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Crisis in the Streams: Urgent Comparative Water Quality Probe in Sabon Gari Nangere, Yobe State, Nigeria

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ABSTRACT

Sabon Gari Nangere, located in Nangere Local Government Area of Yobe State, depends largely on boreholes and hand-dug wells for domestic and agricultural use. This study presents a comparative analysis of water quality from selected sampling points within Sabon Gari Nangere. The analysis focused on key physicochemical parameters such as pH, temperature, hardness, turbidity, electrical conductivity, total dissolved solids (TDS), total suspended solids (TSS), and selected heavy metals, including carcinogenic heavy metals like Lead (Pb), Iron (Fe), Arsenic (As), Cadmium (Cd), and Chromium (Cr). While some parameters like Temperature, Hardness, and TSS met WHO standards, others like turbidity and conductivity were significantly high and exceeded permissible limits in almost all the samples. Likewise, TDS and pH are also above the WHO limit in the majority of the analyzed samples. Surprisingly, Fe is significantly above the set limit in only four samples. However, the analyzed carcinogenic heavy metals like Pb, Cr, As, and Cd are alarmingly very high in almost all the analyzed samples, exceeding all the regulatory bodies' limits. Factors that may contribute to such disasters include shallow groundwater tables, agricultural runoff, poor waste disposal practices, and inadequate protection of wells and boreholes. The study concludes that almost all the water sources in Sabon Gari Nangere are not safe for direct domestic use. However, regular monitoring, improved sanitation practices, proper well protection, and community awareness will greatly enhance the water quality. The findings provide a useful reference for policymakers, researchers, and stakeholders committed to improving water safety in Yobe State.

Keywords: WHO, Nangere, Water Quality, Environmental Sustainability, Comparative Analysis

INTRODUCTION

Evaluating water quality is essential for safeguarding public health and environmental sustainability, particularly in populations dependent on groundwater. The significance of water quality evaluation is escalating due to climate change, population growth, urbanization, heightened human activities, and natural processes such as erosion, rock weathering, and precipitation that influence water supplies. For instance, global fresh water usage rose by 14% from 2000 to 2021, with over 70% allocated to agriculture. According to data from WHO and UNICEF in 2022, at least 1.7 billion individuals utilize a water source tainted with fecal matter (Pointet, 2022; Tomczyk et al., 2026).

Significant worldwide laws and policies emphasize how important it is to preserve high water quality on a global scale. These methods are useful for locating possible pollution sources and putting environmental regulations and monitoring requirements into practice. Still, they do not provide complete, general information on water quality. Water quality indices, which show the overall spatiotemporal status of water quality and may be used as a tool to compare water quality across various sources and places without the need for particular evaluation of water quality data, satisfy this requirement (Pointet, 2022; Sutadian et al., 2018; Tomczyk et al., 2026). Comparative analysis of water quality entails comparing the water's physical, chemical, and biological characteristics to standards to assess whether it is suitable for human consumption or ecological health (Yavuz et al., 2024).

Sabon Garin Nangere is a rural community situated in the Nangere Local Government Area of Yobe State in northeastern Nigeria, located at latitude 11°50'58''N and longitude 11°04'23''E, at an elevation of about 394 meters above sea level. The area lies within the semi-arid Sudan savannah ecological zone and experiences two major seasons: a long, dry season from roughly October to May and a shorter rainy season from June to September. During the dry months, the climate becomes hot and dusty due to harmattan winds from the Sahara, and most surface water bodies such as ponds and seasonal streams shrink or dry up completely. As a result, the community relies mainly on groundwater sources like hand-dug wells and boreholes for drinking, domestic use, and farming (Audu et al., 2021; Lawan, 2021; Pukuma & Ibrahim, 2023).

In the rainy season, the area receives moderate to intense rainfall, leading to surface runoff and temporary flooding in low-lying areas. These rainfall events often wash soil particles, agricultural chemicals, and organic matter into water bodies, increasing turbidity and sometimes altering the chemical and microbial quality of water (Lawan, 2021).

