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EFFECTS OF PROXIMITY TO DUMPSITES ON GROUNDWATER QUALITY IN DUTSE ULTRAMODERN MARKET, JIGAWA STATE, NIGERIA

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ABSTRACT

Purpose: *Groundwater contamination from selected boreholes and wells around Dutse UltraModern Market Dumpsite has been investigated and reported in this study. This is aimed at ascertaining the groundwater quality, taking cognizance of the proximity effects as a factor.*
Design/methodology/approach: *To achieve this aim, samples were collected from the only four available underground water sources (three boreholes and one well) in the vicinity of the dumpsites using the American Public Health Association (APHA). The study was triggered due to reported changes in the groundwater sources near the dumpsites by the communities around the Dutse UltraModern market. The parameters selected are: copper, lead, zinc, cadmium, iron, and manganese using standard methods.*
Findings: *The results show that all the parameters were within the recommended permissible limit of WHO and NSDWQ drinking water standards, but iron and manganese have an escalated concentration, particularly in sample point A. In this sample point (borehole A), iron concentration exceeded the permissible limit (0.112; WHO 1), whilst manganese has surpassed the highest desirable level but is within the maximum permissible limit (0.349; WHO 0.5). It is suspected that the proximity of sample point A (Lat. 0537328, Long. 1292669) to the dumpsites was the contributing factor for the escalated concentration of iron and manganese in the said sample station (sample A).*
Research limitations/Implications*: The limitations include the use of only four samples which were the only available underground water sources (three boreholes and one well) in the vicinity of the dumpsites.*

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Practical implications: *It was concluded that water sources such as boreholes and wells should be situated far away from dumpsites, or rather, the dumpsites should be kept far from boreholes and wells, and be upgraded to meet the current hygienic standards.*
Originality/value *– The study revealed the groundwater contamination from the available groundwater sources (three boreholes and one well) around Dutse Ultra-Modern Market Dumpsite, taking cognizance of the proximity effects as a factor.*

Keywords: Boreholes, Dumpsites, Dutse, Jigawa state, Water quality standards.

1.0 INTRODUCTION

There are increasing concerns about the contamination of groundwater due to unregulated solid waste disposal within cities, particularly at dumpsites proximate to boreholes and wells (Mustapha et al., 2014). Although dumpsites are the preferred method of municipal solid waste (MSW) disposal, however, poorly designed dumpsites can create contamination of not only groundwater, but also soil and air. The most commonly reported danger to human health from these dump sites is from the use of groundwater that has been contaminated by leachate. As water percolates through the dumpsite, contaminants are leached from the solid waste (Nomngongo et al., 2012). Leachate is produced when moisture enters the refuse in a landfill, extracts contaminants into the liquid phase, and produces a moisture content sufficiently high to initiate liquid flow. Leachate is generated in a landfill as a consequence of the contact of water with solid waste.

Leachate may contain dissolved or suspended material associated with wastes disposed in the landfill, as well as many byproducts of chemical and biological reactions (Osazuwa and Abdullahi, 2008). The strength of leachate from MSW landfills varies with the progress of biological activity occurring in dumpsites (Tukur et al., 2018). The rate and characteristics of leachate produced depend on many factors such as solid waste composition, particle size, degree of compaction, hydrology of the site, age of dumpsites, moisture and temperature conditions, and available oxygen.

During the course of stabilization of dumpsites, non-conservative constituents of leachate (primarily organic in nature) tend to decompose and stabilize with time, whereas conservative constituents (e.g., heavy metals, chloride, and sulfide) will remain long after waste stabilization occurs. Metals often are precipitated within the landfill and are infrequently found at high concentrations in leachate, except for iron (Zhou et al., 2016). Considering the significance of water, perhaps as the most precious natural resource after oxygen, and that it is continuously being polluted via waste disposal, all sources of water contamination must be studied often continuously to update its status for various many uses it can be put to (Ibrahim et al., 2015). Thus, suitability categorization can only be made possible with this type of study.

Research has been carried out on the effects of dumpsites on adjoining water tables (Xu et al., 2012); however, to the best of the author's knowledge, the proximity of the water sources to the dumpsites and the soil type were overlooked. This research suggests the need for more studies on the quality of water to better inform the government and the public the need for safe water. It is therefore the aim of this study to determine the effects of the dumpsite on groundwater quality in Dutse Ultramodern Market, Dutse, Jigawa State.

