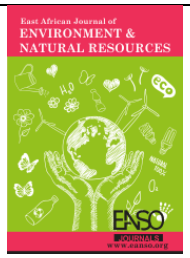
Article DOI: https://doi.org/10.37284/eajenr.8.2.3534



East African Journal of Environment and Natural Resources
eajenr.eanso.org
Volume 8, Issue 2, 2025
Print ISSN: 2707-4234 | Online ISSN: 2707-4242
Title DOI: https://doi.org/10.37284/2707-4242

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Assessment of Groundwater Physical and Microbial Quality in Konduga Local Government Area of Borno State, Nigeria

Kyari Liman Kingimi[1], Dr. Joel Mari Bwala, PhD[2], Dr. Luka Yohanna, PhD[3] & Bitrus Daniel Badar[3]*

[1] Federal Ministry of Labour and Employment, Damaturu, Yobe State, Nigeria.
[2] University of Maiduguri, Maiduguri, Borno State, Nigeria.
[3] Modibbo Adama University, Yola, Adamawa State, Nigeria.
[*] Correspondence ORCID ID; https://orcid.org/0009-0001-8744-8451; Email: kyarikingimi003@gmail.com

Article DOI: https://doi.org/10.37284/eajenr.8.2.3534

Date Published:

22 August 2025

Keywords:

Groundwater, Physical, Microbial, Quality and NSDWQ.

ABSTRACT

The study assessed groundwater physical and microbial quality in Konduga Local Government Area of Borno State, Nigeria. Twenty (20) samples from different groundwater sources in three of the four districts of Konduga Local Government Area were collected and analysed using standard techniques. The findings indicated that there is a presence of physical and microbial concentrations at various levels of NSDWQ standards. The result found average concentration of turbidity (5.87 NTU), Coliform Counts (2.6 mpn/100ml), E. coli (1.1 cfu/100ml) above NSDWQ permissible limits of drinking water quality. Additionally, the water quality data compares across the three districts using various parameters, indicates that all the three districts had turbidity values above the limit of 5 NTU, with Auno (5.63 ± 2.92), Konduga (5.83 ± 3.07), and Dalori (6.23 ± 1.39), but no significant difference was found (p-value 0.911). Coliform levels also exceeded the allowable limit of 1mpn/100ml, with Auno (2.50 ± 2.39), Konduga (2.33 ± 1.86), and Dalori (3.00 ± 2.60), showing no significant differences (p-value 0.873). E. coli concentrations were highest in Auno at 875 ± 1.13, far exceeding the limit of 0 cfu/100ml, while Konduga and Dalori districts had much lower levels, but again, no significant differences (p-value 0.592). The presence of Coliform bacteria and E. coli in the sampled groundwater sources indicated bacterial contamination from faecal matter and other harmful microorganisms. This might have a connection with the depth of the hand pumps and hand-dug wells, which are more susceptible to contamination from surface water and improper waste disposal habits, which greatly affect the water quality. Implementing suitable filtration techniques, including reverse osmosis, activated carbon filters or ion exchange systems to mitigate groundwater contamination, is one of the recommendations put forward in this study.

Article DOI: https://doi.org/10.37284/eajenr.8.2.3534

APA CITATION

Kingimi, K. L. Bwala, J. M., Yohanna, L. & Badar, B. D. (2025). Assessment of Groundwater Physical and Microbial Quality in Konduga Local Government Area of Borno State, Nigeria. *East African Journal of Environment and Natural Resources*, *8*(2), 458-467. https://doi.org/10.37284/eajenr.8.2.3534.

CHICAGO CITATION

Kingimi, Kyari Liman, Joel Mari Bwala, Luka Yohanna and Bitrus Daniel Badar. 2025. "Assessment of Groundwater Physical and Microbial Quality in Konduga Local Government Area of Borno State, Nigeria". *East African Journal of Environment and Natural Resources* 8 (2), 458-467. https://doi.org/10.37284/eajenr.8.2.3534

HARVARD CITATION

Kingimi, K. L. Bwala, J. M., Yohanna, L. & Badar, B. D. (2025) "Assessment of Groundwater Physical and Microbial Quality in Konduga Local Government Area of Borno State, Nigeria", *East African Journal of Environment and Natural Resources*, 8 (2), pp. 458-467. doi: 10.37284/eajenr.8.2.3534.

IEEE CITATION

K. L., Kingimi, J. M. Bwala, L. Yohanna & B. D., Badar "Assessment of Groundwater Physical and Microbial Quality in Konduga Local Government Area of Borno State, Nigeria", *EAJENR*, vol. 8, no. 2, pp. 458-467, Aug. 2025.

