Bima Journal of Science and Technology, Vol. 9(2B) Jul, 2025 ISSN: 2536-6041
E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1272

Determination of Physicochemical Parameters and Heavy Metals in Some Selected Borehole Water Within Nguru Local Government Area, Yobe State

Sadi Idriss[1], Abdussamad Mukhtar Mohammed[1]* and Umar Abba Aji[2]

[1]Department of Chemistry, Yobe State University Damaturu, Yobe State, Nigeria
[2]Department of Applied Chemistry, Federal Polytechnics Damaturu, Yobe State, Nigeria

Corresponding Author: ammohammed@ysu.edu.ng, idrisssadis@gmail.com

ABSTRACT

Recently, there has been widespread kidney infection and other waterborne diseases in Yobe, most especially in areas of Nguru, Gashua, and their environs. This research was conducted to ascertain the water quality of some selected boreholes within Nguru Local Government Yobe State. The samples were collected in four different locations in the area. The Atomic Absorption Spectrophotometer (AAS) was used to identify the heavy metals. A comparison was made with the standard given by the World Health Organization (WHO), Standard Organization of Nigeria (SON), and National Agency for Food and Drug Administration Control (NAFDAC) respectively. The chemical parameters as well as the physical parameters such as pH, turbidity, alkalinity, and color in all the samples were determined. The result revealed that almost all the samples have a higher content of cadmium (0.003-0.005 mg/L) than the required threshold (0.003 mg/L). Cadmium is reported to be toxic to the kidneys, as such this requires serious concern. Likewise, the values obtained for arsenic (0.01-0.02 mg/L) and chromium (0.04-0.1 mg/L) have exceeded the required threshold (0.01 mg/L for arsenic and 0.05 mg/L for chromium). This also calls for serious attention as they are known carcinogens. It is concluded that all the water samples are not safe for drinking and as such require treatment before consumption to meet the standard for portable drinking water.

Keywords: Water, Heavy Metals, Bore Holes, Nguru, Physical Parameters.

INTRODUCTION

One of the most vital components of existence and a high standard of living is water. Significant changes in the quantity, quality, and use of water were brought about by the fast population growth as well as the expansion of industrial, agricultural, and forestry operations. Freshwater sources make up only 2.5 percent of the world's total water reserve, and as many nations have become more interested in studying freshwater quality in recent decades, there is concern that high-quality water will soon become scarce (Mishra, 2023).

Water is essential to preserving human health and well-being. It is commonly acknowledged that everyone has the fundamental right to clean drinking water. Approximately 2.5 billion people lack adequate sanitation, and 780 million people lack access to safe and clean water (Kumar *et al*., 2022; Rahmanian *et al*., 2015) . As a result, illnesses and disasters linked to water cause over 6–8 million deaths annually (Rahmanian *et al*., 2015; Veenema *et al*., 2017). Consequently, in many regions of the world, water quality regulation is a top priority policy agenda item. Domestic water is the term frequently used to describe the water utilized by households (Fan *et al*., 2014). This water has been treated so that it can be safely used for drinking and other uses. Taste, odor, color, and the amount of organic and inorganic debris in the water all affect its quality and suitability for usage (Patil *et al*., 2012).

Water contaminants can have an impact on water quality and, in turn, human health. Geological conditions, industrial processes, agricultural practices, and water treatment facilities are all possible causes of

Bima Journal of Science and Technology, Vol. 9(2B) Jul, 2025 ISSN: 2536-6041
E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1272

contaminated water. These pollutants are further divided into radionuclides, organics, inorganics, microbes, and disinfectants (Rahmanian *et al*., 2015)