Water supply infrastructure in Sabon Garin Nangere is primarily traditional, with shallow wells, hand pumps, and community boreholes serving most households. Because sanitation systems are still developing, practices like open defecation and poor waste disposal occasionally pose risks of contamination to nearby wells and surface water points. The combination of seasonal climatic variation, dependence on natural water sources, and human activities makes water quality in this area vulnerable to environmental influences. The issue of heavy metals exposure is also a great concern, because of the possibility of bioaccumulation and long-term dietary exposure, heavy metal bioaccumulation presents a significant environmental toxicological and public health concern (Abdul & Faragai, 2026).

These characteristics make Sabon Garin Nangere an important rural location for studying water quality patterns, particularly in relation to seasonal changes and community practices. Understanding water conditions in the area helps provide insight into common challenges faced by rural communities in northern Nigeria and forms a useful basis for comparing rural water quality and supply systems with those found in more urban and developed areas. The Sabon Garin community in Nangere LGA faces challenges related to the availability and quality of potable water. Residents rely on various sources, including wells, boreholes, and surface water bodies, many of which may not meet safety standards.

Despite governmental efforts in rural water supply development, concerns over water contamination persist, especially due to inadequate water treatment, agricultural runoff, and poor waste management practices. There is a lack of up-to-date, location-specific data regarding the physicochemical and microbiological characteristics of the water sources in this area. Without such data, health risks associated with the consumption of potentially contaminated water cannot be effectively mitigated. This research seeks to address this gap by conducting a comparative analysis of different water sources within Sabon Garin to assess their suitability for consumption and domestic use.

MATERIALS AND METHODS

Experimental

Before and throughout the experiment, all tools and equipment employed in the study were calibrated. All of the glassware was cleaned with 10% concentrated nitric acid (HNO_3) to eliminate any heavy metals from their surfaces, and then rinsed with deionized water.

Materials and Reagents

All chemicals and reagents employed in the laboratory were of analytical grade. Before analysis, sample and intermediate metal standard solutions were diluted with deionized water, and glassware, along with sample bottles, were washed.

Sampling Study Area

This study focuses on the rural community of Sabon Garin Nangere, located in the Nangere Local Government Area of Yobe State, Nigeria. It is located in the northeastern region of the state at approximately 11.8495°N, 11.0733°E. It serves as a representative example of a rural settlement in the region. The community relies heavily on groundwater, with three specific boreholes selected for this study due to their varying locations and potential contamination risks:

i. Borehole A (Peri-domestic): This borehole is situated in a densely populated residential area. It is surrounded by numerous household pit latrines and animal pens. Its shallow depth makes it highly vulnerable to contamination from septic seepage and animal waste.
ii. Borehole B (Agricultural Zone): Located on the outskirts of the community near farmlands, this borehole is used for both drinking and irrigation. The primary risk here is contamination from agricultural runoff, which may contain fertilizers and pesticides used on the farms.
iii. Borehole C (Central Community): This is a deeper, public borehole located near the central marketplace. While better constructed, it faces high traffic from people and animals. Contamination risks include environmental litter, wastewater from nearby market activities, and general surface runoff.