This study investigates the influence of proximity of the groundwater sources to the contamination of the groundwater in the area, and how best the groundwater quality conforms to the WHO and Nigerian Standard for Drinking Water Quality (NSDWQ) standards.

2.0 LITERATURE REVIEW

Since groundwater is a major source of drinking water for millions of people worldwide and supports agricultural, industrial, and recreational activities, its quality is a crucial component of environmental sustainability and public health. Groundwater is stored in aquifers, which are naturally occurring underground formations made of permeable rock, sand, or gravel. Because groundwater is essential to maintaining ecosystems and human livelihoods, it is crucial to monitor and assess its quality in order to ensure its safety and sustainability for present and future generations (Sharma et al., 2021). The assessment of groundwater quality is driven by the need to detect contamination, identify natural and anthropogenic factors influencing water quality, and implement effective management strategies. Groundwater can become contaminated from various sources such as agricultural runoff, industrial discharges, sewage effluents, and infiltration of hazardous chemicals from dumpsites and landfills (Singh et al., 2020). Groundwater pollution is particularly concerning because contaminants in the subsurface are often difficult to detect and may persist for long periods, posing risks to human health, agriculture, and aquatic life.

Effective groundwater quality assessment programs rely on a variety of chemical, physical, and biological parameters. Common indicators of water quality include pH levels, dissolved oxygen, microbial content, heavy metals, and organic compounds (Mallam et al., 2025). Analysing these parameters helps scientists and policymakers determine whether the water is suitable for consumption, irrigation, or industrial purposes, and guides the development of mitigation measures where necessary (Adamu et al., 2025). Furthermore, groundwater quality can vary widely depending on geographic location, geological formations, and the proximity to pollution sources. In regions where groundwater is the primary source of potable water, such as rural and semi-urban areas, the risks associated with poor water quality are heightened (Muhammad et al., 2024). In these areas, a lack of infrastructure to provide alternative water sources and inadequate treatment options make the regular monitoring of groundwater quality a critical public health priority (Basharat et al., 2025).

This chapter will explore the existing body of literature on groundwater quality, examining factors influencing its composition, common methods used for its assessment, and the health and environmental implications of contamination. It will also highlight relevant case studies and regulatory frameworks aimed at safeguarding groundwater resources.

2.2.1 Concept of Groundwater

Groundwater refers to the water that exists beneath the Earth’s surface within soil pore spaces and in the fractures of rock formations. This water is stored in aquifers, which are underground layers of water-bearing permeable rock or sediments such as sand, gravel, and silt. Groundwater forms a crucial part of the hydrological cycle, originating from surface water that percolates into the ground through infiltration, eventually replenishing aquifers (Muhammad et al., 2024).

Groundwater is the world’s largest available freshwater source, accounting for approximately 30% of the Earth’s freshwater reserves (Adamu et al., 2025). It plays a significant role in meeting the demand for potable water, irrigation, and industrial processes, especially in regions where surface water sources such as rivers and lakes are scarce. The movement of groundwater occurs slowly through aquifers, and its quality is naturally filtered as it moves through the earth's layers. However, this does not completely protect it from contamination, as human activities and natural processes can affect its purity (Tóth, 2009). Understanding groundwater systems requires knowledge of the geological and hydrological processes that govern their formation, flow, and storage. Variations in these factors influence the recharge rates and quality of groundwater, making it necessary to assess groundwater conditions regularly for sustainable use (Mukherjee et al., 2021).