Compared to organic chemicals, inorganic chemicals make up a larger percentage of drinking water pollutants; some of these inorganics include minerals that are forms of heavy metals (Srinivasan, 2011) . Human organs and the neurological system are prone to heavy metal accumulation, which disrupts their regular functions. Heavy metals like lead (Pb), arsenic (As), magnesium (Mg), nickel (Ni), copper (Cu), and zinc (Zn) have drawn a lot of attention lately since they can cause health issues (Okechukwu Ohiagu *et al*., 2022) . Furthermore, epidemiological studies have linked traces of metals including cadmium (Cd) and chromium (Cr) to cancer, kidney issues, cardiovascular ailments, and neurocognitive disorders. While arsenic (As) and mercury (Hg) can cause serious poisoning with skin pathology and cancer as well as subsequent damage to the kidney and liver, respectively, lead (Pb) is known to influence an infant's physical and mental development (Rahmanian *et al*., 2015).

To evaluate water contaminants, a number of scientific methods and instruments have been developed. These include the study of several parameters like conductivity, turbidity, and pH. If these metrics' values are higher than the World Health Organization's (WHO) safe limits, it may have an impact on the quality of the drinking water (Rahmanian *et al*., 2015) . Consequently, researchers and government agencies have been routinely investigating the quality of drinking water all over the world (Li & Wu, 2019).

Several works were reported in the literature on the determination of physical parameters and heavy metals in some selected borehole waters in some parts of Yobe (Damaturu, Potiskum, etc) and other parts of the country (Bayelsa, Ilorin, Jabi, etc) (Amararu *et al*., 2023; Ismaila *et al*., 2017; Samuel & Gashua, 2024; Usman *et al*., 2025) . However, to the best of our knowledge there is no published information in the literature on the determination of physical parameters and heavy metals in some selected boreholes water within Nguru Local Government Area, Yobe State, therefore this research intends to determine physical parameters and heavy metals in some selected borehole water within Nguru Local Government Area, Yobe State in order to ascertain the quality of the water.

MATERIALS AND METHODS

Before and during the experiment, the devices and equipment utilized in this investigation were carefully calibrated to assess their condition. Volumetric flasks and measuring cylinders were among the equipment that was carefully cleaned using detergents and tap water before being rinsed with deionized water. To remove any heavy metal from its surfaces, all of the glassware was cleaned with 10% concentrated nitric acid (HNO_3) before being rinsed with distilled deionized water.

Brief Description of Study Area

With its headquarters located at Nguru town, next to the Hadejia river, Nguru is one of the local governments in Yobe state, Nigeria. The coordinates are 12°52′45 N 10°27′09 E. According to the 2006 Census, it has a population of 150,632 and an area of 916 km². The settlement is most likely from the 15th century, and its postal code is 630. The region features a range of geographical types, such as the semi-desert Dunes and the protected Hadejia-Nguru wetlands of Nguru Lake (Babagana *et al*., 2018; Yakubu Yusuf *et al*., 2023).

Bima Journal of Science and Technology, Vol. 9(2B) Jul, 2025 ISSN: 2536-6041
E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1272

