Research Journal of Chemical Sciences ISSN 2231-606X
Vol. **15(4),** 42-52, October **(2025)** *Res. J. Chem. Sci.*

Assessment of Heavy Metals in Hand Dug wells sited close to septic tanks in Badagry Local Government Area of Lagos State, Nigeria using GIS Techniques

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Available online at: www.isca.in, www.isca.me
Received 18th September 2025, revised 4th October 2025, accepted 17th October 2025

Abstract

Groundwater contamination has become one of the most pressing environmental challenges of our time. Among the many pollutants that threaten water resources, microbial agents and heavy metals are of particular concern. Microbial contamination can trigger outbreaks of diseases such as cholera, while heavy metals are highly toxic even at very low concentrations. In Nigeria, the persistent shortage of safe drinking water has forced many households to rely on hand-dug wells, often constructed just a few meters from septic tanks, typically at a distance of about nine meters. This reliance on alternative water sources underscores the severity of potable water scarcity across communities. This study addresses the issue by examining the concentration of heavy metals in water samples drawn from fifteen hand-dug wells located near septic tanks in Badagry Local Government Area of Lagos State, Nigeria. Samples were collected in both the rainy and dry seasons, and the presence of iron, copper, manganese, cadmium, lead, and zinc was analyzed using an Atomic Absorption Spectrometer. Findings showed that concentrations of copper, iron, zinc, and cadmium were below the permissible limits set by the World Health Organization (WHO). Manganese levels also fell within the WHO acceptable range. However, lead was consistently detected at concentrations between 0.01 and 0.05 mg/L, exceeding the WHO permissible limit of 0.01 mg/L across all sampled wells. The presence of lead at such levels renders the well water unsafe for human consumption due to its toxic effects, which can cause serious health disorders even when ingested in small amounts. To safeguard public health, regular monitoring and systematic assessment of well water quality are essential. Furthermore, sanitary inspection officers should enforce stricter measures to prevent the indiscriminate introduction of heavy metals into groundwater, thereby ensuring safe and sustainable water supplies for the growing population in the study area.

Keywords: Well water, Heavy Metal, Hand-dug Wells, Septic tanks, Arc GIS.

Introduction

Groundwater is a vital resource across much of the developing world, providing drinking water that is generally more reliable, less seasonally variable, and closer to users than surface water. For many low-income and peri-urban communities, shallow hand-dug wells and small-diameter boreholes remain the primary sources of potable water because they are affordable, accessible, and locally managed[1-3]. Yet these sources are increasingly vulnerable to contamination from both natural and human-induced pressures. Geogenic factors such as fluoride, arsenic, iron, and manganese often degrade groundwater quality in specific localities, while wastewater disposal, agricultural runoff, and unplanned urbanization compound risks through anthropogenic inputs[4-6]. Protecting these shallow aquifers therefore requires targeted monitoring approaches that account for both natural variability and human pressures.

The quality of groundwater has direct implications for public health because water intended for drinking and domestic use must meet both physicochemical and microbiological standards. Parameters such as pH, turbidity, dissolved ions, and trace metals determine physicochemical safety, while indicators like coliform bacteria and Escherichia coli reflect microbial risk[7,8]. In practice, water quality depends on four interacting factors: the geology of aquifers, local sanitation and waste-disposal practices, industrial and agricultural inputs, and hydrogeological conditions that control contaminant transport[9-11]. In low-income and peri-urban settings, shallow wells are particularly vulnerable because poor construction and inadequate protection allow both pathogens and chemicals to infiltrate easily, exposing communities to acute diarrhoeal diseases and long-term health effects from heavy metals[12,11]. This dual burden highlights the urgency of safeguarding shallow groundwater sources.

Among local contamination sources, septic tanks represent a persistent challenge. These systems, designed for onsite wastewater management, provide affordable alternatives where sewerage is absent, yet they often become pathways of pollution when poorly designed, sited, or maintained[13]. Effluents from septic tanks can migrate into surrounding soils and aquifers through leaching, seepage, or infiltration, with the extent of contamination influenced by soil permeability, depth to water table, and tank condition[14]. These discharges are complex mixtures containing nutrients, pathogens, and trace metals, all of which can threaten water quality and public health if they reach wells[15,16]. While microbial risks from septic systems are widely documented, less attention has been paid to the chemical dimension, particularly heavy metals, which are persistent, bioaccumulative, and capable of causing long-term toxic effects.