2.2.2 Groundwater Contamination

Groundwater contamination occurs when harmful substances enter the aquifer systems, reducing water quality and rendering it unsafe for human use or ecological sustainability. Contaminants can be classified as either point-source pollution or non-point-source pollution. Point-source pollution originates from specific locations such as industrial waste discharge, leaking septic systems, and landfills. Non-point-source pollution, on the other hand, comes from diffuse sources like agricultural runoff, atmospheric deposition, and urban stormwater (Adamu et al., 2025). Natural factors like geological formations can also contribute to contamination, as certain rock formations may release harmful substances, such as arsenic, fluoride, or radon, into groundwater supplies. Anthropogenic activities, however, are the most significant contributors to groundwater contamination, including the overuse of fertilisers and pesticides in agriculture, the disposal of hazardous wastes, and mining activities (Nolan et al., 2014). Groundwater contamination can have severe consequences on public health and the environment. For instance, nitrate contamination is linked to methemoglobinemia, also known as "blue baby syndrome," a condition affecting infants (Mallam et al., 2025). Similarly, heavy metal contamination, particularly arsenic and lead, is associated with long-term health effects such as cancer, kidney damage, and neurological disorders (Muhammad et al., 2024).

2.2.3 Groundwater Quality Assessment

Assessing the quality of groundwater involves evaluating its physical, chemical, and biological properties to determine its suitability for various uses such as drinking, irrigation, and industrial applications. Groundwater quality is influenced by both natural processes and human activities, and the parameters assessed typically include pH levels, dissolved solids, temperature, nutrients, microbial content, and concentrations of heavy metals (WHO, 2017). The World Health Organisation (WHO) and other regulatory agencies have established standards for the acceptable levels of these parameters in drinking water. For instance, the WHO's Guidelines for Drinking-Water Quality (2017) set specific limits for substances such as nitrates, fluoride, and arsenic to protect human health. Regular monitoring of these parameters ensures that water sources remain safe and helps in the early detection of contamination events.

Groundwater quality assessment typically involves two key components: field sampling and laboratory analysis. Field sampling includes the collection of water samples from wells, boreholes, or springs, and the measurement of in-situ parameters like temperature, pH, and electrical conductivity. Laboratory analysis, on the other hand, provides a more comprehensive evaluation of chemical contaminants and biological indicators such as Escherichia coli and total coliforms (Mallam et al., 2025). In addition to chemical and microbial assessments, emerging technologies such as remote sensing and geographic information systems (GIS) are increasingly being used to map groundwater contamination and assess water quality over large spatial areas. These methods allow for the identification of pollution hotspots and the development of more effective management strategies (Adamu et al., 2025).

2.2.4 Conceptual Framework

A conceptual framework provides a theoretical structure for understanding the key concepts and relationships involved in groundwater quality assessment. In this context, the framework outlines how natural and anthropogenic factors interact to influence groundwater quality and the subsequent health and environmental outcomes. The framework integrates various factors, including:

1. Natural Factors: These include the geology, hydrology, and geochemistry of the region. The composition of the aquifer, its recharge rate, and the natural filtration processes within the soil and rock layers determine the baseline quality of groundwater (Mukherjee et al., 2021).

2. Anthropogenic Activities: Human activities such as agriculture, industrialisation, urbanisation, and waste disposal are significant sources of groundwater contamination. The type and intensity of these activities, along with land-use practices, contribute to the pollution load entering aquifer systems (Adamu et al., 2025).

3. Regulatory and Policy Frameworks: Governments and international organisations establish guidelines for groundwater quality to protect human health and the environment. Effective policies are essential to managing groundwater resources sustainably and preventing contamination (Kumar et al., 2022).

4. Public Health Impacts: Contaminated groundwater poses severe risks to human health, particularly in regions where groundwater is a primary source of drinking water" (Rahman et al., 2020).

3.0. AREA OF THE STUDY

Dutse, the capital city of Jigawa State, lies between latitude 11.69099 and longitude 9.33907. With an estimated population of 335,600 in 2016 and estimated to reach 3,418,465 in 2024 (TytkowskaOwerko et al., 2025), Dutse is currently the most populated city in Jigawa State. The average climate of Dutse is denoted as a Hot Semi-Arid climate under the Koppen climate classification. These climates tend to have hot, sometimes extremely hot, summers and warm to cool winters, with some minimal precipitation. The average annual highest temperature in Dutse is 40.3°C (104.5°F). The warmest time of year in Dutse is around April, where temperatures usually get up to 40.3°C (104.5°F), and May 5th is the hottest day on average. The average annual lowest temperature in Dutse is 11.9°C (53.4°F), and December 31st is the coldest day on average. The months with the most rainfall occurrence are August and July. The average annual rainfall for Dutse is 576mm (23"). The main source of water in Dutse is groundwater; thus, they rely mostly on boreholes, wells, and taps (Figure 1)