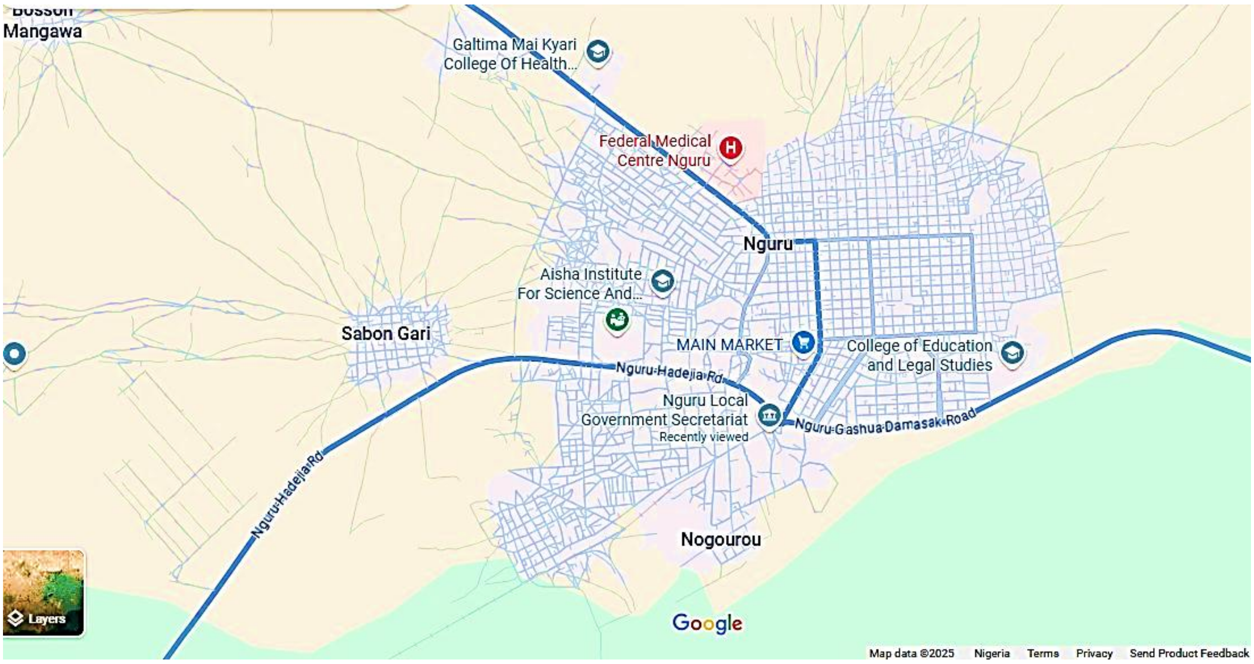

Figure 1: Map of the study area.

Preparation of 1000mg/litre stock aas standard solution for Selected Heavy Metals

The calibration curve for each metal was used to determine the concentration of that metal in the experimental solution. The manufacturer's firm provided a stock solution of 1000 ppm of each metal ion, from which a standard working solution of 100 ppm was made in order to plot the calibration curves for lead, cadmium, zinc, and other metals (Lamrot Yohannes *et al*., 2024).

Standard Working Solution

A workable solution of 100 ppm was made from the 1000 ppm that had previously been prepared. The volume of the stock solution to be diluted to the new required concentration was determined using the straightforward dilution formula ($C_1V_1 = C_2V_2$). Each working standard received 1 mL of concentrated HNO_3, which was then diluted with deionized water to the appropriate amount.

Pb, Cr, Cd, and other stock solution standards were pipetted into 100 ml calibrated flasks, diluted with deionized water, and carefully mixed to create 100. Pipetting the required volume into calibrated flasks and adding deionized water to make up the volume, the other standard working solutions were created starting at 100 ppm (Mendil *et al*., 2015).

Preparation of Calibration Curve

To ascertain the metal concentration in the sample solution, calibration curves were created. The instrument was calibrated using series of working standards. The working standard solutions of each metal were prepared from standard solutions of their respective metals and their absorbances were taken using the AAS. Calibration curve for each metal ion to be analyzed was prepared by plotting the absorbance as a function of metal ion standard concentration (Mendil *et al*., 2015).

Determination of Metal Contents of each Sample

By measuring the absorbance of the metal ions in the sample using AAS (Buck Scientific model 210GP) and comparing it to the corresponding standard calibration curve, the concentration of the metal ions was ascertained. For every sample, three replicate determinations were made. The instrument readout was manually recorded for every solution, and the metals were identified using the absorption/concentration mode. The components in the digested blank (soil only) solutions and the spiked samples were determined using the same analytical technique (Lamrot Yohannes *et al*., 2024; Mendil *et al*., 2015). Microsoft Office Excel was utilized for the analysis of the data. Descriptive statistics were used to express the data, and mean values (Mean±SD) were used to display the figures.