Sample Collection

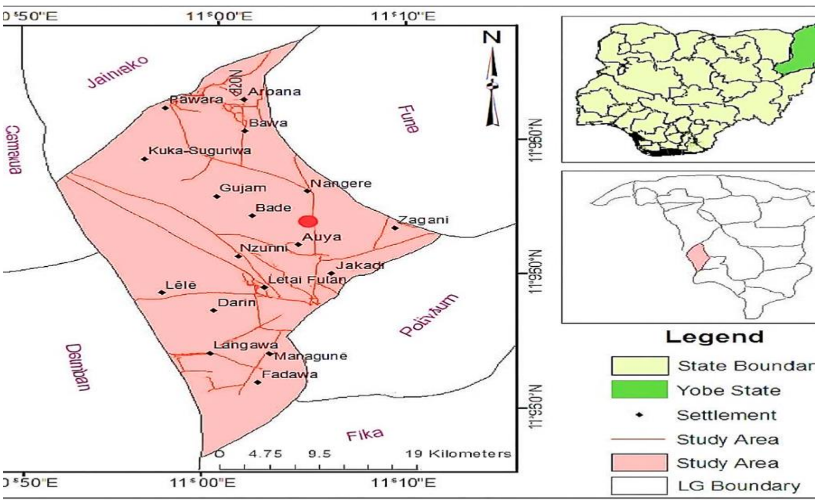

Figure 1: Map of Sabon Garin Nangere

The sample collection was done in October 2025, at the end of the rainy season. Nine water samples were collected from three boreholes located at three different locations within Sabon Gari Nangere, as stated before. They are Ruwan solar, Kofar Fada, and Sabon Fegi boreholes. The three boreholes were selected to represent different environmental risk factors: domestic waste, agricultural activity, and high public use. Studying these specific locations will help determine how the immediate surroundings influence the quality of drinking water from each source. The findings will provide a clear, scientific basis for targeting protection measures for boreholes in similar rural settings. The sample containers (75 cl plastic bottles) were purchased locally in Damaturu. Before sampling, each bottle was thoroughly rinsed with the water from the borehole it was intended to collect. Following standard sampling protocols, the bottles were then neatly wrapped and placed in separate containers to prevent cross-contamination during transport to the Chemistry Department Laboratories at Yobe State University for analysis.

Table 1: Sampling Sites and ID Code

S/N	Sample sites	ID code
1	Ruwan Solar	A1
2	Ruwan Solar	A2
3	Ruwan Solar	A3
4	Kofar Fada	B1
5	Kofar Fada	B2
6	Kofar Fada	B3
7	Sabon Fegi	C1
8	Sabon Fegi	C2
9	Sabon Fegi	C3

Physicochemical Analysis

Water samples from wells, boreholes, and taps in Bularafa were analyzed for pH, temperature, electrical conductivity (EC), turbidity, total dissolved solids (TDS), and total hardness (TH) following APHA (2017) methods. pH and temperature were measured in situ, EC and TDS using a conductivity meter, turbidity with a turbidimeter, and TH by EDTA titration (mg/L $CaCO_3$). All measurements were done in triplicate, and mean values were recorded. These analyses provide information on water quality and its suitability for domestic, industrial, and agricultural use.

pH Measurement

The pH was measured using a pH meter (Model HI 4358). After the pH meter was switched on and allowed to warm for about 5 minutes and standardized with a buffer solution, it was then immediately introduced into the water sample, and the measurement was taken. The electrode was then rinsed with deionized water before another measurement

Temperature Measurement

The temperature of water samples was recorded at the point of sampling using a thermometer by immersing inside the water immediately after collection. The values were then taken and recorded accordingly in each case.

Conductivity Measurement

Conductivities of the water samples were measured using a digital conductivity meter. The meter was switched on and then standardized using 0.1N KCl. The electrode was then immersed in the water sample, and the conductivity reading of each sample was recorded.

Turbidity Measurement

The turbidity of the water samples was measured using a digital turbidity meter. The meter was standardized with clean deionized water. The turbidity reading of each sample was then recorded.

The Determination Of Total Dissolved Solid

The total dissolved solid was determined using a conductivity meter. The programming of the conductivity meter, the programme menu of the conductivity meter was switched to total dissolved solids, 100 cm^3 of the sample was measured into the beaker, and the electrode was introduced into the sample. The results of the dissolved solids were then displayed and recorded.

Determination Of Total Hardness

50cm^3 of water sample was pipetted into a conical flask. 1 cm^3 of buffer solution (NH_4Cl) of pH=10 and 3 drops of erichrome black T indicator were added to the flask. The mixture was then titrated with 0.01M EDTA (ethylene diammine tetra acetic acid) until the colour changed from wine red to blue. The procedure was repeated two more times to obtain the average liter value.

$$Total\ Hardness = \frac{Vol.of\ titrant \times 100}{Vol.of\ sample\ (cm^3)} \quad (1)$$

Preparation of 1000mg/Litre Stock AAS Standard Solution for Selected Heavy Metals

The manufacturer's company 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 the different metals.

Standard Working Solution and Preparation of Calibration Curve

The volume of the stock solution to be diluted to the new required concentration was determined using the straightforward dilution formula ($C_1V_1 = C_2V_2$). 1mL of concentrated HNO_3 was added to each working standard and finally diluted to the desired volume with deionized water.