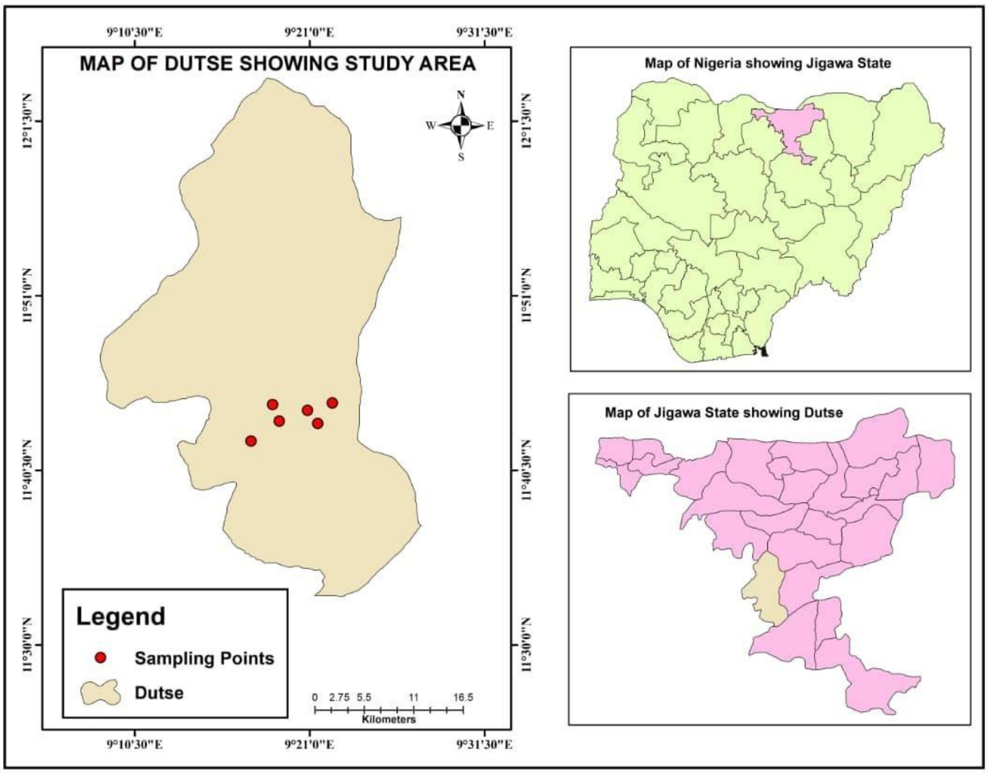


Figure 1: Map of Jigawa State, Dutse town and sampling points

4.0 METHODOLOGY

Four water samples were collected, three from boreholes and one from a well, using 1-litre polythene bottles. This is because they are the only groundwater sources in the vicinity of the two dumpsites. Parameters with low stability, such as pH and temperature, were detected in situ during each sampling process. The sampling containers were rinsed with the borehole water, and each borehole was allowed to operate for at least three minutes before sample collection was made. All samples were collected in pre-cleaned one-litre polythene plastic bottles and acidified with analytical-grade concentrated nitric acid to a pH of approximately 2.0, except for samples that were collected separately and not acidified for nitrate determination (Tukur et al., 2020). Samples were respectively labelled according to the sampling points and were taken to the laboratory for analysis in a cooler containing ice blocks. Sampling locations were indicated in Table 1 with coordinates derived from a Global Positioning System Device (GPS) (Umar et al., 2019). The sampling points were meticulously selected, taking cognisance of their proximity to the open dumpsite, which makes them susceptible to pollution. This will help to fill in the gap overlooked by previous researchers regarding the influence of proximity to groundwater sources such as boreholes and wells (Table 1).