Heavy metals in domestic wastewater are introduced through diverse household activities, including cleaning, plumbing corrosion, food residues, and consumer products. Even in non-industrial settings, septic tanks accumulate measurable levels of zinc, copper, lead, chromium, iron, nickel, and cadmium in both effluents and sludge[17-19]. These metals are of particular concern because they are non-degradable, persistent in the environment, and capable of bioaccumulation in food chains. Chronic exposure has been linked to neurological, renal, cardiovascular, reproductive, and carcinogenic effects, with mechanisms involving oxidative stress, enzyme disruption, and genomic instability[20,21]. When septic effluents infiltrate shallow groundwater, heavy metals may create long-term exposure pathways that extend beyond immediate consumers to wider ecosystems, compounding public health risks[22].

The susceptibility of hand-dug wells to this form of contamination is well established in several West African studies, which report shallow depths, unlined walls, and lack of protective covers as major structural deficiencies. In Ghana, for example, more than 80% of hand-dug wells are sited within 10 to 30 meters of pollution sources, with nearly all lacking adequate maintenance or protective infrastructure; over half were found to contain both E. coli and Adenovirus[23,24]. Nigerian studies similarly show that wells located near septic tanks register significantly higher microbial loads and altered physicochemical parameters than those further away, with experts recommending a setback distance of at least 30 meters upstream of septic systems[25,26]. Defective linings, apron fissures, and the widespread use of buckets and ropes for water extraction further exacerbate risks, rendering many wells unfit for consumption without treatment[24,27]. Yet while microbial contamination is well documented, the heavy metal dimension of this problem remains underexplored, leaving a critical gap in understanding the full spectrum of risks associated with wells sited close to septic tanks.

Geographic Information Systems (GIS) offer powerful tools for filling this gap. Unlike traditional methods, GIS allows for the integration of spatial and chemical data to model contaminant transport, map high-risk zones, and visualize patterns of groundwater vulnerability[28,29,30]. Applications in other regions have demonstrated its value, from mapping groundwater potential using weighted overlay analysis to interpolating water quality parameters with kriging methods[31]. In arid environments, combining GIS with hydrochemical analysis has revealed how land use and climate shape groundwater degradation[32,33], while integration with remote sensing has enabled monitoring of temporal changes linked to population growth and agricultural expansion[34]. These capabilities make GIS an indispensable tool for assessing not just where contamination occurs but also how it spreads across space and time, offering a robust evidence base for interventions. Although heavy metal pollution in groundwater is a growing concern globally, very few studies have focused specifically on hand-dug wells situated near septic tanks, and fewer still have employed GIS to analyze contamination patterns in such local contexts. This study therefore addresses a critical knowledge gap by combining water quality assessment with spatial analysis to evaluate heavy metal risks in wells located close to septic systems. Its findings will contribute directly to sustainable water resource management in communities reliant on shallow groundwater, while advancing environmental health knowledge by explicitly linking household sanitation practices to groundwater safety. Beyond academic contribution, the study has strong policy relevance: it will inform siting regulations for wells and septic tanks, support the design of sanitation strategies that protect aquifers, and demonstrate the potential of GIS-based mapping as a decision-support tool for environmental monitoring, urban planning, and long-term water security.

Materials and Methods

Badagry, traditionally known as Gbagle, is a coastal town and Local Government Area (LGA) in Lagos State, Nigeria. It is located between the city of Lagos and the Seme border with the Republic of Benin, lying between latitudes 6°22′N and 6°42′N, and longitudes 2°42′E and 3°42′E. The area spans about 170 square miles (441 km²). Badagry Creek flows directly into Ologe Lagoon, another important water body within Lagos State. The region is largely inhabited by fishing communities whose livelihoods depend heavily on the aquatic resources of these water bodies (Figure-1).

GIS Mapping: A handheld GPS receiver (Garmin GP12 Personal Navigator) was used to record the coordinates of the sampled well water points. The spatial distribution maps of heavy metals in the sampled water were then generated using ArcView 3.29 software developed by the Environmental Systems Research Institute (ESRI), Redlands[35]. The results are presented in Table-1.

Table-1: Coordinates of each well sampled in Badagry, Lagos state.

