FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 7 No. 2, April, 2023, pp 152 - 158
DOI: https://doi.org/10.33003/fjs-2023-0702-1472

PROGRESS ON DRINKING WATER QUALITY MONITORING IN THE NORTHERN PART OF NIGERIA: A CATALYST TO ACHIEVING SUSTAINABLE DEVELOPMENT GOALS

***[1]Naziru Imam, [2]Nuraddeen Abdurrahman, [3]Lawal Abdulshakur Isah, [1]Olayide S. Lawal**

[1]Department of Industrial Chemistry, Federal University Oye-Ekiti, Nigeria
[2]Department of Pure and Industrial Chemistry, Umaru Musa Yar'adua University, Katsina, Nigeria
[3]Department of Chemistry, Kaduna State University, Nigeria

*Corresponding authors' email: naziruimam2@gmail.com Phone: +2348091499349

ABSTRACT

Access to clean water for drinking and domestic activities remains a critical issue in Nigeria, especially in the northern region. The increasing global population and importance of water for life have led to a quantitative and qualitative increase in its demand. This paper reports a comprehensive review of the quality of water sources utilized for consumption in northern Nigeria over the last decade. The report aims to serve as a reference point to assess the possibility of achieving Sustainable Development Goal 6 (clean water and sanitation) by 2030 based on the level of quality of water sources in the region. The study found that well and borehole water remain the primary sources of drinking water in northern Nigeria, with little or no established networks of pipe-borne water across the region. Significantly, 55.74% of these sources were reported to be unfit for consumption due to poor portability. Additionally, 31.14% of the water sources were categorized as fair, meaning they required additional treatment to prevent disease outbreaks and health implications due to some level of contamination that did not conform to WHO standards. The report indicates that only 13.11% of clean water is accessible to the northern Nigerian populace, making it difficult to achieve SDG goal six by 2030 unless all stakeholders take action drastically. Failure to achieve SDG goal six could also impede Nigeria's progress towards achieving other SDGs, as they are all directly or indirectly linked to it.

Keywords: Clean water, sustainability assessment, physicochemical, Northern Nigeria, sustainable development goals (SDGs), drinking water quality

INTRODUCTION

It has been an indisputable fact that water remains the most important resource that is necessary to sustain life. This assertion was backed up by many substantial scientific findings and evidence that revolve around the potency of water as an indispensable means of survival. Water is a pre-requisite for human existence and it plays a significant role in the good health, well-being and economic development of a nation (Abdulsalam et al., 2019), thus making it a necessity for mankind and their environment as it has existed since time immemorial, perhaps before the existence of mankind (Abdullahi et al., 2016a). In other words, Adekola *et al.* (2015) articulated that water is the most important nutrient for the survival of human beings due to its involvement in body function. Similarly, Adesakin et al. (2020) reported that water is an important component of human nutrition—directly as drinking water or indirectly as a food medium, in addition to other numerous applications.

The importance of water as a necessity for life and other uncountable applications for societal development earns it a badge that justifies its demand quantitatively and qualitatively. In addition to its natural distribution on earth with an imbalance that leads to its scarcity in some regions, the growing population has undoubtedly played a significant role in its demand, which has detrimentally affected its quality. Although the earth has abundant water, usually surface and groundwater, distributed through myriads of media such as rivers, lakes, oceans, seas, glaciers, and streams (Adesakin et al., 2020; Abdullahi et al., 2016a; Amoo et al., 2018), only about 0.3% is portable and can be used by humans (Adesakin et al., 2020). Primarily, water doesn't exist in isolation and, owing to its universal solvent characteristic property, it always exists with some level of contamination depending on many factors such as the geology of the environment or nature of aquifers, anthropogenic activities taking place around it, and the sanitation as well as hygienic level of the community under consideration. The rapid industrialization, urbanization, and rise in the global population have been attributed to the increasing demand for portable water for recreational, industrial, agricultural, domestic applications, and other anthropogenic activities (Amoo et al., 2018; Adesakin et al., 2020), which has put together a great burden of contamination on the water.

Many health implications bedevilling developing nations such as Nigeria have been attributed to a lack of access to potable drinking water (Abdulsalam et al., 2019; Abdullahi et al., 2016b). About 66.3 million Nigerians lack access to quality drinking water (Ighalo and Adeniyi, 2020), which forces them to depend on surface water for their daily activities and as a waste disposal medium simultaneously (Adesakin et al., 2020). The development of any country is proportional to the nation's ability to provide adequate and safe drinking water to its citizens. Amoo et al. (2018) reported that the quality of water available to people is critical to their standard of living because consumption of polluted water, especially those contaminated by pathogens or highly toxic substances, causes various types of diseases such as typhoid, diarrhoea, dysentery, cholera, skin diseases, cancer, stomach-ache etc. (Abdulsalam et al., 2019), which is often facilitated by the poor hygiene connected to the lack of adequate portable drinking water. Abubakar (2021) reported that in the year 2015, about 2 billion people globally have no access to potable drinking water in their homes, of which close to 80% of them rely on surface water, which is unsafe for not only drinking but other domestic applications. A similar claim was made by Adabara et al. (2011), who argued that many developing nations depend on untreated surface water, which is unfit and often contaminated by excreta. As of 2017,

Abubakar (2021) also pointed out a worrisome figure of 73% of sub-Saharan Africans that have not gained access to safe drinking water, which has been attributed to a heavily microbial disease burden on developing countries (Griffiths, 2008).