Table 1: Sampling points, elevation, and coordinates

Sampling points	*Elevation (above sea level)*	*Latitude*	*Longitude*
Dumpsite A	455m	0537402	1292563
Dumpsite B	457m	0537390	1292594
Point A (Borehole)	446m	0537328	1292669
Point B(Well)	450m	0537412	1292773
Point C (Borehole)	454m	0537502	1292715
Point D (Borehole)	453m	0537624	1292431

Source: GPS 2023 Note: Only three boreholes and wells were available as groundwater sources in the vicinity of the two dumpsites

The working conditions of all field meters and equipment were checked, and they were calibrated according to the manufacturer's specifications. Blank samples made with deionised water were also passed in between every three measurements of the sample as a check for possible contamination and malfunctioning of the equipment (Sellami et al., 2014). A Flame photometer is used to determine the concentration of selected heavy metals such as zinc, copper, iron, cadmium, lead, and manganese in the samples.

4.1. Statistical Analysis

To correlate the selected heavy metals investigated, SPSS 20 Version was employed. Additionally, charts showing the average values of the parameters collected over three sampling intervals for the different sampled boreholes were shown in relation to the WHO (2006) and NSDWQ (2007) standards for drinking water.

5.0 PRESENTATION AND DISCUSSION OF RESULTS

The results of the analysed heavy metals concentration of three boreholes and a well within proximity of the Ultra-Modern Market Dumpsite in Dutse L.G.A. are presented in Table 2. Comparisons were made between the results obtained and drinking water quality standards set by WHO and NSDWQ in some previous studies (Awoyemi, 2024; Muhammad et al., 2024; Tytkowska-Owerko et al., 2025).

Table 2; Heavy metals of interest and their average mean values.

Heavy Iron: Cadmiu Lead: Copper: Zinc: Mangane metals → ***Fe*** *m:* ***Cd*** ***Pb****(mg/ Cu (mg/L)* ***Zn*** *se:* ***Mn*** *Sample (mg/L) (mg/L) L) (mg/L (mg/L)*

points ↓

)

0.111

A (Borehole)	0.112	-0.018	-0.880	0.090		0.349
B (Well)	0.046	-0.019	-0.097	0.088	0.034	0.203
C (Borehole)	0.012	-0.017	-1.164	0.106	0.046	0.277
D (Borehole)	0.047	-0.015	-1.270	0.119	0.043	0.181
MEAN	0.054	-0.017	-1.078	0.101	0.059	0.253

Source: laboratory analysis 2023

As shown from Table 2, iron concentration from the borehole water ranged from 0.012 -0.112mg/l, designated A, C, and D. The minimum value from the borehole samples is 0.012mg/l, designated as C, while the maximum value is 0.112 mg/l/, designated as A. The mean concentration value is 0.054mg/l. The fact that WHO's highest desirable standard of iron is 0.1mg/l and the maximum permissible limit is 1mg/l, borehole A (0.112mg/l) has exceeded the highest desirable level recommended, but all other sampled points were below the desirable and maximum standards of WHO. In the process of literature reviewing, the researchers were able to select some heavy metals of interest (Fe, Cd, P, Cu, and Mn) and compare them 2015-2025 (Table 3)

Table 3: Heavy metals of interest and their average mean values (2015 & 2025).

SN	*Elements*	*Mean 2015*	*Mean 2025*	*Max. Permissible Conc. WHO & NSDWQ*	*Remark*
1	Iron(Fe) (mg/L)	**1.824**	0.054	0.3	APL/BPL
2	Cadmium(Cd) (mg/L)	0.003	-0.017	0.005	BPL
3	Lead(Pb) (mg/L)	0.0147	-1.078	0.015	BPL
4	Copper(Cu) (mg/L)	0.015	0.101	1.3	BPL
5	Zinc(Zn) (mg/L)	0.0695	0.059	0.2	BPL
6	Manganese(Mn)	**0.273**	**0.253**	0.05	APL

Source: literature and laboratory analysis

It is also indicated that Cadmium concentration, which ranged from -0.015 - -0.019mg/l (Table 2), is within the permissible limit. The minimum concentration (-0.015mg/l) was from borehole D, while the maximum (-0.019mg/l) was from the well water designated as B, and the mean concentration is -0.017mg/l. The maximum permissible limit of Cadmium recommended by WHO and NSDWQ is 0.005mg/l and 0.003mg/l, respectively. Thus, Cadmium concentrations are below the permissible limits of both WHO and NSDWQ.