Samples and Sampling

As indicated in Table 1, the samples were gathered from four (4) distinct locations. A. Federal Medical Center Nguru (12°52′45″N 10°27′09″E), B. College of Health Science and Technology, Nguru (12°53'14.3"N 10°26'40.8"E), C. Atiku Abubakar College of Education and Legal Studies Nguru (12°55′12″N 10°28′26″E), and D. Nguru Local Government Secretariat (12°52′45″ N 10°27′09″ E). The samples were collected from the sources in 1.5 liters containers thoroughly washed and rinsed with the water sample. The containers were sealed to prevent contamination. The samples were then stored in a refrigerator until analyzed.

Table 1: The Sampling Location

S/N	Sample	Name of place
1.	A	Federal Medical Center Nguru
2.	B	College of Health Science and Technology Nguru
3.	C	Atiku Abubakar College of Education and Legal Studies Nguru
4.	D	Nguru Local Government Secretariat

Analysis of the Samples

Using a digital pH meter model 3505 Jenway, the samples' pH and electrical conductivity were measured. However, Heavy metals were analyzed using Atomic Absorption Spectroscopy (AAS).

RESULTS AND DISCUSSION

Table 2 displays the outcome of the physiochemical parameters. It is evident that every sample's pH is within the WHO, SON, and NAFDAC limits. However, in the case of samples A and C, the turbidity is comparatively higher than the standards. Because it indicates a higher degree of cloudiness or haziness brought on by the presence of suspended particles like silt, clay, or algae, high turbidity is a crucial indicator of water quality. Light is scattered by these particles, giving the water a muddy or less clear appearance. Meanwhile, the color intensity falls within the required limit (Salim *et al*., 2025). Nevertheless, according to WHO criteria, the conductivity of every sample is greater than the required limit. However, the water is safe to drink according to NAFDAC and SON conductivity criteria. The ability of water to carry electric current is referred to as its conductivity. This capability is closely correlated with the amount of electrically charged dissolved ions in the water. Higher conductivity water has a greater ability to carry electricity because it usually contains more dissolved salts and other inorganic components (Yap *et al*., 2025).

Table 2: Physical parameters of the samples in comparison with NAFDAC, SON, and WHO standards.

Sample	A	B	C	D	NAFDAC	SON	WHO
pH	6.85+0.02	7.65+0.03	6.93+0.02	6.9+0.02	6.5-8.5	6.5-8.5	6.5-8.5
Turbidity (FAU)	5.72+0.02	4.24+0.04	5.46+0.05	4.05+0.04	5.0	5.0	5.0
Color (TCU)	6+0.2	0+0.1	0+0.1	8+0.3	15	15	1
Conductivity (µS/cm)	520+5	410+20	460+10	410+20	1000	1000	400

Bima Journal of Science and Technology, Vol. 9(2B) Jul, 2025 ISSN: 2536-6041
E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1272

The concentrations of the different heavy metals found in all the samples gathered are shown in Table 3 along with the health effects of each heavy metal in comparison to the various regulatory agencies. In the case of zinc, the values fall within the required limit with a little addition in the case of samples A and C. Zinc is not known to cause any health problem, but rather suitable amount of it is required by the body as it is an essential mineral that supports the immune system, aids in wound healing, and promotes general growth and development. It also helps to synthesize DNA and proteins, as well as retain taste and smell. Zinc may potentially lower the incidence of age-related disorders and increase immunological response by increasing T-cell and natural killer cell activity (Kanwar & Sharma, 2022). Likewise, in the case of copper, the values all fall within the required limit with the exception of sample D with a relatively higher content of copper. This sample may require treatment before consumption as the high content of copper in water leads to gastrointestinal disorders and other problems (Jomova *et al*., 2024).

Table 3: Heavy metals concentrations in comparison with NAFDAC, SON, and WHO standards.