To ascertain the metal concentration in the sample solution, calibration curves were created. A number of operational standards were used to calibrate the equipment. Each metal's working standard solutions were made from standard solutions of that metal, and the AAS was used to measure their absorbances. Plotting the absorbance as a function of metal ion standard concentration allowed for the preparation of calibration curves for each metal ion to be examined.

Sample Digestion

The sample is digested using microwave-assisted acid digestion to solubilize metals and destroy organic matter. SONEO Master 40 Microwave Digester (Hanon, China) equipped with PTFE/TFM digestion vessels and a pressure relief mechanism, was used. The digester is also equipped with an integrated fiber-optic/infrared temperature sensor and an online temperature monitoring system. 40.0 ± 0.5 mL of acidified water sample was measured into the cleaned PTFE digestion vessel, followed by the addition of 2.0 mL concentrated HNO_3 (65-70%) and 1.0 mL H_2O_2 (30%). The mixture was allowed to stand for 10-15 minutes in a fume hood to allow initial oxidation. The vessel was allowed to cool to < 40°C before opening. The solution was then transferred to a 50.0 mL volumetric flask, and the vessel walls were then rinsed with ultrapure water (3 × 5 mL) and added to the flask, followed by dilution to volume and filtering through a 0.45 µm syringe filter.

Determination of Metal Contents of Each Sample

The concentration of the metal ions contained in the sample was evaluated by reading their absorbance using a Buck Scientific AAS Model 210VGP (Buck Scientific, East Norwalk, CT, USA) and comparing it to the relevant standard calibration curve. The machine is equipped with Hollow Cathode Lamps (HCL) light source for each element and a

Deuterium background corrector. It also has a titanium burner head with an air-acetylene flame type. Three replicate determinations were carried out on each sample. The metals were determined by absorption/concentration mode, and the instrument readout was recorded for each solution manually.

RESULTS AND DISCUSSION

This section presents the analytical results of the study conducted to assess the water quality of boreholes in the Sabon Gari Nangere area of Nangere District. The findings for the selected physicochemical parameters and heavy metal content from the three sampled boreholes (designated as Sample A, Sample B, and Sample C) are systematically detailed in this section.

Temperature

The temperature values ranged between 17°C and 20°C, which falls within the typical groundwater temperature range. These values suggest minimal thermal influence from external environmental factors and are suitable for drinking purposes.

Table 2: Results of analyzed physicochemical parameters

S/N	Parameters	A1	A2	A3	B1	B2	B3	C1	C2	C3	WHO Standard
1	Temperature (°C)	17	17	18	20	20	20	19	18	19	12-25
2	Total Hardness (mg/L)	50±2.0	50±3.0	50±2.0	61±2.0	61±2.0	61±3.0	51±3.0	51±2.0	51±2.0	100
3	Turbidity (NTU)	5±2.0	5±1.0	5±2.0	6±1.0	6±3.0	6±1.0	5±2.0	5±1.0	5±1.0	5.0
4	Conductivity (µs/cm)	595±1.0	585±2.0	550±3.0	600±1.0	590±1.0	610±1.0	650±2.0	600±1.0	580±1.0	50-500
5	Total Dissolved Solids (mg/L)	545±2.0	550±1.0	500±1.0	570±1.0	610±2.0	660±1.0	630±2.0	650±1.0	660±1.0	300-600
6	Total Suspended Solids (mg/L)	6.89±0.5	7.04±1.0	6.0±1.0	6.94±0.5	7.00±1.0	8.50±0.5	8.60±0.5	7.9±0.5	8.9±0.5	30
7	pH	8.4±0.2	8.6±0.2	8.2±0.1	8.4±0.1	8.7±0.2	8.9±0.1	8.6±0.2	8.6±0.2	9.0±0.11	6.5-8.5

Total Hardness

Hardness values ranged from 50 mg/L to 61 mg/L, classifying the water as soft to moderately hard. These values fall below the WHO limit of 200 mg/L, suggesting low levels of calcium and magnesium. While soft and moderately hard water have less scaling in household use, the combination of such water and higher pH can also reduce pipe corrosion (Li et al., 2016). Judging from the obtained pH and total hardness values, the water of Sabon Gari Nangere can be regarded as moderately hard alkaline water.