Access to portable water remains a major challenge to many developing countries, particularly African rural communities (Adekola et al., 2015), and the challenge is a continuum. However, the onus to provide clean and portable water rests on the shoulders of the government, philanthropists, and local and multinational organizations. Over the years, the health implications of contaminated water have been receiving serious attention in developed countries and are recently gaining the recognition they deserve in developing countries like Nigeria. Through several efforts by governmental and non-governmental organizations, local and international organizations, and private and public companies, several intervention projects were executed, and some are still ongoing in a bid to ensure quality water supply to all and sundry. Such interventions include the building of boreholes (Adekola et al., 2015), which is popular in northern Nigeria, even though well water remains a major source of drinking water for many people. In order to curtail the health consequences of contaminated water, it is important to continuously and sustainably ensure effective water quality monitoring (Alhassan and Ujoh, 2012). Portable water is not only essential to all organisms but necessary for healthy communities and to achieve sustainable development goals (SDGs) (Adabara et al., 2011). To stem the tide, in 2015, the United Nations (UN) through its member states unanimously adopted the 2030 agenda to achieve sustainable development goals. The organization (UN) pledges to ensure a peaceful and prosperous society for people and the planet through seventeen SDGs, one of which is clean water and sanitation (Goal 6). The goal aims to achieve, by 2030, universal and equitable access to safe and affordable drinking water for all (UN, 2015).

It is on this trajectory that this paper aims to provide a comprehensive review of the quality of water sources in northern Nigeria over the last decade. An insight into the possibility of realization of SDG-6 by 2030 will also be generated based on the level of quality of water sources in the region. The paper will also provide a clear roadmap that will guide policy-makers and governments at the regional level in their efforts toward achieving SDG goal 6 in line with the follow-up and review measures of the SDGs.

Research Area

The paper focuses on northern Nigeria because the region is the most populated in the country, with the highest rate of poverty and the least socioeconomic development.

Nigeria is divided into six geopolitical zones, and the northern part of the country constitutes the northwest (NW), northeast (NE), and northcentral (NC), with a total of 19 states (Fig. 1). Although there is no accurate data to account for Nigeria's population (Azeez, 2021), it was estimated that the country has a total of about 216 million people based on the elaboration of the latest United Nations data (Worldmeter, 2022). According to the 2006 census, Northern Nigeria contributes about 57% of Nigeria's population (Fig. 1), and by 2030, Nigeria's population was projected to reach 264 million with a growth rate of about 2.57% (World Population Review, 2022), which poses a serious threat to the water system and increases its demand linearly.

Northern Nigeria shares boundaries with the Niger Republic through the NW border, and the Chad Republic to the east (NE). The region has a temperature of about 30- 40ºC during the dry season and 25–30ºC during the rainy season. The major occupation of the inhabitants of the area is farming – raining and dry season farming - which has a direct influence on the quality of water in the area caused by the agricultural activities.