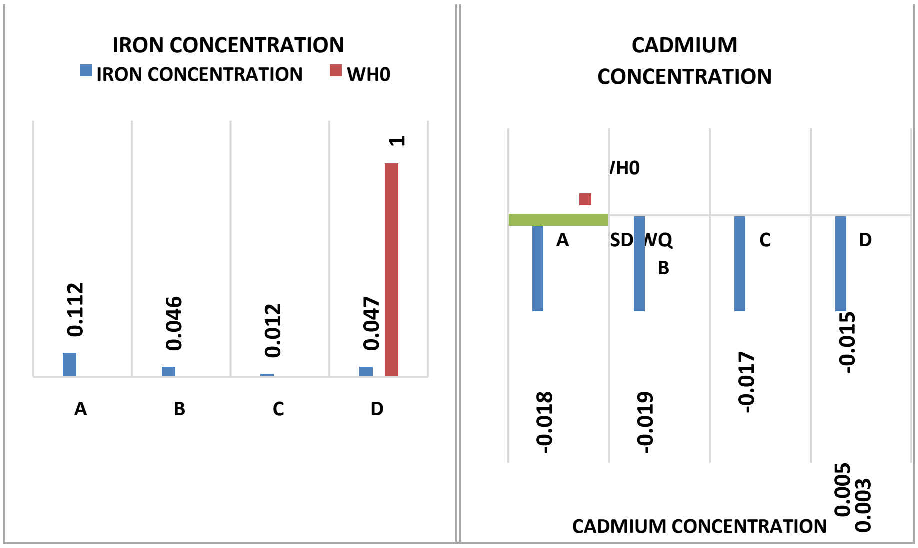
The results of heavy metals analysis in Dutse town in 2015 and 2025, taking into consideration land use changes that portrayed the evidence of urban sprawl in Dutse town. The heavy metals chosen for this study were within the maximum permissible concentration in both 2015 and 2025, except manganese, which shows elevated concentration above the maximum permissible level in 2015 and 2025, and iron in 2015, respectively. The escalated concentration of manganese in both 2015 and 2025 is a source of concern, and the possible causes of the increase in manganese concentration in underground water are anthropogenic activities such as mining activities, industrialization, and leaching from dumpsites/landfills (Tytkowska-Owerko et al., 2025). All these sources were found to be present at a certain level around Dutse town (Muhammad et al., 2024).

Rock mining for different purposes is concomitantly visible within and around Dutse town; there is expansion and an increase in small and large industries within the study area. Additionally, the possibility of increased leaching of manganese via dumpsites and landfills is greater, as the fact that increase in waste generation is intensifying day by day, as Dutse town, the capital city of Jigawa state, is grossly sprawling from both sides, and strangers are trooping due to relative peace and security within and around the city. Thus, the increase in manganese in the study area corresponds with the activities that result in high concentrations of manganese in drinking water worldwide (Awoyemi, 2024). Increasing manganese above the permissible limit in our drinking water will have serious health issues, such as neurological and behavioral effects, as well as deficits in memory, attention, and motor skills.

Although the concentration of manganese is comparatively decreasing from 0.273 in 2015 to 0.253 in 2025, the authority concerned with safe drinking water needs to take the necessary steps to drastically reduce manganese concentration in Dutse town drinking water. Table 3 also indicates an increase in iron concentration above the permissible limit in 2015, but the narrative was changed in 2025, where it dropped to below the permissible limit 2025 (Table 2). Both natural and man-made factors can contribute to elevated iron levels in groundwater. Naturally, a lot of subterranean rock formations contain iron, which dissolves in groundwater when it seeps through them. The breakdown of iron from rocks and minerals can also be accelerated by low oxygen levels or acidic groundwater. Iron can also enter groundwater through anthropogenic processes such as inappropriate waste disposal, agricultural runoff, and industrial discharges (Awoyemi, 2024).