MLA CITATION

Kingimi, Kyari Liman, Joel Mari Bwala, Luka Yohanna & Bitrus Daniel Badar. "Assessment of Groundwater Physical and Microbial Quality in Konduga Local Government Area of Borno State, Nigeria". *East African Journal of Environment and Natural Resources*, Vol. 8, no. 2, Aug 2025, pp. 458-467, doi:10.37284/eajenr.8.2.3534

INTRODUCTION

Water is essential to sustain life, and a satisfactory, adequate, safe and accessible supply must be available to all. Improving access to safe drinking water can have real health benefits (WHO, 2022). Groundwater is found beneath the earth's surface in soil pore spaces and in the fractures of rock formation (Akhtar *et al.,* 2020). More than 60% of Nigerians depend on groundwater for domestic water supply (Danert and Healy, 2021). Groundwater in certain Nigerian towns is at risk of contamination due to factors such as environmental geochemistry and geology, organic matter, heavy metals, landfill and dumpsite leachates, and the impact of seasonal flooding (Ferreira *et al.,* 2023). In Northern Nigeria, especially in Borno State, surface water is scarce because of the very low and erratic rainfall in the region. Individuals and households, communities, local states, and the federal government have been sinking wells and boreholes to tap groundwater resources for domestic uses and irrigation purposes (Pearce, 2018). Due to its effects on health, water is most visibly connected to the problem of social development. The absence of clean drinking water is a major cause of illness in the developing world (WHO, 2022). Without a secure water supply, there can be no positive state of community health and wellbeing (Wutich *et al.,* 2020). Although great strides have been made in meeting the challenges in terms of the provision of services, the safety of many water supplies remains unknown and uncertain. Water supply requires guidelines on microbial and chemical contamination (Afolabi and Raimi, 2021). pH, salinity, colour, clarity, and the presence of contaminants like heavy metals, dissolved gasses, trace elements, and microbiological contaminants are among the indicators used to evaluate the quality of water (Saleh and Hassan, 2021).

Bomb explosions and the storage of explosives in conflict-affected areas such as Konduga Local Government Area, Nigeria, have significant implications for groundwater quality. Explosions release harmful chemicals, including heavy metals, nitrates and hydrocarbons, which infiltrate the soil and contaminate aquifers over time. The unsafe storage and dismantling of explosives further exacerbate this contamination, introducing residues into groundwater sources. In Konduga, insecurity-driven activities disrupt waste management systems, increasing the risk of polluting groundwater sources. Contaminated groundwater poses severe public health risks, particularly in a region heavily reliant on groundwater for domestic

Article DOI: https://doi.org/10.37284/eajenr.8.2.3534

and agricultural use. The lack of adequate monitoring and remediation efforts worsens the long-term environmental and health consequences. Addressing these issues requires immediate attention to conflict resolution, robust groundwater protection policies, and implementation of sustainable remediation strategies to safeguard vital water resources in affected areas. This also calls for regular research to determine the quality of groundwater in the local government area. This research aimed at assessing groundwater physical and microbial quality in Konduga Local Government Area using hand dug wells, boreholes and hand pump boreholes as a major source of groundwater to: identify and map the types of groundwater sources in Konduga Local Government area, determine the physical and microbial parameters of various groundwater sources in line with Nigerian Standard for Drinking Water Quality (NSDWQ).