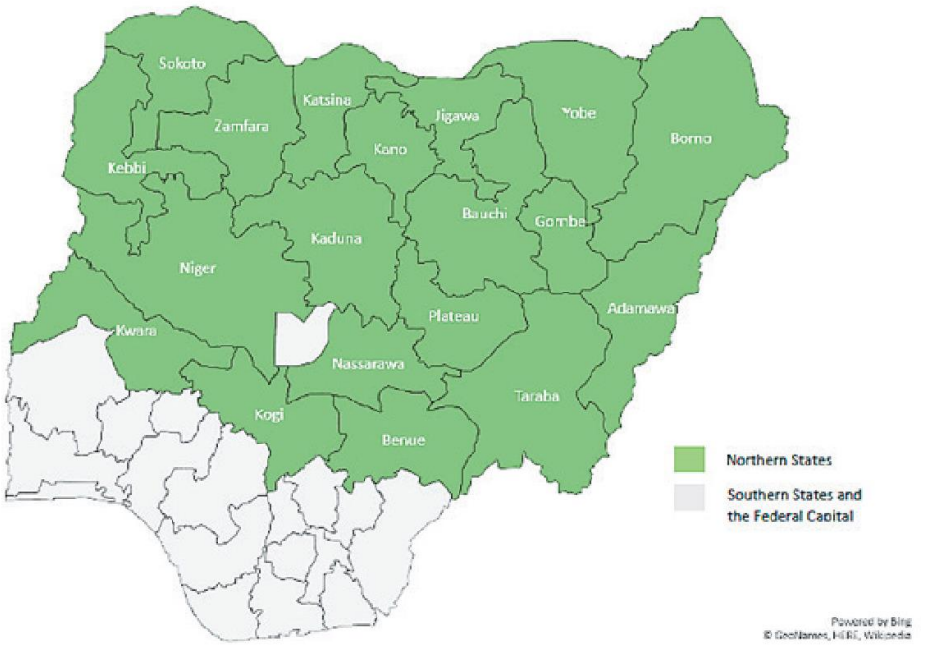

Figure 1: Map of Nigeria indicating Northern Nigeria (Sarki and Roni, 2019).

Drinking Water

Good and portable drinking water has been characterized by a number of chemical, physical, radiological and biological parameters. In general, the appearance, taste, colour, and odour of drinking water are used to determine its quality (Garba et al., 2012). Regrettably, those physical properties of water do not necessarily indicate whether it is devoid of harmful substances or fit for consumption. This necessitates

further scientific investigations to check the aforementioned parameters before one can ascertain the quality of water. When those parameters conform to the standards set by national and international organizations such as the Standard Organization of Nigeria (SON), the United State Environmental Protection Agency (USEPA), and the World Health Organization (WHO), the water is said to be portable. Otherwise, the water is not suitable for drinking and may be hazardous to the health if eventually consumed (Table 1).

Table 1: Physicochemical parameters standard values approved by WHO/NSDWQ

Parameter	Mean Value	WHO/NSDWQ Value
Temperature (ºC)	23.1	30
pH	7.1	6.5 – 8.5
Turbidity (NTU)	5.645	5
Nitrates (mg/L)	5.75	50
Phosphates (mg/L)	0.45	6.5
Sulphates (mg/L)	8	100
DO (mg/L)	8.49	5
BOD (mg/L)	3.425	5
Electrical Conductivity (µS)	73.1	1000
Total Dissolved Solids (mg/L)	50.65	500
Colour (PtCo)	57	15
Hardness (mg/L $CaCO_3$)	44	50

Source: (Ogbodo et al., 2020).

There are two main sources of water that are most prominently exploited for domestic, industrial, agricultural, and other anthropogenic activities. Firstly, surface water, which includes; lakes, streams, and drainage systems, which funnel water toward the holding reservoirs, and secondly, groundwater such as wells, springs, and horizontal galleries Garba et al., 2012; Garba et al., 2013; Sojobi, 2016; Dusa et al., 2017). Although water is one of the most abundant natural resources and it covers almost 70% of the earth's surface, the quantity of water is equally important as its quality (Garba et al., 2012). Omole (2013) reported that about 60% of Nigerians use groundwater for their domestic activities, including cooking food. He further articulated that inadequate and poorly maintained infrastructure, a shortfall in public utility water supply, improper financial resource management, inadequate funding for water and sanitation programs, and pollution of available surface water bodies are some of the factors that have exacerbated Nigeria's excessive demand for groundwater. Despite many national and international intervention projects on the need to deliver quality water to Nigerians, wells and boreholes remain the major sources of water for consumption. Several scientific investigations were carried out to ascertain the quality of water sources consumed in northern Nigeria (Amoo et al., 2018; Abubakar and Adekola, 2012; Boyi et al., 2017). Most of the existing research findings reported the quality of the investigated water as being suitable for consumption or otherwise, without much focus as far as achieving SDG-6 is concerned. With this, it has become imperative to ask ourselves how feasible it is by 2030 to ensure access to clean water for all (SDG-6), particularly in northern Nigeria.

The present state of water quality

In order to achieve sustainable development goals (SDG), particularly clean water and sanitation, it remains pertinent to know the present state of water quality in the region, the progress recorded and the journey so far, which are key performance indicators for the realisation of the goals. The review of existing literature on the assessment of water quality across the region in the last decade shows significant and insightful results. The results of all the literature reviewed were categorized into three, namely, suitable, fair, and unsuitable. Research results that prove the assessed water to be fit for consumption and free from all microbes were considered suitable. Unsuitable was applied to the water assessment that reported the investigated water as unfit and posing health threats to people. The last category was fair, which was applied to water that was suitable to some extent but required additional treatment or precautionary measures to prevent contracting diseases.