Well Code	Location/ Sampling Site	Cordinates
WW 1	No. 34 Joseph Dosu Way, Old NEPA, Badagry	N06.41662, E002.88341
WW 2	1, Sanapon Junction, Adariko Compound, Dosu Way, Badagry	N06.41531, E002.88366
WW 3	No. 8 Market Street, Centre Oba Akran Way, Badagry	N06.41648, E002.87625
WW 4	House 1, Mercy of God Health Centre, Sycomore, Ajara Topa	N06.43087, E002.88182
WW 5	Topa Guest House, Whenton Road, Topa-Ajara	N06.43135, E002.88450
WW 6	1, Madam Grace Street, Opposite Aro Fashion Centre, Ajara	N06.43292, E002.89019
WW 7	13/15 Ajayi Francisco Compound (2), Ajara Vedo	N06.43532, E002.89225
WW 8	Ajara Phase I, Ajara Public Toilet Vedo Town	N06.43573, E002.89412
WW 9	Ibereko AOCOED Staff Quarters, 2nd Well to Right	N06.43674, E002.90882
WW 10	Ibereko LASU Staff Quarters, Ibereko	N06.43742, E002.90818
WW 11	Ibereko Staff Quarters, Ibereko	N06.43813, E002.90983
WW 12	Ajakale Compound Old Lagos Road, Ibereko Bus/Stop, Ibereko	N06.44099, E002.91689
WW 13	Zion Printer House beside Ascension College Road, Aradagun	N06.43805, E002.95858
WW 14	House 1, Amoten Petrol Station, Ascension College Road, Aradagun	N06.44205, E002.95569
WW 15	House 1, Aduragbemi Mosque, Muwo Bus/Stop, Age-Muwo	N06.46029, E002.96000

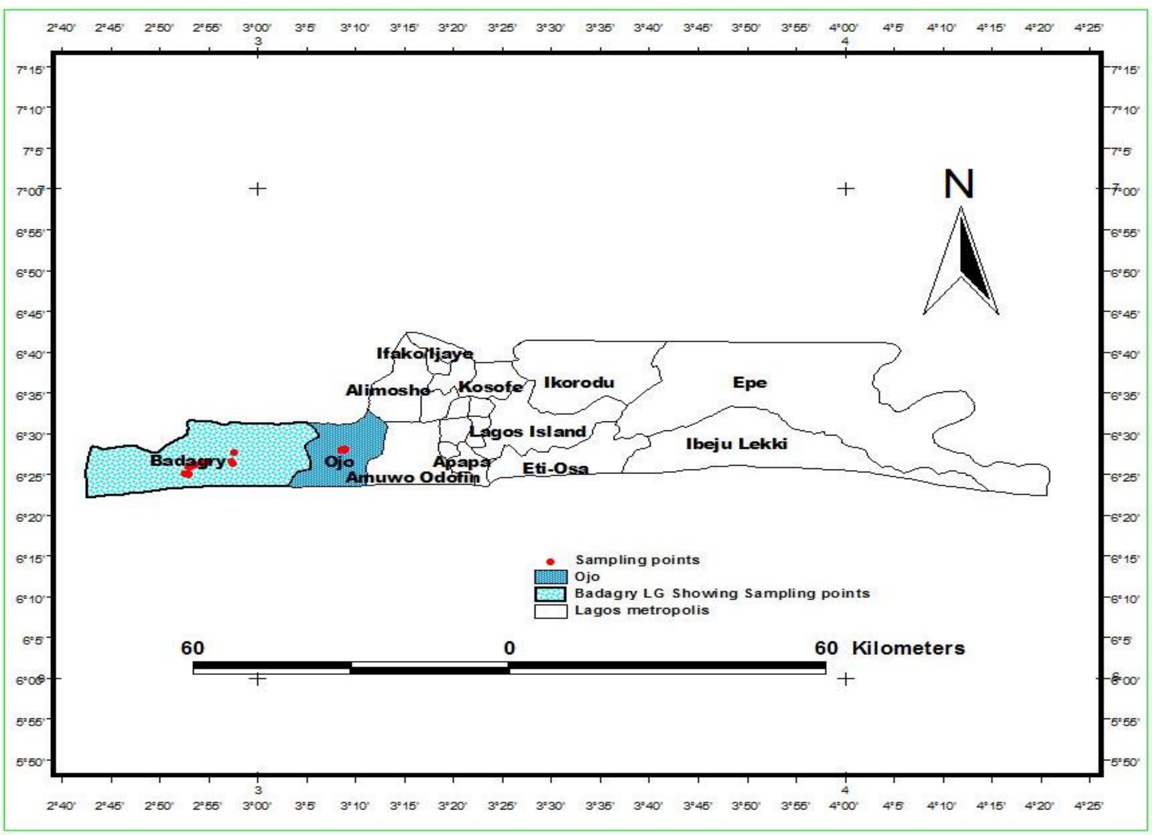

Figure-1: Map showing of Badagry showing selected wells for sample collection.

