-.634**
	Sig. (2-tailed)	.262	.009	.000
	N	171	171	171
	Pearson Correlation	.034	.121*	.081
	Sig. (2-tailed)	.475	.020	.197
	N	171	171	171
	Pearson Correlation	-.001	-.014	.006
	Sig. (2-tailed)	.981	.917	.932
	N	171	171	171
Time Expenditure	Pearson Correlation	.623**	.132	.232**
	Sig. (2-tailed)	.003	.240	.000
	N	171	171	171

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5 Regression Model of Water Scarcity Drivers

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.554[a]	.327	.321	14.7316652
Predictors: (Constant), NWS, SDWS, TWF				

Table 6 ANOVA of the Regression Model

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	64051.924	3	21350.641	67.907	.000[b]
1	Residual	85834.463	168	314.412		
	Total	149886.387	171			

a. Dependent Variable: Water Supply

b. Predictors: (Constant), NWS, SDWS, TWF