About 31.14% of the water being utilized in the north is fair – can be utilized for consumption but requires additional treatment to prevent disease outbreaks and health implications (Ezeribe et al., 2012; Olukosi et al., 2016; Dusa et al., 2017; Atiku et al., 2018). More than 50% of the water found to be fair was in good physical condition. Parameters such as temperature, pH, conductivity, colour, TDS, TSS, turbidity, etc were all reported to be within the acceptable limit (Iliyasu et al., 2021; Magaji and Abimbola, 2020; Ogah and Ukaegbu, 2019; Bello et al., 2017; Uba et al., 2017; Bello et al., 2018; Mustapha et al.,2021). The water conforms to the physicochemical parameters standard set by WHO and SON (Table 1) but requires a serious treatment of biological and radiological, as well as heavy metals contamination which could be more harmful to people (Bwadi et al., 2021; Abba et al. 2020; Ijah et al., 2020; Badejo et al., 2017; Olatunji et al., 2015; Aremu et al. 2014; Giwa et al. 2014; Udiba et al. 2013). The majority of the water consumed in northern Nigeria (55.74%) was reported to be unsuitable for consumption (Raji et al., 2010; Adabara et al., 2011; Abubakar and Adekola, 2012; Garba et al., 2012; Amadi et al., 2013; Garba et al., 2013; Isa et al., 2013; Sabo et al., 2013, Omole, 2013; Abdullahi et al., 2016a; Abdullahi et al., 2016b; Adekola et al., 2016; Jabbo et al., 2016; Unique et al, 2016; Sojobi, 2016; Boyi et al., 2017; Amoo et al., 2018; Abdulsalam et al., 2019; Adesakin et al., 2020; Abubakar, 2021). This was attributed to the high level of contamination from different sources, as proved by the most deviated biological and radiological parameters against standards set by recognized local and international organizations. The concentration of heavy metals and microbiological loads in the water was significantly high and is a major roadblock to portable water for northerners (Ibrahim et al., 2020; Musa et al., 2020; Aliyu et al., 2020; Ogbozige et al., 2017; Haruna et al., 2016; Allamin et al., 2015; Ojo et al., 2014). Chemical and microbial contamination of the water was attributed to the high rate of population growth and several anthropogenic activities, as well as lack of access to enough water for

sanitation and hygiene (Odey et al., 2022; Raji et al., 2020; Emurotu and Habib, 2019; Fardami et al., 2019; Sunday et al. 2019; Omotayo et al., 2017; Zubairu et al., 2016).

Although 2030 is eight (8) years away from now, it is unfortunate that only 13.11% of clean water is accessible to the northern populace (Sani and Rabiu, 2022; Paul et al., 2021; Abdulsalam and Sule, 2020; Gana et al., 2020; Suleiman et al., 2018; Gav et al., 2015; Tukura, 2013; Alhassan and Ujoh, 2012). This represents the few available pipe-borne water and boreholes, and well waters that are far away from contamination sources—such as anthropogenic activities. Regardless of the reasons responsible for this, it is a great cause of concern and a major threat to achieving SDG goal 6.

Access to clean water suitable for consumption has been quite challenging because hand-dug open wells and boreholes remain the major sources of water for the masses, as the cost of exploitation is far cheaper when compared to pipe-borne water (Adeyeye et al., 2019). It is crystal clear that achieving clean water and sanitation, particularly in the northern part of the country, is near impossible unless a magical approach to circumventing the problem is employed. Mor and Griffiths (2008) claimed that water-related diseases that exist in developed countries at a very low level remain a major source of illness and mortality in developing countries such as Nigeria. He further attributed it to inadequate access to improved sanitation.

CONCLUSION

Water, as a very important resource necessary to sustain life, is crucial to be obtained in a clean and portable way - devoid of impurities. Its quality is characterized by the physical, chemical, biological, and radiological parameters obtainable from analyses of the necessary parameters. The reviewed existing literature shows that the water quality in the north is extremely poor, as the majority of the populace relies on wells and boreholes for their consumption, which have proven unsuitable due to various levels of contamination. The challenges of lack of access to clean water were attributed to poverty, government negligence and poor policies, indifferent attitudes and lack of orientation of the public, particularly the localities. In order for northern Nigeria, as a major part of Nigeria, to achieve SDG goal 6, which will, in turn, push Nigeria towards meeting the SDG goals by 2030, there is a collective need for intensive projects to provide pipe-borne water, which is reported to be the most portable among all sources of water for consumption. Achieving SDG-6 in Nigeria may not be feasible by 2030 unless a magical approach is employed by the government, NGOs, and individual households to improve the standard of water utilized in the region. These approaches could include providing access to improved sanitation; proper waste disposal, particularly, solid waste and e-waste; state and local water treatment plants; and pipe-borne water in various communities. It is also critical to note that water quality is an essential part of sustainability and must be taken seriously if the SDGs are to be achieved by 2030.

DECLARATION OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

Abba, S. I., Usman, A. G, Danmaraya, Y. A, Usman, A. G. and Abdullahi, H.U. (2020). Modeling of water treatment plant performance using artificial neural network: case study Tamburawa Kano-Nigeria. *Dutse Journal of Pure and Applied Sciences (DUJOPAS)* 6(3): 135-144.