Sample	A	B	C	D	NAFDAC	SON	WHO	Health Impact
Zinc (mg/L)	3.2+0.3	3.0+0.2	3.1+0.2	3.0+0.3	3.0	3.0	3.0	None
Copper (mg/L)	0.26+0.02	0.41+0.01	0.45+0.01	2.231+0.01	1.0	1.0	2.0	Gastrointestinal disorder
Cadmium (mg/L)	0.005+0.001	0.005+0.001	0.004+0.002	0.003+0.001	0.003	0.003	0.003	Toxic to the kidney
Arsenic (mg/L)	0.02+0.002	0.02+0.002	0.021+0.002	0.01+0.001	0.01	0.01	0.01	Cancer
Chromium (mg/L)	0.1+0.01	0.07+0.02	0.06+0.01	0.04+0.01	0.05	0.05	0.05	Cancer

Worthy of note here is the amount of cadmium in the samples. It can be seen that almost all the samples have a higher content of cadmium than the required threshold. Cadmium is reported to be toxic to the kidneys, this calls for serious concern. It is frequently seen in many environmental compartments owing to industrial emissions, agricultural operations, and inappropriate waste disposal (Yang *et al*., 2025) . Gashua which is very close to Nguru is a hotspot for kidney infection. The problem was reported to be associated with the water, soil, and plants of the area (Babagana-Kyari, 2023) . The people of Gashua and its environs engaged in irrigation farming with the water that is known as the Hadejia-Jama'are-Komadugu River. The river passes through Nguru before finally reaching Gashua. So, the elevated amount of heavy metals such as cadmium in the waters of Nguru and its environs is an indicator that the problem of kidney infection does not start and ends in Gashua alone. Other neighboring towns have to take serious measures to arrest this problem. Likewise, in the case of arsenic and chromium. The values obtained from the samples call for serious attention as they are known carcinogens (Smith & Steinmaus, 2009). All the values obtained have exceeded the required threshold, as such the samples required treatment before consumption.

Several methods can be used to remediate water that has high levels of arsenic and chromium, including reverse osmosis, oxidation, coagulation/filtration, and adsorption. Reverse osmosis is especially effective for removing arsenic and chromium (Pezeshki *et al*., 2023) . As such these methods can be employed to treat this water to avoid adverse health effects. The types of heavy metals and their concentration depend on the nature of the minerals present and the type of underground racial formation the concentration of metals tends to increase after a considerable stay in the distribution pipes (Gao *et al*., 2019).

CONCLUSION

This research was conducted to ascertain the water quality of some selected boreholes within Nguru Local Government Yobe State. The samples were collected in four different locations in the area. The heavy metals were determined using AAS. A comparison was made with the standard given by WHO, SON, and NAFDAC respectively. The chemical parameters as well as the physical parameters such as pH, turbidity, alkalinity, and color in all the samples were determined. The results showed that almost all of the samples contained more cadmium than the acceptable threshold. Cadmium is considered to be harmful to the kidneys, which raises major concerns. Similarly, the arsenic and chromium concentrations exceeded the required level. This also requires serious attention because they are recognized carcinogens. It is decided that all of the water samples are not suitable for drinking, and hence require treatment before consumption to fulfil the criteria for potable drinking water.

REFERENCES

Amararu, O. I., Udom, G. J., Ideozu, R. U., Amararu, O. I., Udom, G. J., & Ideozu, R. U. (2023). Physico-Chemical Characteristics and Heavy Metals in Groundwater Bassambiri-Nembe, Bayelsa State, Nigeria. *International Journal of Geosciences*, *14*(11), 1065–1084. https://doi.org/10.4236/IJG.2023.1411054

Babagana, M., Adamu, A., D. D., U., H. A., A., Ado, G., Yakubu, M., & I.U., Z. (2018). Characteristics and Socio Economic Activities of Local Communities Living Along the Nguru Wetlands, Yobe State, Nigeria. *International Journal of Contemporary Research and Review*, *9*(06), 20224–20239. https://doi.org/10.15520/ijcrr/2018/9/06/528