Turbidity

The turbidity values of the water samples ranged between 5 and 6 NTU. The WHO permissible limit for turbidity in drinking water is ≤ 5 NTU, with an ideal target of ≤ 1 NTU for effective disinfection. Turbidity values closer to 6 NTU slightly exceed the WHO-recommended limit. Elevated turbidity results from suspended particulates. It presents considerable health hazards by serving as a barrier for pathogens, enabling bacteria, viruses, and parasites to endure disinfection. It signifies possible contamination, results in aesthetic concerns (taste/odour), and may result in gastrointestinal disorders (Bandh & Mushtaq, 2025). Such a type of water requires treatment before drinking.

Conductivity

Conductivity values between 550 and 600 µS/cm were observed, typical of water with moderate salinity and dissolved mineral constituents. This range is prevalent in natural groundwater, treated or municipal water, signifying a moderate concentration of inorganic dissolved solids, including calcium, magnesium, and chlorides. Most health organizations advocate for a conductivity value below 1000 µS/cm for potable water. Although a value between 550 and 600 µS/cm is safe, it is slightly more than the average "good" taste preference, suggesting that it is somewhat mineralized and hard (Tang et al., 2024).

Total Dissolved Solids (TDS)

TDS values ranging from 500 to 660 mg/L were recorded, far above the WHO allowable limit of 500 mg/L. This indicates the water contains very high dissolved inorganic and organic substances, showing bad chemical purity and hardness as evident by the conductivity values obtained. In terms of taste, such a type of water may appear salty, bitter, or mineral-like, which may lead to reduced water intake. Likewise, prolonged use of water with a higher TDS than required results in excessive scale accumulation inside boilers, kettles, water heaters, and pipelines, which lowers their lifespan and energy efficiency. Meanwhile, highly sensitive individuals, or those with pre-existing diseases such as renal strain or hypertension, may experience moderate issues with extended drinking of water with elevated mineralization or salinity due to high sodium levels in the TDS (Wang, 2021). All these are strong indicators that direct consumption of Sabon Gari Nangere water is problematic and requires treatment before use.

Total Suspended Solids (TSS)

Total Suspended Solids (TSS) in potable water refers to the dry mass of organic and inorganic particles above 2 microns in size that are retained by a filter and remain undissolved (Boyd, 2020). It is a tangible metric of water quality that deteriorates the condition of lakes and rivers. TSS is a fractional element of the "total solids" in the same sample that has been subjected to filtration. TSS constituents comprise particulate elements such as sediment, silts, algae, and other suspended solid particles (Adjovu et al., 2023). To ensure clarity and safety, TSS in drinking water should ideally approach zero, with tolerable concentrations often below 5 mg/L. (Butler & Ford, 2017). A TSS score ranging from 6.0 to 8.9 mg/L signifies modest concentrations of suspended particles and often denotes moderate water clarity.

pH

All water samples recorded a pH range of 8.2 – 9.0, with most of the samples exceeding the WHO acceptable range of 6.5 –

8.5. This indicates that the borehole water is basic (alkaline). The alkalinity could be attributed to natural geological conditions or dissolved basic minerals. Such a type of water may be slippery and sometimes may have an unpleasant, soapy feel or a bitter taste. Usage of high-alkaline water often leads to the accumulation of calcium carbonate or magnesium, resulting in obstructed pipes, fixtures, and damage to water-utilizing appliances. Likewise, water with an elevated pH, apart from diminishing the efficacy of chlorine disinfection, can induce irritation to the skin, eyes, and gastrointestinal tract (Kim et al., 2011; Rakib et al., 2022).

Results of Analyzed Heavy Metals

Heavy metals substantially impact water quality for home and agricultural purposes, and even minimal concentrations can pose health hazards if they exceed allowed thresholds. As shown in Table 3, the concentrations of Lead, Iron, Arsenic, Cadmium, and Chromium in nine water samples from the three locations (A, B, C) in Sabon Gari Nangere were compared with WHO (2017) drinking water guidelines to evaluate their safety for human consumption. The heavy metals concentration profile of the three locations is also shown in Figure 2.