Abdullahi, S., Ndikilar, C. E., Suleiman, A. B. and Hafeez, H. Y. (2016a). Evaluation of radioactivity concentration in drinking water collected from local wells and boreholes of dutse town, North West, Nigeria. *International Journal of Environmental Monitoring and Analysis* 4(1): 6-11. https://doi.org/10.11648/j.ijema.20160401.12

Abdullahi, S., Ndikilar, C. E., Suleiman, A. B. and Hafeez, H. Y. (2016b). Assessment of heavy metals and radioactivity concentration in drinking water collected from local wells and boreholes of Dutse Town, North West, Nigeria. *Journal of Environment Pollution and Human Health* 4(1):1-8. https://doi.org/10.12691/jephh-4-1-1

Abdulsalam, Z. B. and Sule, I. O. (2020). Assessment of the potability of water source in some rural communities in Ilorin East, Kwara, Nigeria. *Science World Journal* 15(1): 84-89.

Abdulsalam, H., Nuhu, I. and Lawal, Y. (2019). Physicochemical and heavy metals assessment of some selected borehole water in Dutse town of Jigawa state. *FUDMA Journal of Sciences* 3(4): 212 –223.

Abubakar, B. and Adekola, O. (2012). Assessment of borehole water quality in Yola-Jimeta Metropolis, Nigeria. *International Journal of Water Resources and Environmental Engineering* 4(9): 287-293. https://doi.org/10.5897/IJWREE12.012

Abubakar, I. R. (2021). Understanding the socioeconomic and environmental indicators of household water treatment in Nigeria. *Utilities Policy* 70: 101209. https://doi.org/10.1016/j.jup.2021.101209

Adabara, N. U., Mawak, J. D., Momohjimoh, A., Bala, J. D., Abdulrahaman, A. A., Oyedum, U. M. and Jagaba, A. (2011). Relative bacteriological assessment of public borehole and well water in Bosso town, North-Central Nigeria. *International Journal of Biomedical and Advance Research* 2(10): 416-419.

Adekola, O., Bashir, A. and Kasimu, A. (2015). Physico-chemical characteristics of borehole water quality in Gassol Taraba State, Nigeria. *African Journal of Environmental Science and Technology* 9(2): 143-154. https://doi.org/10.5897/AJEST2014.1794

Adesakin, T. A., Oyewale, A. T., Bayero, U., Mohammed, A. N., Aduwo, I. A., Ahmed, P. Z., Abubakar, N. D. and Barje, I. B. (2020). Assessment of bacteriological quality and physico-chemical parameters of domestic water sources in Samaru community, Zaria, Northwest Nigeria. *Heliyon* 6: e04773. https://doi.org/10.1016/j.heliyon.2020.e04773

Adeyeye, O. A., Ikpokonte, E. A. and Arabi, S. A. (2019). GIS-based groundwater potential mapping within Dengi area, NorthCentral Nigeria. *The Egyptian Journal of Remote Sensing and Space Sciences* 22: 175–181. https://doi.org/10.1016/j.ejrs.2018.04.003

Alhassan, M. M. and Ujoh, F. (2012). Assessment of the chemical quality of potable water sources in Abuja, Nigeria. *British Journal of Applied Science & Technology* 2(2): 146-172.

Aliyu, D., Mustapha, M. and Ahmed, S. (2020). Assessment of groundwater quality in Panteka, Tudun Nupawa, Kaduna south, Kaduna state, Nigeria. *American Journal of Engineering Research (AJER)* 9(06): 62-72.

Allamin, I. A., Borkoma, M. B., Joshua, R. and Machina, I. B. (2015). Physicochemical and bacteriological analysis of well water in Kaduna Metropolis, Kaduna State. *Open Access Library Journal* 2: e1597. http://dx.doi.org/10.4236/oalib.1101597

Amadi A. N., Dan-Hassan, M. A., Okoye, N. O., Ejiofor, I. C. and Aminu T. (2013). Studies on pollution hazards of shallow hand-dug wells in Erenaand environs, North-Central Nigeria. *Environment and Natural Resources Research* 3(2): 69-77. https://doi.org/10.5539/enrr.v3n2p69

Amoo, A. O., Gambo, Y. H., Adeleye, A. O. and Amoo, N. B. (2018). Assessment of groundwater quality in Sharada industrial area of Kano, north-western Nigeria. *FUW Trends in Science & Technology Journal* 3(24): 407 – 411.