Babagana-Kyari, M. (2023). Exploratory GIS-based Mapping and Analysis of Chronic Kidney Disease Incidences in Gashua Town, Yobe State, Nigeria. *International Journal of Advances in Nephrology Research*, 31–45. https://journalijanr.com/index.php/IJANR/article/view/40

Fan, L., Liu, G., Wang, F., Ritsema, C. J., & Geissen, V. (2014). Domestic water consumption under intermittent and continuous modes of water supply. *Water Resources Management*, *28*(3), 853–865. https://doi.org/10.1007/S11269-014-0520-7/METRICS

Gao, J., Liu, Q., Song, L., & Shi, B. (2019). Risk assessment of heavy metals in pipe scales and loose deposits formed in drinking water distribution systems. *Science of The Total Environment*, *652*, 1387–1395. https://doi.org/10.1016/J.SCITOTENV.2018.10.347

Ismaila, O. S., Samsudeen, O. A., Yusuf, O. A., & Gunu, U. C. (2017). Assessment of Physicochemical Characteristics of Selected Borehole Waters in Oke-Oyi Community, Ilorin East Local Government Area, Kwara State. *Journal of Applied Sciences and Environmental Management*, *21*(6), 1127–1129. https://doi.org/10.4314/JASEM.V21I6.22

Jomova, K., Alomar, S. Y., Nepovimova, E., Kuca, K., & Valko, M. (2024). Heavy metals: toxicity and human health effects. *Archives of Toxicology 2024 99:1*, *99*(1), 153–209. https://doi.org/10.1007/S00204-024-03903-2

Kanwar, A., & Sharma, A. (2022). A review on role of zinc as a potent immunity boosting agent. *Materials Today:*

Proceedings, *68*, 880–885. https://doi.org/10.1016/J.MATPR.2022.06.423

Kumar, P., Srivastava, S., Banerjee, A., & Banerjee, S. (2022). Prevalence and predictors of water-borne diseases among elderly people in India: evidence from Longitudinal Ageing Study in India, 2017–18. *BMC Public Health*, *22*(1), 1–11. https://doi.org/10.1186/S12889-022-13376-6/TABLES/4

Lamrot Yohannes, Feleke, H., Melaku, M. S., & Amare, D. E. (2024). Analysis of heavy metals and minerals in edible vegetable oils produced and marketed in Gondar City, Northwest Ethiopia. *BMC Public Health*, *24*(1), 1–14. https://doi.org/10.1186/S12889-024-19695-0/TABLES/8

Li, P., & Wu, J. (2019). Drinking Water Quality and Public Health. *Exposure and Health*, *11*(2), 73–79. https://doi.org/10.1007/S12403-019-00299-8/METRICS

Mendil, D., Karatas, M., & Tuzen, M. (2015). Separation and preconcentration of Cu(II), Pb(II), Zn(II), Fe(III) and Cr(III) ions with coprecipitation method without carrier element and their determination in food and water samples. *Food Chemistry*, *177*, 320–324. https://doi.org/10.1016/J.FOODCHEM.2015.01.008

Mishra, R. K. (2023). Fresh Water availability and Its Global challenge. *British Journal of Multidisciplinary and Advanced Studies*, *4*(3), 1–78. https://doi.org/10.37745/BJMAS.2022.0208

Okechukwu Ohiagu, F., Chikezie, P. C., Ahaneku, C. C., & Chikezie, C. M. (2022). Human exposure to heavy metals: toxicity mechanisms and health implications. *Material Science & Engineering International Journal*, *6*(2), 78–87. https://doi.org/10.15406/mseij.2022.06.00183

Patil, P. N., Sawant, D. V., & Deshmukh, R. N. (2012). Physico-chemical parameters for testing of water – A review. *International Journal of Environmental Sciences*, *3*(3), 1194–1207. https://www.indianjournals.com/ijor.aspx?target=ijor:ijes&volume=3&issue=3&article=028