Samples Collection: Water samples were collected from fifteen hand-dug wells in the study area during the rainy and dry seasons over a twelve-month period (12). The sampling sites were selected due to their proximity to an obvious source of septic tank contamination.

For collection, new one-litre plastic bottles with hard screw caps were used. Before sampling, the containers were thoroughly cleaned following APHA guidelines[36]: they were treated with a 1:1 nitric acid (HNO_3) solution, rinsed several times with distilled water, and finally rinsed with the well water itself. Samples were taken using the same fetching containers typically employed by households, which were either rubber scoops made from motorcycle or car inner tubes attached to long cords, or repurposed four-litre paint buckets fastened to ropes.

Heavy Metals Determination (Iron, Manganese, Zinc, Copper, Cadmium and Lead) in the fifteen sampled wells in Badagry LGA, Lagos: The concentrations of heavy metals in the water samples were analyzed using a Buck 210 VGP Atomic Absorption Spectrophotometer (AAS system), with each metal (Fe, Cu, Mn, Cd, Pb, and Zn) measured at its specific wavelength.

Sample pretreatment for total heavy metal analysis: To prepare the samples for analysis, 5 ml of concentrated nitric acid (HNO_3) was added to 250 ml of raw water in a beaker and thoroughly mixed. The mixture was heated on a hot plate until it was reduced to about 50 ml, then allowed to cool. An additional 5 ml of concentrated HNO_3 was added and the solution was reheated for 2–5 minutes to ensure complete dissolution of metal ions. After cooling, the solution was transferred to a volumetric flask and diluted to a final volume of 50 ml with distilled water. This prepared solution was then analyzed for metal concentrations using the Buck 210 VGP Atomic Absorption Spectrophotometer.

Results and Discussion

Assessment of physical characteristics of the sampled wells: A total of fifteen hand-dug wells were sampled in Badagry Local Government Area of Lagos State, Nigeria. All the sampled wells were found to be in close proximity to septic tanks. Every well (100 percent) was uncovered, uncemented, and visibly dirty. Their depths ranged from 1.75 to 5.50 meters, while the distance between the wells and the nearest septic tanks varied from 2.0 to 35 meters. The surrounding soil type in all locations was sandy. Each well was cased, with the number of casing rings ranging from 2 to 6 (Table-2).

Concentration of Heavy Metals in Sampled Wells during rainy and dry seasons: The results of the heavy metal analysis for the well water samples are summarized in Tables-3a and 3b. Six metals were examined during both the rainy and dry seasons: iron (Fe), copper (Cu), manganese (Mn), cadmium (Cd), lead (Pb), and zinc (Zn). The findings were compared with the drinking water standards set by the World Health Organization (WHO).

Table-2: Physical characteristics of the sampled hand dug (HD) wells.

Well code	Characteristics of hand dug wells	Distance from septic tank (m)	Well depth (m)	No of casing	Soil Type
WW 1	Not covered + not cemented dirty environment.	16.00	1.94	2	Sand
WW 2	Not covered + not cemented dirty environment.	16.37	2.70	2	Sand
WW 3	Not covered + not cemented dirty environment.	5.05	2.83	2	Sand
WW 4	Not covered + not cemented dirty environment	16.00	5.50	6	Sand
WW 5	Not covered + not cemented dirty environment.	18.00	5.00	6	Sand
WW 6	Not covered + not cemented dirty environment	7.00	4.00	5	Sand
WW 7	Not covered + not cemented dirty environment.	20.70	3.50	3	Sand
WW 8	Not covered + not cemented dirty environment.	8.00	3.65	4	Sand
WW 9	Not covered + not cemented swampy dirty environment.	17.00	2.50	3	Sand
WW 10	Not covered + not cemented swampy dirty environment.	35.00	2.70	3	Sand
WW 11	Not covered + not cemented dirty environment.	25.00	1.75	2	Sand
WW 12	Not covered + not cemented dirty environment	20.00	3.82	5	Sand
WW 13	Not covered + not cemented + dirty environment	2.00	2.90	3	Sand
WW 14	Not covered + not cemented dirty environment	25.00	2.68	3	Sand
WW 15	Not covered + not cemented dirty environment	10.00	2.85	3	Sand