Anzaku, M. and Umar, I. G. (2021). Analysis of water quality for domestic use in Lafia Town, Nasarawa State, Nigeria. *Global Journal of Human-Social Science Research* 21(1B) https://socialscienceresearch.org/index.php/GJHSS/article/view/3558

Aremu, M. O., Majabi, G. O., Oko, J. O., Opaluwa, O. D., Gav, B. L. and Osinfade, B. G. (2014). Physicochemical analyses of different sources of drinking water in Okene local government area of Kogi State, Nigeria. *Civil and Environmental Research* 6(5): 143-150.

Atiku, S., Ogbaga, C. C., Alonge, O. O. and Nwagbara, O. F. (2018). Comparative study of the physicochemical and bacteriological qualities of some drinking water sources in Abuja, Nigeria. *Global Journal of Pure and Applied Sciences* 24: 91-98. https://dx.doi.org/10.4314/gjpas.v24i1.11

Azeez, W. (2021). FACT CHECK: Is the north's population 160m as claimed by a northern coalition? Accessed on 20th April, 2022 from https://www.thecable.ng/fact-check-does-the-north-have-population-of-160m-as-claimed-by-a-northern-coalition

Badejo, B. I., Abubakar, K. A., Zira, J. D. and Enoch, B. B. (2017). Assessment of physicochemical parameters of river Yobe, Gashua, Yobe State, Nigeria. *International Journal of Fisheries and Aquatic Studies* 5(2): 93-98.

Bello, N., Adamu, I. A. and Musa, A. (2017). Evaluation of factors influencing the quality of surface and ground sourced sachet water in Sokoto metropolis using principal components analysis (PCA). *International Journal of Scientific & Engineering Research* 8(2): 308-317.

Bello, S., Yahaya, M. M. and Bakara, L. M. (2018). Assessment of water chemical parameters of Kware Lake in Sokoto State. *International Journal of Innovative Biosciences Research* 6(1):8-19.

Boyi, S., Yusuf, Y. O., Sawa, B. A. and Adegbehin, A. B. (2017). An assessment of the physicochemical qualities of water sources in Kano metropolis, Nigeria. *Zaria Geographer* 24(1): 127-138.

Boyi, S., Yusuf, Y.O., Sawa, B. A. and Adegbehin, A. B. (2017). An assessment of the physicochemical qualities of water sources in Kano metropolis, Nigeria. *Zaria Geographer* 24(1): 127-138.

Bwadi, B. E., Yusuf, M. B., Abdullahi, I., Giwa, C. Y. and Audu, G. (2021). Analysis of ground water from selected sources in Jalingo Metropolis, Nigeria. In Dunea, D. (ed.): Water Quality - Factors and Impacts. *IntechOpen*. https://doi.org/10.5772/intechopen.99082

Dusa, A. A., Timothy, N., Magili, S. T. and Tukur, S. (2017). Determination of heavy metals in boreholes, hand dug wells and surface water in some selected areas of Mubi north local government area Adamawa State, Nigeria. *International Research Journal of Chemistry and Chemical Sciences* 4(1): 075-081.

Emurotu, J. E. and Habib, L. O. (2019). Assessment of some water quality of Obuburu River, Okene, Kogi State, Nigeria. *Journal of Applied Science and Environmental Management* 23(11): 1995-2002. https://dx.doi.org/10.4314/jasem.v23i11.14

Ezeribe, A. I., Oshieke, K. C. and Jauro, A. (2012). Physico-chemical properties of well water samples from some villages in Nigeria with cases of stained and mottle teeth. *Science World Journal* 7(1): 1-3.

Fardami, A. Y. Mamuda, B. and Kangiwa, I. A. (2019). Bacteriological analysis of drinking water in Zamfara north senatorial district, Nigeria. *Microbiology Research Journal International* 27(5): 1-7. https://doi.org/10.9734/MRJ/2019/v27i530110

Gana, A. J., Adeniyi, I. A., Braimoh, S. O., Oguntayo, D. O., Ibitogbe, E. M. and Ejigboye, P. O. (2020). Quality assessment of sachet packed water in Omu-Aran, Kwara State. *IOP Conference Series: Materials Science and Engineering* 1036 (2021) 012069.https://doi.org/10.1088/1757-899X/1036/1/012069

Garba, N. N., Rabi'u, N., Dewu, B. B. M., Sadiq, U. and Yamusa, Y. A. (2013). Radon assessment in ground water sources from Zaria and environs, Nigeria. *International Journal of Physical Sciences* 8(42): 1983-1987. https://doi.org/10.5897/IJPS2013.4035

Garba, Z. N., Gimba, C. E. and Galadima, A. (2012). Arsenic contamination of domestic water from Northern Nigeria. *International Journal of Science and Technology* 2(1): 55-60.

Gav, B. L., Aremu, M. O., Usman, Y., and Tsaviv, J. N. (2015). Assessment of water quality parameters of river Doma, Farinruwa and Mada in Nasarawa State, Nigeria. *Journal of Natural Sciences Research* 5(11): 16-21.