Pezeshki, H., Hashemi, M., & Rajabi, S. (2023). Removal of arsenic as a potentially toxic element from drinking water by filtration: A mini review of nanofiltration and reverse osmosis techniques. *Heliyon*, *9*(3), e14246. https://doi.org/10.1016/J.HELIYON.2023.E14246

Rahmanian, N., Ali, S. H. B., Homayoonfard, M., Ali, N. J., Rehan, M., Sadef, Y., & Nizami, A. S. (2015). Analysis of Physiochemical Parameters to Evaluate the Drinking Water Quality in the State of Perak, Malaysia. *Journal of Chemistry*, *2015*(1), 716125. https://doi.org/10.1155/2015/716125

Salim, A., Rajeev, A., Perumkuni, S. P., Raj, R., Sankaran, A., Pillai, I. M. S., & Pullukkuchalil, F. (2025). Developing the recommendations for restoration of Ashtamudi Lake, Kerala, India, by data analysis based on a novel water body index using Google Earth Engine. *Environmental Science and Pollution Research*, *32*(11), 7025–7043. https://doi.org/10.1007/S11356-025-36141-9/METRICS

Samuel, Y. M., & Gashua, I. B. (2024). Environmental Pollution and Characterization of Borehole Water in Some Parts of Damaturu Metropolis Yobe State. In *Journal of Multidisciplinary Research and Innovation (SAMRI)* (Vol. 1).

Smith, A. H., & Steinmaus, C. M. (2009). Health Effects of Arsenic and Chromium in Drinking Water: Recent Human Findings. *Annual Review of*

E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1272

Public Health, *30*, 107. https://doi.org/10.1146/ANNUREV.PUBLHEALTH.031308.100143

Srinivasan, R. (2011). Advances in Application of Natural Clay and Its Composites in Removal of Biological, Organic, and Inorganic Contaminants from Drinking Water. *Advances in Materials Science and Engineering*, *2011*(1), 872531. https://doi.org/10.1155/2011/872531

Usman, M. I., Aliyu, A., & Agada, L. E. (2025). Investigation of Groundwater Pollution: A Case Study of Potiskum, Yobe State. *Journal of Science Research and Reviews*, *2*(2), 20–32. https://doi.org/10.70882/JOSRAR.2025.V2I2.65

Veenema, T. G., Thornton, C. P., Lavin, R. P., Bender, A. K., Seal, S., & Corley, A. (2017). Climate Change–Related Water Disasters' Impact on Population Health. *Journal of Nursing Scholarship*, *49*(6), 625–634. https://doi.org/10.1111/JNU.12328;WGROUP:STRING:PUBLICATION

Yakubu Yusuf, Y., Garba, H., Mohammed Daki, M., Abdullahi, U., Umar, M., Alhaji Abdullahi, M., & Ahmed, A. (2023). Analysis of Two Decades Variations in Urban Heat Island Using Remotely Sensed Data in Nguru Local Government Area, Yobe State, Nigeria. *International Journal of Environment and Geoinformatics*, *10*(2), 110–119. https://doi.org/10.30897/ijegeo.1220431

Yang, Y., Hassan, M. F., Ali, W., Zou, H., Liu, Z., & Ma, Y. (2025). Effects of Cadmium Pollution on Human Health: A Narrative Review. *Atmosphere 2025, Vol. 16, Page 225*, *16*(2), 225. https://doi.org/10.3390/ATMOS16020225

Yap, A. C. W., Lee, H. S., & Loo, J. L. (2025). Magnetic Induction on pH, Oxidation-Reduction Potential, Conductivity and Dissolved Oxygen Level of Water and Its Properties: A State-of-the-Art Review. 279–309. https://doi.org/10.1007/978-3-031-82194-3_13