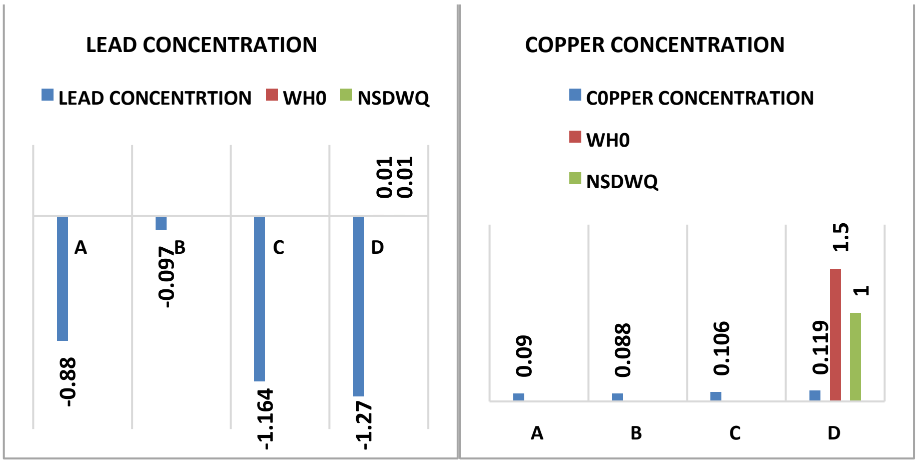
Thus, it was reported that in 2015, the urban sprawl and concretization of the urban surfaces bearing developmental projects were minimal (Muhammad et al., 2024) compared to 2025, as shown by the land use land cover changes (Figures 1&2).

The anthropogenic factors aggravating high iron concentration in groundwater, such as inappropriate waste disposal and agricultural runoff in particular, were reduced in their effects in 2025, because some measures to manage indiscriminate waste disposal have been taken; for example, waste disposal infrastructures were increased; however, consideration for their proximity to sources of groundwater has not been duly observed. Additionally, the agricultural runoff that injects the close-settlement zone agricultural runoff was tempered by surface concretization via urban development; thus, this agricultural runoff can no longer leach the contaminant within the vicinity of Dutse town as was the case before. These are some of the reasons for the reduced iron concentration below the permissible limit in 2025 (Figures 2 and 3)



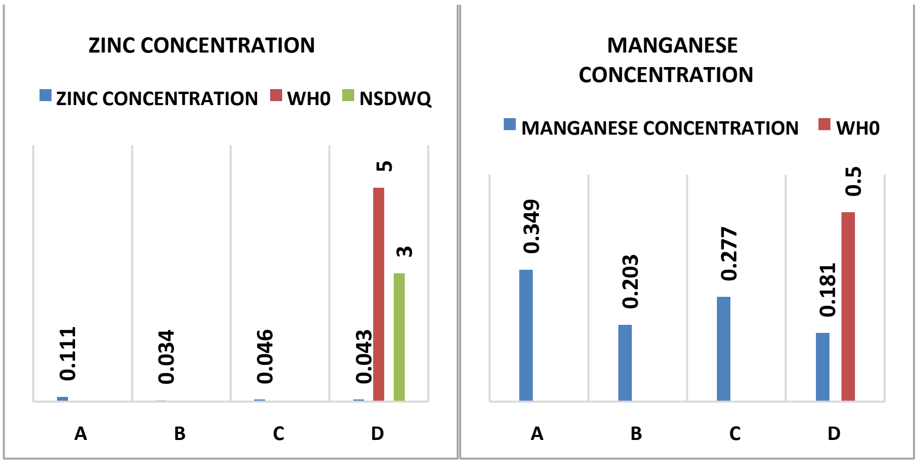
Figures 1 and 2: Iron and Cadmium concentration in comparison with the WHO and NSDWQ standards

Similarly, Table 2 shows Lead concentrations, the range is from -0.097 to 1.270mg/l (Table 2). The minimum concentration (-0.097mg/l) is from well water designated as B, while the maximum concentration (-1.270mg/l) was from borehole D. The mean concentration is -1.078mg/l. Considering the maximum permissible standard of lead in drinking water as permitted by WHO (0.01mg/l) and NSDWQ (0.01mg/l), Lead concentrations from all samples were within the recommended standard. Table 2, further, revealed Copper mean concentration value (0.101mg/l), ranges (0.088 - 0.119mg/l), minimum concentration (0.088mg/l) which was recorded from well water designated as B, and the maximum concentration (0.119mg/l) which is however, from borehole D. Since, the WHO highest desirable concentration (0.05mg/l) and the maximum permissible limit (1.5mg/l), and the maximum permissible standard recommended by NSDWQ is 1mg/l., cupper concentration from all the samples are thus, within the permissible standards of both WHO and NSDWQ.