Giwa, S. I., Abubakar, M. G., Zakari, A. and Ishaq, D. U. (2014). Determination of lead concentrations in different water sources collected from Sokoto Metropolis, Nigeria. *IOSR Journal of Applied Chemistry* 7(12): 53-56.

Haruna, M. K., Idi-Ogede, A. M., Wali, A. S. and Vershima, A. D. (2016). Coliform bacteria analysis of river Amba, Lafia, Nasarawa State. *CARD International Journal of Medical Science and Applied Biosciences* 1(3): 31-39.

Ibrahim, E. G, Gube-Ibrahim, M. A, Ankwai, G. E and Dapam, I. L. (2020). Assessment of drinking water quality in selected locations in selected states of north central Nigeria. *IOSR Journal of Applied Chemistry* 13(1): 12-21. https://doi.org/10.9790/5736-1301011221

Ighalo, J. O and Adeniyi, A. G. (2020). A Comprehensive review of water quality monitoring and assessment in Nigeria. *Chemosphere* 260, 127569. https://doi.org/10.1016/j.chemosphere.2020.127569

Ijah, A. A., Zakka, E. J., Oladele, O. N. and Olagunju, O. E. (2020). Assessment of ground water quality (A case study of Mando, Igabi local government area, Kaduna State). *Asian Journal of Geological Research* 3(4): 16-25. https://journalajoger.com/index.php/AJOGER/article/view/30114

Isa, M. A., Allamin, I. A., Ismail, H. Y. and Shettima, A. (2013). Physicochemical and bacteriological analyses of drinking water from wash boreholes in Maiduguri Metropolis, Borno State, Nigeria. *African Journal of Food Science* 7(1): 9-13.https://doi.org/10.5897/AJFS12.073

Jabbo, J. N., Ugodulunwa, F. X. O., Yusuf, U. M., Maiauduga, N. A., Gin, N. S., Usman, A. M., Gani, S. J. and Dung, S. G. (2016). Water Quality Assessment of Some Selected Hand Dug Wells and a Borehole in North Eastern Parts of Bauchi Metropolis, Nigeria. *Journal of Environment and Earth Science* 6(6): 137-145.

Magaji, J. Y. and Abimbola, T. A. (2020). Comparative analysis of water quality from different sources in Masaka, Nasarawa State, Nigeria. *Australian Journal of Science and Technology* 4(3): 303-311.

Griffiths, J. K. (2008). Waterborne Diseases. In: Heggenhougen, H. K. (ed.). *International Encyclopedia of Public Health*. Elsevier, 551 – 563.https://doi.org/10.1016/B978-012373960-5.00565-7

Musa, J. J., Akpoebidimiyen, O. E., Musa, M. T., Dada, P. O. O. and Musa, E. T. (2020). Evaluation of temporal changes in deep well water quality in Igabi local government area of Kaduna State. *Journal of Environmental Protection* 11(1): 22-33. https://doi.org/10.4236/jep.2020.111003

Mustapha, M., Sridhar, M. and Coker, A. O. (2021). Assessment of water supply system from catchment to consumers as framed in WHO water safety plans: A study from Maiduguri water treatment plant, North East Nigeria. *An international journal of environmental health and sustainability* 7(1): 1-14. https://doi.org/10.1080/27658511.2021.1901389

Odey, M. O., Udiba, U. U., Adindu, E. A., Enyievi, P. B., Edu, B. C., Eteng, M. U., Uboh, F. E. and Emuru, O. E. (2022). Safety evaluation and potential health implications of water from post-remediated lead-polluted areas of Zamfara State, Nigeria. *Calabar Journal of Health Science* 6(1): 15-23.https://doi.org/10.25259/CJHS_39_2021

Ogah, S. P. I. and Ukaegbu, E. E. (2019). Physicochemical analysis of water samples from Lafia metropolis, Nasarawa State, Nigeria. *IOSR Journal of Applied Chemistry* 12(8): 13-23. https://doi.org/10.9790/5736-1208021323

Ogbodo, C., Wuana, R., Itodo, A. U. and Eneji, I. S. (2020). Physicochemical parameters and water quality index of water in the lower Usuma Dam, FCT, Nigeria. *IIARD International Journal of Geography and Environmental Management* 6(2): 30-40.

Ogbozige, F. J., Adie, D. B., Igboro, S. B. and Giwa, A. (2017). Evaluation of the water quality of river Kaduna, Nigeria using water quality index. *Journal of Applied Sciences and Environmental Managemen*, 21 (6): 1119-1126. https://dx.doi.org/10.4314/jasem.v21i6.21

Ojo, O. I., Graham, W. B. R. and Pishiria, I. W. (2014). Environmental implications of groundwater quality in irrigated agriculture in Kebbi State, Nigeria. *Civil and Environmental Research* 6(9): 21-28.