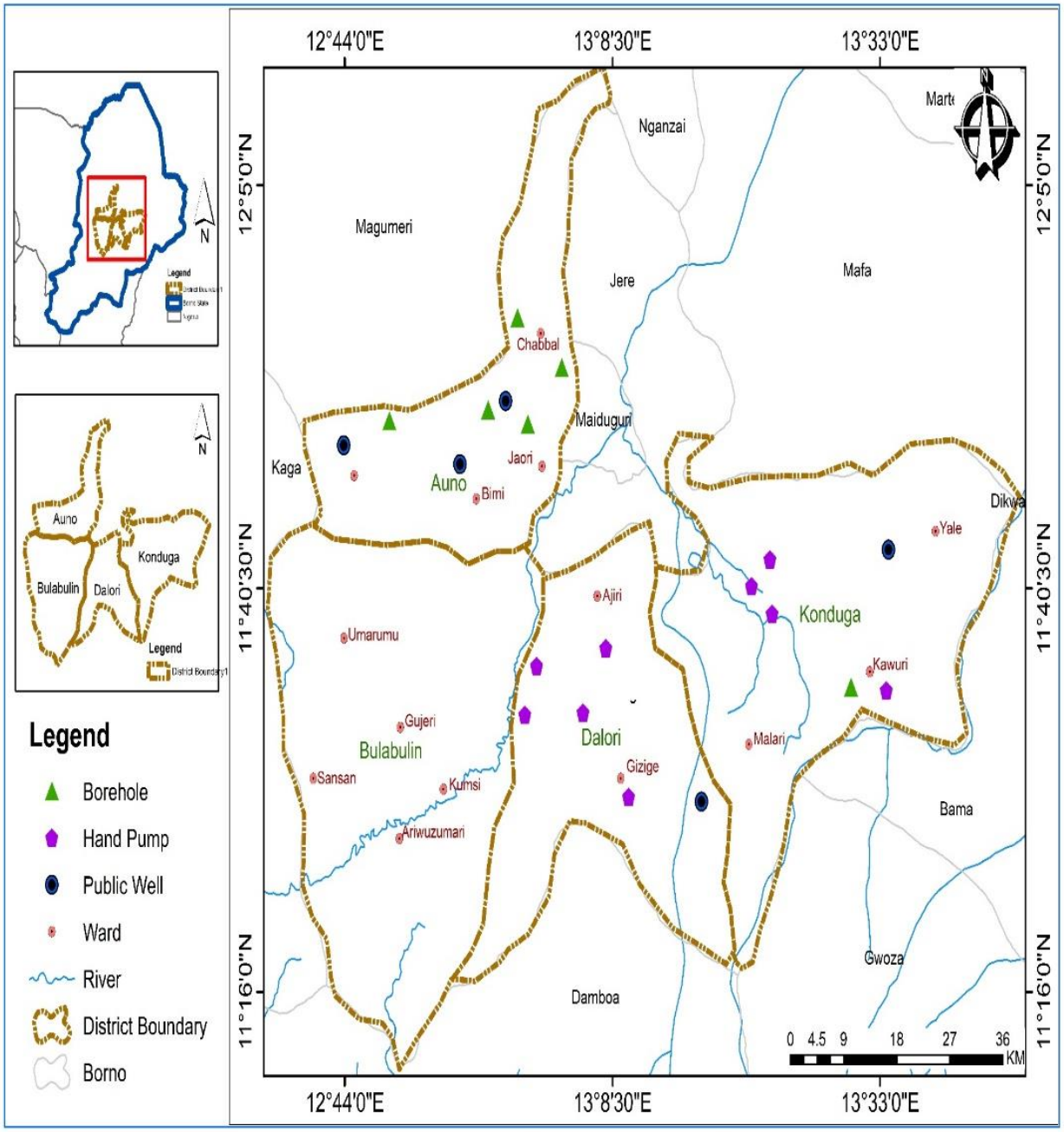
MATERIAL AND METHODS

Study Area:

Konduga Local Government Area is located between Latitude 11° 39′ 0″ and 12° 5′ 0″ and Longitude 12° 44′ 0″ and 13° 33′ 0″ E. It has a landmass of 6,066km^2. The landforms of the LGA can be classified into plains and ridges, such as the Paleo-lagoon plains, lacustrine plain, recent flood plains, and Bama Beach Ridge (BBR) (Nyanganji, 2002). The plains are variously interspersed with sandy beach ridges and sandy mounts, capped with Aeolian sediments. There are also marshes, ponds, mud-flats, abandoned channels, and meanders on the plains. In some places, the plains are dissected by rills and gullies, which are described differently as drainage channels, flood spill channels, or flood siphoning tracts. Figure 1 shows the location of the LGA.

Article DOI: https://doi.org/10.37284/eajenr.8.2.3534

Figure 1: Konduga Local Government showing Study Areas.



Source: *Borno State Ministry of land and survey: Redrawn in GIS Lab, Dept. of Geography, University of Maiduguri.*

Methods

Sampling Techniques and Data Analysis:

There are four districts in Konduga Local Government Area, namely: Auno, Bulabulin Ngabura, Dalori and Konduga. For security reasons, Bulabulin Ngabura was not considered. Hence, a sample of three districts (Auno, Dalori, and Konduga) was used. Purposive and stratified random sampling were used to select twenty samples of groundwater sources (boreholes and wells). The selection of sample points was based on