Figures 3 and 4: Lead and Copper concentration in comparison with the WHO and NSDWQ standards

The concentration of Zinc ranges from 0.034 - 0.111mg/l (Table 2). Zinc minimum concentration of zinc (0.034mg/l) was obtained from the well water designated as sample B, while the maximum (0.111mg/l) was recorded at borehole A. The mean concentration is 0.059mg/l. The highest desirable concentration of zinc in drinking water ascribed by WHO is 5mg/l. However, the maximum permissible limit by WHO and NSDWQ are 15mg/l and 3.0mg/l, respectively. Thus, all samples of interest are well within the designated limits.



Figures 5 and 6: Zinc and Manganese concentration in comparison with the WHO and NSDWQ standards

The last heavy metal concentration reported from Table 2 is Manganese, with concentrations ranging from 0.181- 0.349mg/l (Table 2). The minimum concentration is 0.181 mg/l/, which was obtained at borehole D, while the maximum concentration is 0.349mg/l and was recorded at borehole A. The mean concentration acquired is 0.253mg/l, while the highest desirable level recommended by WHO is 0.05mg/l and the maximum permissible limit is 0.5mg/l. Thus, water sources at the study area have exceeded the desirable level recommended by WHO but are within the maximum permissible standard. Hence, regular analysis is advisable in these areas. Additionally, One-way ANOVA was used to carry out the statistical analysis of variation of heavy metals parameters between the sample points (Borehole A, Well B, Bore C, and D), Table 4.

Table 4: Heavy metals concentration by using Analysis of Variance (ANOVA)

Treatment →	*A*	*B*	*C*	*D*	*Pooled Total*
observations N	6	6	6	6	24
sum ∑xi∑xi	-0.2360	0.2550	-0.7400	-0.8950	-1.6160
mean ¯xx¯	-0.0393	0.0425	-0.1233	-0.1492	-0.0673
sum of squares ∑x2i∑xi2 sample	0.9295	0.0620	1.4454	1.6641	4.1010
variance s2s2 sample	0.1840	0.0102	0.2708	0.3061	0.1736
std. dev. ss std. dev. of mean SE¯x	0.4290	0.1012	0.5204	0.5533	0.4166
	0.1751	0.0413	0.2125	0.2259	0.0850

The Analysis of Variance results show that the mean square of 0.0454 and the sum of squares of 3.9922of 3.9922. The p-value (0.8707) corresponding to the F-statistic (0.2353) of one-way ANOVA is higher than 0.05 (Table 5), suggesting that the treatments did not differ significantly between the sample points at the chosen significant level

Table 5: Analysis of Variance Test on the mean of sample points

source sum of degrees of mean square F statistic p-value squares SS freedom νν MS

treatment	0.1361	3	0.0454	0.2353	0.8707
error	3.8561	20	0.1928		
total	3.9922	23			

6.0 CONCLUSION AND RECOMMENDATIONS

The principal aims of monitoring drinking water are to prevent the spread of water-borne diseases and to protect the health of the community. The data obtained at the time of this research and its comparison with WHO and NSDWQ (2007) drinking water quality standard revealed that most of the water sources in proximity to Ultra-Modern Market Dumpsite may be safe for drinking with exception of concentration of phosphate, zinc and manganese which may be attributed to the dumpsite containing all sorts of municipal waste and waste from adjoining market. Zinc is an essential nutrient for body growth and development; however, drinking water containing high levels of Zinc can lead to stomach cramps, nausea, and vomiting. Phosphate in small quantities is not injurious to humans and animals. However, high levels of phosphate can cause digestive complications. Children and adults who drink water with high levels of manganese for a long time may have problems with memory, attention, and motor skills. Infants (babies under one year old) may develop learning and behavior problems if they drink water with too much manganese in it.

It is thus recommended that boreholes and wells should not be constructed in proximity to a dumpsite, and public awareness should be intensified to educate people on the effects of indiscriminate dumping of refuse and the ill-advised manner of consumption and usage of water a few feet away from a dumpsite. Further treatment of water is advised after collection from boreholes and wells. The public should be educated on domestic water treatment processes.

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