Olatunji, J. A., Odediran, O. A., Obaro, R. I. and Olasehinde, P. I. (2015). Assessment of groundwater quality of Ilorin metropolis using water quality index approach. *Nigerian Journal of Technological Developments* 12(1): 18-21.

Olukosi, O. M., Ameh, J. B., Abdullahi, I. O. and Whong, C. M. Z. (2016). Physicochemical quality of drinking water from various water sources of Kaduna state, Nigeria.*Bayero Journal of Pure and Applied Sciences* 9(2): 141 – 144. http://dx.doi.org/10.4314/bajopas.v9i2.26

Omole, D. O. (2013). Sustainable groundwater exploitation in Nigeria. *Journal of Water Resources and Ocean Science* 2(2): 9-14. https://doi.org/10.11648/j.wros.20130202.11

Omotayo, A. R., EL-Ishaq, A., Bafeto, M. A. and Yunusa, M. A. (2017). Evaluation of water quality parameters from five locations in Yobe State, Nigeria. *Direct Research Journal of Public Health and Environmental Technology* 2(2): 16-20.

Paul, Y., Ocheme, V. A. and Timothy, L. (2021). Analyzing the quality of ground water in Kaduna South local government area, Kaduna State, Nigeria. *FUDMA Journal of Sciences (FJS)* 5(2): 413-418. https://doi.org/10.33003/fjs-2021-0502-63

Raji, M. I. O., Ibrahim, Y. K. E. and Ehinmidu, J. O. (2010). Physico-chemical characteristics and Heavy metal levels in Drinking Water sources in Sokoto metropolis in North-western Nigeria. *Journal of Applied Science and Environmental Management* 14(3): 81 – 85. https://doi.org/10.4314/jasem.v14i3.61473

Sabo, A., Adamu, H. and Yuguda, A. U. (2013). Assessment of Wash-Borehole water quality in Gombe Metropolis, Gombe State, Nigeria. *Journal of Environment and Earth Science* 3(1): 65-71.

Sani, Z. R. and Rabiu, S. (2022). Surface water comparative assessment of physicochemical properties of channels effluent and new Gusau reservoir, Zamfara State, Nigeria. *Arid Zone Journal of Basic and Applied Research* 1(1): 168-176.

Sojobi, A. O. (2016). Evaluation of groundwater quality in a rural community in North Central of Nigeria. *Environmental Monitoring and Assessment* 188(192): 1-17. https://doi.org/10.1007/s10661-016-5149-y

Sulaiman, M. B., Maigari, A. U. and Ringim, S. A. (2018). Quality index of drinking water from different sources in Gombe town, northern Nigeria. *Journal of Chemical Society of Nigeria* 43(4): 752 -758.

Sunday, M., Wyasu, G. and Yilleng, M. T. (2019). Physicochemical and bacteriological quality of water collected from dams and rivers along gold mining sites in Zamfara State. *Science World Journal* 14(1): 148-155.

Tukura, B. W., Ibrahim, E. G., Onche, E. U., and Ibrahim, M. A. G. (2013). Preliminary assessment of physicochemical properties of borehole water in the vicinity of public health facilities in Nasarawa State, Nigeria. *IOSR Journal of Applied Chemistry* 5(6): 55-63.

Uba, A., Liman, M. G., Yahaya, M., Abdullahi, M. I. and Yusuf, A. J. (2017). Physicochemical and heavy metal analysis of raw, treated water and sludge samples from a treatment plant in Sokoto, Nigeria. *FUW Trends in Science and Technology Journal* 2(1): 65-68.

Udiba, U. U., Bashir, I., Akpan, N. S., Olaoye, S., Idio, U., Odeke, E. H., Ugoji, V., Anyahara, S. and Agboun T. D. T. (2013). Impact of mining activities on ground water quality status, Dareta Village, Zamfara, Nigeria. *Archives of Applied Science Research* 5(1): 151-158.

Unique, N. K., Babadoko, M. A., Francis, O. A. and Awe, E. (2016). Assessment of the quality of selected borehole water in the federal polytechnic, Bida, Niger state, Nigeria. *Fresenius Environmental Bulletin* 25(9): 3475-3483.

United Nations (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. A/RES/70/1. United Nations, New York. 41p.

World population reviews (2022) Accessed on 20th April, 2022 from https://worldpopulationreview.com/countries/nigeria-population

Worldmeter (2022). Nigeria Population (Live) accessed on 20th April, 2022 from https://www.worldometers.info/world-population/nigeria-population/

Zubairu, A. Y., Mukhtar, M., Sokoto, A. M., Zubairu, A. and Lafiya, H. M. (2016). Preliminary assessment of heavy metals and water quality of some selected wells in Talata Mafara, Zamfara, Nigeria. *FU Lafiya Journal of Science & Technology* 2(2): 100-105.