Article DOI: https://doi.org/10.37284/eajenr.8.2.3534

the number of groundwater sources at such locations. Hence, Auno district has 8 samples, while Dalori and Konduga districts have 6 samples each. GPS was used for recording the locations of the sample points. Quality of groundwater from microbial (Coliform and E. coli) and physical parameters (Temperature, Turbidity and colour) were primarily obtained from the analyses of water sampled from the NAFDAC Laboratory of North-East Zonal Office, Maiduguri, Borno State. Water samples were collected in the morning in 750ml plastic containers from the groundwater sources in the second week of July 2023. The containers used for sample collection were thoroughly washed, rinsed, sterilised, and stored in a neatly fitted cool box to prevent contamination. Each container was carefully labelled according to the designated districts and stratums prior to sample collection. This ensured proper identification and traceability of the samples during laboratory analysis to determine the groundwater quality parameters. The data collected were analysed using descriptive statistical tools in the Microsoft Excel software package. Inferential statistics were applied to determine statistically significant differences between the values of water qualities across the three districts through one-way ANOVA (Analysis of Variance). The results were effectively presented using charts and graphs to enhance clarity and interpretation.

RESULTS AND DISCUSSION

Water Physical Parameters and the NSDWQ Permissible Ranges

The description of the water's physical parameters and the NSDWQ permissible ranges is presented in Table 1

Table 1: Water Physical Parameters and the NSDWQ Permissible Ranges

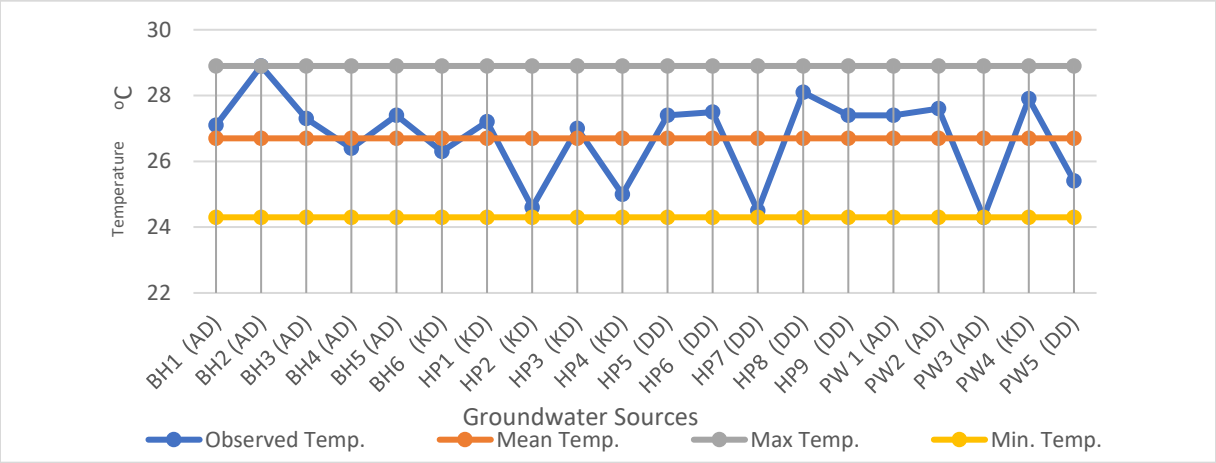
Parameters	Mean	Standard Deviation	Sample Variance	NSDWQ
Temperature	26.54	1.33	1.77	
Turbidity	5.87	2.45	6.06	5
Color	10.05	3.00	9.05	15

Temperature

The highest temperature in the sampled groundwater sources was found in BH2 (AD) at 28.9^0C located at Auno town of Auno District and the lowest at 24.3^0C was found in PW3, located at Attommiri of the same district. The mean temperature was found at 26.71^0C. as depicted in Figure 2. High temperature in water enhanced the growth of micro-organisms and led to the spreading of chemical reactions in water (WHO, 2022). Furthermore, a rise in the temperature of water accelerates chemical reactions, reduces the solubility of gases, amplifies taste and odour and elevates the metabolic activity of organisms (Nayar, 2020)