Table 3: Heavy Metals Concentration Obtained for the Samples

S/N	Heavy metals	A1	A2	A3	B1	B2	B3	C1	C2	C3	WHO Standard
1	Lead (mg/L)	0.5±0.1	0.3±0.1	0.4±0.2	0.2±0.2	0.2±0.2	0.4±0.2	0.2±0.2	0.1±0.2	0.6±0.1	0.01
2	Iron (mg/L)	0.3±0.01	0.3±0.01	0.2±0.01	0.4±0.01	0.3±0.02	0.4±0.01	0.3±0.02	0.4±0.02	0.5±0.01	0.3
3	Arsenic (mg/L)	0.041±0.01	0.038±0.01	0.040±0.02	0.007±0.03	0.002±0.02	0.020±0.03	0.010±0.01	0.014±0.02	0.08±0.01	0.01
4	Cadmium (mg/L)	0.002±0.02	0.002±0.01	0.003±0.01	0.004±0.02	0.005±0.01	0.004±0.01	0.008±0.02	0.007±0.01	0.007±0.01	0.003
5	Chromium (mg/L)	0.2±0.02	0.1±0.01	0.3±0.02	0.4±0.01	0.6±0.01	0.8±0.01	0.4±0.01	0.6±0.02	0.7±0.02	0.05

Lead (Pb)

Lead concentrations in the water samples ranged from 0.1 mg/L (C2) to 0.6 mg/L (C3), with the WHO limit set at 0.01 mg/L. All of the samples have a comparatively high lead concentration, which is extremely dangerous. Samples A1 (0.5 mg/L), B3 (0.4 mg/L), and C3 (0.6 mg/L) possess a terrifyingly high lead content. Higher pH, total dissolved solids, turbidity, and conductivity were previously seen in those samples. Corroded pipes, battery trash, and agricultural runoff can all contribute to elevated lead levels. Extended contact with lead can cause neurological issues, anemia, and kidney difficulties, especially in children and pregnant people, making water from contaminated sources dangerous to drink without treatment (Ali et al., 2019; Collin et al., 2022). Such forms of water require effective monitoring and treatment before consumption, but the majority of locals take the water directly without any treatment.

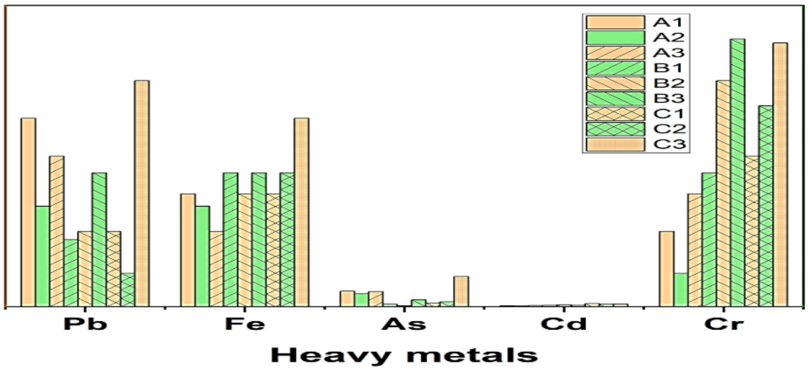

Figure 2: Heavy Metals Concentration Profile for Tsangayan Gabas, Unguwar Sarki, and Unguwar Yamma

Iron (Fe)

The concentration of iron in the analyzed water samples varied from 0.2 mg/L (A3) to 0.5 mg/L (C3). The WHO permissible limit for iron in drinking water is 0.3 mg/L, meaning that some of the samples, like B1 (0.4 mg/L), B3 (0.4 mg/L), C2 (0.4 mg/L), and C3 (0.5 mg/L), all fall within the unsafe range. Whereas iron is a vital mineral for human health, excessive levels can produce a disagreeable taste, discolouration, and staining of clothes and plumbing fixtures (Zairullah et al., 2025). Water with an elevated amount of iron may appear slightly yellow, orange, or reddish-brown in colour, and such stains can form on clothing, dishes, and plumbing equipment like sinks and toilets. These types of water often have a metallic taste and odour, primarily generating aesthetic and technical concerns rather than urgent health threats (Li et al., 2016; Rahman et al., 2024).