Article DOI: https://doi.org/10.37284/eajenr.8.2.3534

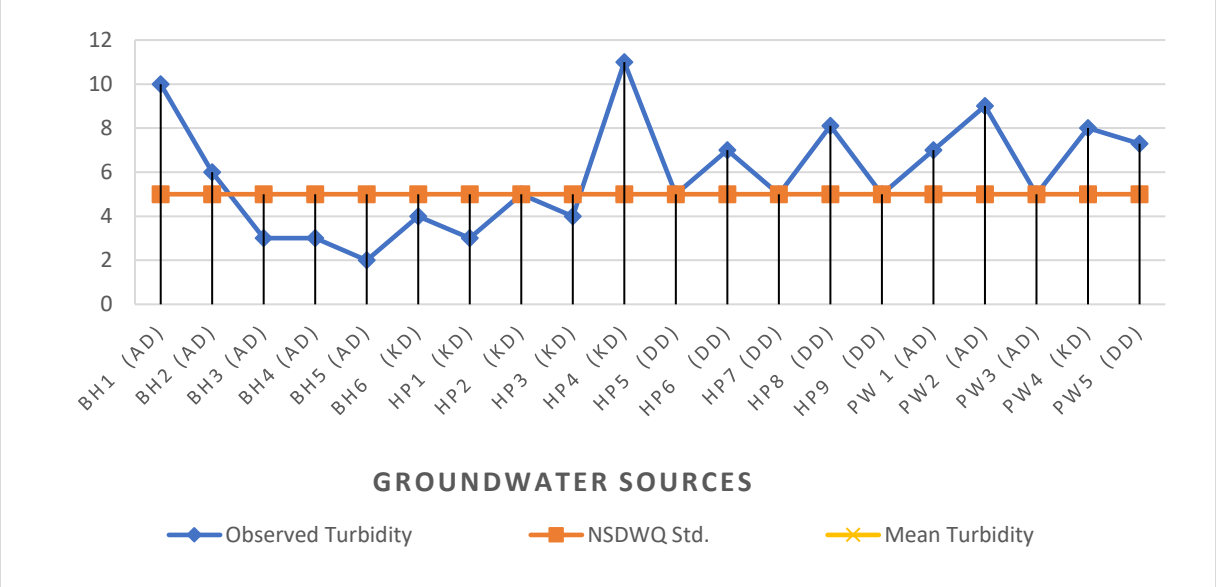
Figure 2: Groundwater Temperature



Turbidity

The turbidity in 11 out of 20 sampled groundwater sources of Konduga districts was found within the permissible limits of 5*NTU* sets by NSDWQ ranging from 2.0*NTU* to 5.0*NTU* with an average mean of 5.87 *NTU* (Fig. 3). Only nine sources at PW1 (AD), Njimtilo, PW2 (AD) Dogumuri, BH2 (AD) Auno Town, BH1(AD) Jakana, and HP4 (KD) Tashan kefi, PW4 (KD) Anguwar Kofar Ruwa, PW5 (DD) Jetete, HP6 (DD) Malari Bulaburin, as well as HP8 (DD) Kalari Abdul were found above the limits. They respectively recorded 7.0*NTU*, 9.0*NTU*, 6.0*NTU*, 10.0*NTU*, 11.0*NTU*, 8.0*NTU*, 7.3*NTU*, 7.0*NTU*. High turbidity is caused by sediment runoff or chemicals in the water.

Figure 3: Groundwater Turbidity in Water Samples

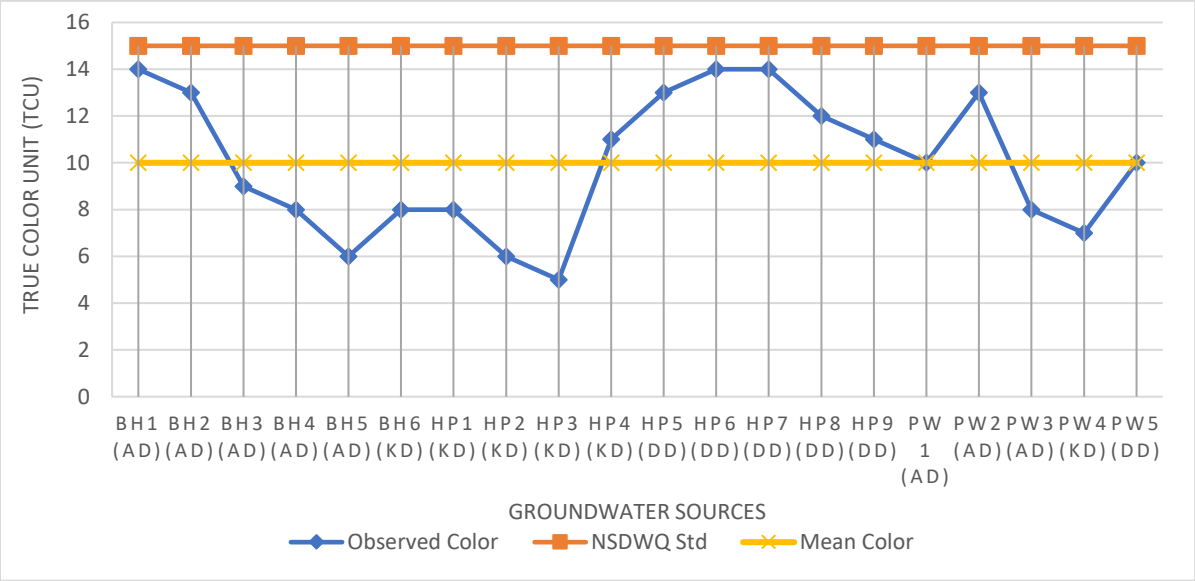


Color

All the groundwater sources sampled for colour were found within the permissible limits of 15*TCU* set by NSDWQ standards. They range between 5.0*TCU* to 14.0*TCU* with a mean of 10 *TCU*. As indicated in Figure 4.

Article DOI: https://doi.org/10.37284/eajenr.8.2.3534

Figure 4: Groundwater Colour



Microbial Parameters

The result of the microbial parameters found in the study area is presented in Table 2

Table 2: Microbial Parameters in the Study Area

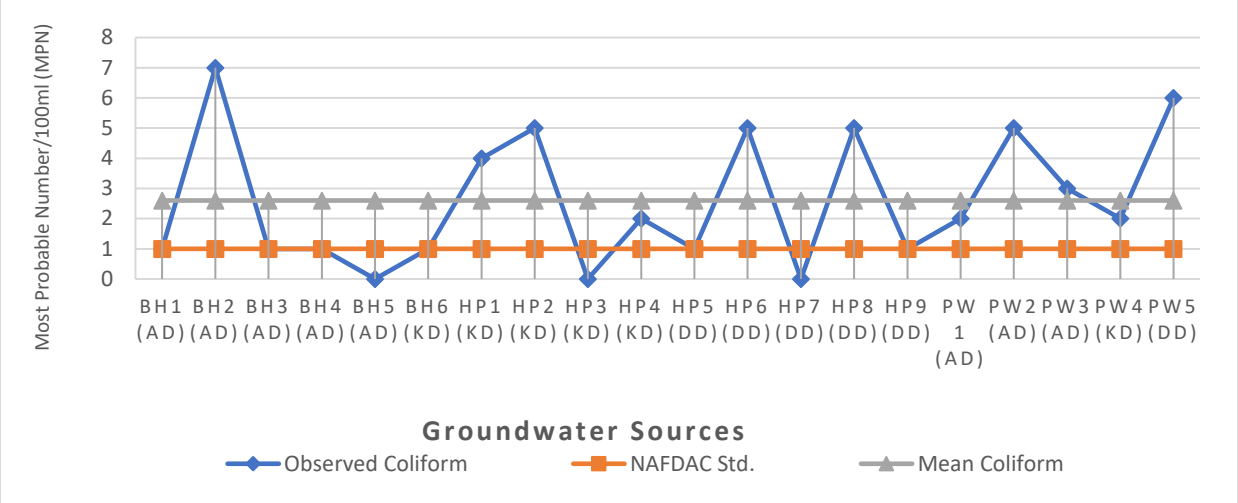
Parameters	Mean	Standard Deviation	Sample Variance	Standard Error
Coliform	2.6	2.237375	5.005848	1
E. coli (Escherichia)	1.1	1.118688	1.251462	0

Coliform

The mean coliform count found in the groundwater was 2.6 *mpn/100ml,* which ranged from 0 *mpn/100ml* to 7 *mpn/100ml* in BH2 located at Auno Town of Auno district area. The coliform count concentration in all 11 groundwater sources of the 20 sources exceeded the permissible limit set by NSDWQ of 1 *mpn/100ml*. The result showed that BH2, PW1, PW2, PW3, PW4, PW5, HP1, HP2, HP4, HP6, and HP8 are the groundwater sources where coliform count concentration exceeded the maximum permissible of 1 *mpn/100ml*. The result found more coliform in wells and hand pumps than in boreholes, as shown in Figure 5. This might have a connection with the depth of hand pumps and wells, which are more susceptible to contamination from surface water. These findings are in agreement with the results of Ishaya & Abaje (2009), who noted excessive concentration of coliform in the Gwagwalada area of Abuja metropolitan city, North Central Nigeria. The presence of coliform bacteria indicates the source water may be contaminated with pathogens, disease-causing bacteria, or viruses that can also be present in faeces. The presence of coliform contamination is an indicator that potential health risks like waterborne pathogenic diseases, such as typhoid, fever, viral and bacterial gastroenteritis, and hepatitis A exist for individuals exposed to these water sources.