Arsenic (As)

The concentration of arsenic in the analyzed samples ranges from 0.002 mg/L to 0.08 mg/L. The WHO permissible limit for arsenic in drinking water is 0.01 mg/L, signifying that more than half of the samples have exceeded the maximum limit. Samples like A1 (0.041 mg/L), A2 (0.038 mg/L), A3 (0.040 mg/L), B3 (0.020 mg/L), and C3 (0.08 mg/L) have all exceeded the maximum threshold. High levels of arsenic in drinking water pose a serious threat to human health worldwide. In acute cases, it produces immediate gastrointestinal distress, but prolonged exposure greatly raises the lifetime risk of several malignancies, severe skin lesions, and neurological and cardiovascular disorders (Genchi et al., 2022). This is an indicator that such water is not fit for direct consumption; it requires substantial treatment before use. Arsenic has no taste, colour, or smell because it is a naturally occurring element that dissolves from rock and soil into subterranean aquifers. Testing the water is the only way to determine its safety. If elevated amounts are discovered, specialized treatment equipment, including distillation units or adsorptive iron-oxide filters are employed to minimize or eliminate arsenic (Valskys et al., 2022).

Cadmium (Cd)

The concentration of cadmium in the samples ranged from 0.002 mg/L (A1 and A2) to 0.08 mg/L (C1), while the WHO standard for cadmium is 0.003 mg/L. The results show that almost all samples exceeded the WHO permissible limit, except for A1 and A2 (0.002 mg/L). The elevated levels suggest potential pollution from inorganic fertilizers, herbicides, or inappropriate waste disposal. Even at trace amounts, cadmium is extremely hazardous and has been linked to kidney failure, bone deterioration, and cancer (Charkiewicz et al., 2023). As a result, the obtained values imply that the water sources in the locations under study are dangerous due to cadmium contamination.

Chromium (Cr)

Chromium concentrations in the water samples ranged between 0.1 mg/L (A2) and 0.8 mg/L (B3), with a WHO permissible limit of 0.01 mg/L. Severe chromium pollution was indicated by all of the measured values exceeding the acceptable limit. Excessive exposure to chromium, especially hexavalent chromium (Cr^{+}), has been linked to respiratory problems, skin irritation, and an increased risk of cancer. Prolonged consumption results in anemia, stomach discomfort, liver and kidney damage, and reproductive problems (Alvarez et al., 2021). Without adequate treatment, the water's high chromium levels render it unfit for human consumption.

CONCLUSION

This study offers a comparative investigation of water quality from designated sampling locations inside Sabon Gari Nangere. Nine water samples were collected from three different locations, labeled A1–A3, B1–B3, and C1–C3. The analysis concentrated on essential physicochemical parameters, including pH, temperature, hardness, turbidity, electrical conductivity, TDS, TSS, and specific heavy metals, particularly carcinogenic ones such as Pb, As, Cd, Cr, and Fe. Although certain metrics such as temperature, hardness, and TSS complied with WHO criteria, others are above allowed limits, particularly turbidity and conductivity, which were markedly elevated in nearly all samples. Similarly, TDS and pH levels are markedly elevated and exceed WHO limits in most of the examined samples. Surprisingly, Fe is much higher than the stated limit in only four samples. However, carcinogenic heavy metals such as Pb, Cr, As, and Cd were found to be frighteningly high in virtually all of the examined samples, exceeding all regulatory agencies' limits, necessitating prompt action. High concentrations of such heavy metals pose serious health threats such as kidney damage, anemia, bone weakness, and neurological disorders. Shallow groundwater tables, agricultural runoff, poor waste disposal methods, and inadequate well and borehole protection may all have contributed to the disaster. The study reveals that practically all of the water sources in Sabon Gari Nangere are unsafe for direct household consumption and must be treated to ensure their quality and safety. Hence, regular monitoring, public awareness, environmental control, and efficient water treatment. Similarly, regular monitoring, improved cleaning methods, adequate well protection, and community awareness will significantly improve water quality. Likewise, to prevent microbiological and chemical contamination, the population should be urged to treat borehole water prior to consumption, particularly by procedures such as boiling, chlorination, or filtering. Boreholes' surroundings should be kept clean and free of trash dumping, agricultural runoff, and open defecation, which all contribute to water contamination. The findings are valuable resources for policymakers, researchers, and stakeholders working to improve water safety in Yobe State.

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