Article DOI: https://doi.org/10.37284/eajenr.8.2.3534

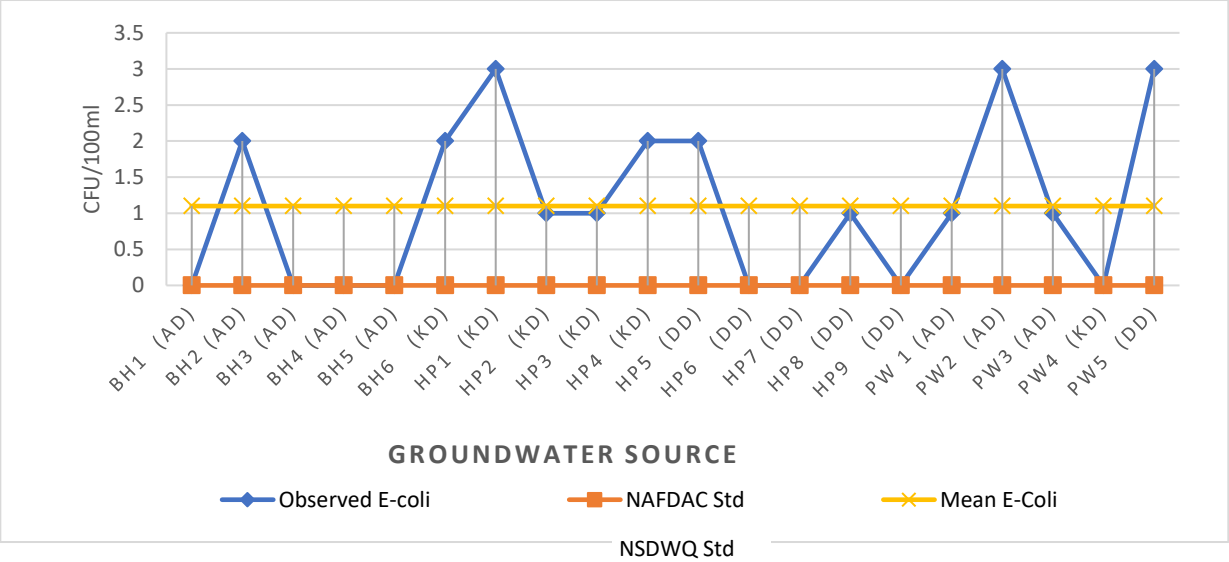
Figure 5: Coliform Concentration in Groundwater Samples



Escherichia (E. coli)

The result on *E. coli* showed that 8 out of the groundwater samples were found within the (0 *cfu/100ml)* permissible standard set by NSDWQ, with an average mean of 1.1 *cfu/100ml*. The remaining 12 samples exceeded the permissible limit and their presences were mostly recorded in wells and hand pumps. The maximum values of 3 NSDWQ *cfu/100ml* were respectively recorded in PW3 located at Dumugumi of Auno district, HP1 at Konduga Lawanti and PW5 at Jetete of Dalori District as revealed in Figure 6. These results are in line with the findings of Usman et al. (2016), who reported a higher E. coli concentration of +4 in groundwater along river Ngadda. This suggests that sewage contamination is present.

Figure 6: E. coli Concentrations in Sampled Groundwater



The results in Table 3 present the relationship between the water parameters measured in the sampled groundwater sources in all the 3 districts in relation to the Nigerian Standard for Drinking Water Quality

Article DOI: https://doi.org/10.37284/eajenr.8.2.3534

Table 3: Analysis of Variance (ANOVA) of Water Parameters across the Three Sampled Districts Areas in Relation to Nigerian Standard for Drinking Water Quality

Parameters	District			NSDWQ	p-value	Remark
	Auno	Konduga	Dalori			
	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$			
Turbidity	5.63±2.92[a]	5.83±3.07[a]	6.23±1.39[a]	5	0.911	NS
Color	10.13 ±2.90[ab]	7.50±2.07[a]	12.3±1.63[b]	15	0.009	S
Coliform	2.50±2.39a	2.33±1.86a	3.00±2.60a	1	0.873	NS
E coli	875±1.13a	1.50±1.04a	1.00±1.26a	0	0.592	NS

Significant Level= 0.05, N= Significant, NS= Not Significant

Table 3 presents a comparison of water quality across the three districts, Auno, Konduga, and Dalori, using analysis of variance (ANOVA) in comparison with the Nigerian Standard for Drinking Water Quality (NSDWQ) limits. Significant differences were observed in colour,

All three districts had turbidity values above the NSDWQ limit of 5 NTU, with Auno (5.63 ± 2.92), Konduga (5.83 ± 3.07), and Dalori (6.23 ± 1.39), but no significant difference was found (p-value 0.911). Coliform levels also exceeded the NSDWQ limit of 1, with Auno (2.50 ± 2.39), Konduga (2.33 ± 1.86), and Dalori (3.00 ± 2.60), showing no significant differences (p-value 0.873). E. *coli* concentrations were highest in Auno at 875 ± 1.13, far exceeding the NSDWQ limit of 0, while Konduga and Dalori districts had much lower levels, but again, no significant differences (p-value 0.592). Parameters like turbidity, coliform and E. coli are problematic across all the districts. The lack of significant differences in other parameters suggests that water quality improvements should focus on specific issues such as turbidity, microbial contamination.

CONCLUSION AND RECOMMENDATION

This study determined the physical and microbial quality of groundwater in Konduga Local Government Area, assessing physical and microbiological indicators against Nigerian Standard for Drinking Water Quality (NSDWQ) guidelines. Key findings revealed exceedances in turbidity (5.87 NTU), coliform count (2.6 MPN/100ml), E. coli (1.1 CFU/100ml). Microbial contamination emerged as a critical concern. Comparisons among the districts of Auno, Konduga, and Dalori revealed significant variations in colour. No significant differences were observed for turbidity, coliforms and E. *coli* across the districts, although their concentrations often exceeded NSDWQ standards, posing severe health risks to humans. Implementing suitable filtration techniques, including reverse osmosis, activated carbon filters or ion exchange systems to mitigate groundwater contamination and regular monitoring of water sources is essential to detect variation in microbial and physical parameters. This will ensure compliance with NSDWQ and facilitate timely interventions to mitigate public health risks, are suggested recommendations.

REFERENCES

Afolabi, A. S., & Raimi, M. O. (2021). When Water Turns Deadly: Investigating Source Identification and Quality of Drinking Water in Piwoyi Community of Fed-eral Capital Territory, Abuja Nigeria.

Akhtar, N., Syakir, M. I., Anees, M. T., Qadir, A., & Yusuff, M. S. (2020). Characteristics and assessment of groundwater. *Groundwater management and resources*. *DOI: http://dx.doi.org/10.5772/intechopen. 93800*

Danert, K., & Healy, A. (2021). Monitoring groundwater use as a domestic water source by urban households: analysis of data from Lagos state, Nigeria and sub-Saharan Africa with implications for policy and practice. *Water*, *13* (4), 568.

Article DOI: https://doi.org/10.37284/eajenr.8.2.3534

Ferreira, C. S., Adama-Ajonye, O., Ikenna, A. E., & Kalantari, Z. (2023). Groundwater quality in the vicinity of a dumpsite in Lagos metropolis, Nigeria. *Geography and sustainability*, *4* (4), 379-390.

Ishaya, S., Abaje, I. B. (2009). Assessment of Borehole Water Quality in Gwagwalada Town, Abuja FCT. *Journal of Ecology and Natural Environment,* 1 (2), 32-36.

Nayar, R. (2020). Assessment of water quality index and monitoring of pollutants by physico-chemical analysis in water bodies: a review. *International Journal of Engineering Research and Technology*, *9* (01).

Nyanganji, J. K. (2002). The Morphology and Hydrography of the Ngadda Catchment and the Bama Beach Ridge.

Pearce, F. (2018). When the rivers run dry, fully revised and updated edition: water-the defining crisis of the twenty-first century. Beacon Press.

Saleh, H. M., & Hassan, A. I. (2021). Water quality standards. *Applied Water Science Volume 1: Fundamentals and Applications*, 441-468.

Usman, Y. M., Mohammed, A., Ibrahim, B., Saleh, B. A. (2016). Assessment of Groundwater Quality Status along River Ngadda in Maiduguri, Nigeria. *The International Journal of Engineering And Science* (IJES). 5 (1). 08-14.

WHO. (2022). Guidelines for Drinking-Water Quality: Fourth Edition Incorporating the First and Second Addenda. 978-92-4-004506-4

Wutich, A., Brewis, A., & Tsai, A. (2020). Water and mental health. *Wiley Interdisciplinary Reviews: Water*, *7* (5), 1461.