Table-3a: Concentrations of heavy metals in Badagry sampled wells (Rainy Season)

Sample Number	Co-ordinates	Heavy metal ion concentration in mg/l					
		Fe	Cu	Mn	Cd	Pb	Zn
WW1	N06.41662,"E002.88341"	0.12	0.002	0.03	0.002	0.01	0.02
WW2	N06.41531, "E002.88366"	0.09	0.003	0.01	0.003	0.01	0.02
WW3	N06.41648, "E002.87625"	0.05	0.001	0.03	0.001	0.04	0.02
WW4	N06.43087, "E002.88182"	0.05	0.000	0.05	0.002	0.05	0.02
WW5	N06.43135, "E002.88450"	0.07	0.000	0.04	0.003	0.02	0.02
WW6	N06.43292, "E002.89019"	0.05	0.001	-.0004	0.003	0.01	0.02
WW7	N06.43532, "E002.89225"	0.07	0.002	0.01	0.002	0.02	0.01
WW8	N06.43573, "E002.89412"	0.06	0.001	0.02	0.001	0.03	0.02
WW9	N06.43674, "E002.90882"	0.08	0.002	0.02	0.002	0.01	0.01
WW10	N06.43742, "E002.90818"	0.13	0.000	0.01	0.001	0.01	0.01
WW11	N06.43813, "E002.90983"	0.11	0.000	0.01	0.002	0.00	0.03
WW12	N06.44099, "E002.91689"	0.05	-0.002	0.02	0.001	0.00	0.01
WW13	N06.43805, "E002.95858"	0.09	0.000	0.01	0.001	0.00	0.01
WW14	N06.44205, "E002.95569"	0.072	-0.000	0.02	0.001	-0.00	0.01
WW15	N06.46029, "E002.96000"	0.07	-0.002	0.00	.002	-0.00	0.00
WHO STD		0.3	1.3	0.2	0.005	0.01	3

Table-3b: Concentrations of heavy metals in Badagry sampled wells (Dry Season).

Sample Number	Co-ordinates	Heavy metal ion concentration in mg/l					
		Fe	Cu	Mn	Cd	Pb	Zn
WW1	N06.41662,"E002.88341"	0.08	0.002	0.03	0.003	0.03	0.02
WW2	N06.41531, "E002.88366"	0.10	0.002	0.08	0.002	0.03	0.02
WW3	N06.41648, "E002.87625"	0.12	0.003	0.05	0.002	0.03	0.02
WW4	N06.43087, "E002.88182"	0.06	0.001	0.09	0.002	0.03	0.02
WW5	N06.43135, "E002.88450"	0.07	0.002	0.23	0.002	0.03	0.02
WW6	N06.43292, "E002.89019"	0.06	0.001	0.04	0.002	0.03	0.03
WW7	N06.43532, "E002.89225"	0.06	0.002	0.02	0.003	0.04	0.01
WW8	N06.43573, "E002.89412"	0.07	0.001	0E-8	0.002	0.03	0.01
WW9	N06.43674, "E002.90882"	0.10	0.001	0.04	0.002	0.03	0.01
WW10	N06.43742, "E002.90818"	0.11	0.001	0.05	0.005	0.04	0.01
WW11	N06.43813, "E002.90983"	0.08	0.001	0.06	0.003	0.04	0.01
WW12	N06.44099, "E002.91689"	0.08	0.001	0.06	0.003	0.04	0.01
WW13	N06.43805, "E002.95858"	0.11	0.001	0.03	0.004	0.04	0.02
WW14	N06.44205, "E002.95569"	0.10	0.001	0.03	0.005	0.04	0.01
WW15	N06.46029, "E002.96000"	0.11	0.001	0.04	0.004	0.04	0.01
WHO STD		0.3	1.3	0.2	0.005	0.01	3

For iron, concentrations ranged between 0.05 mg/L and 0.13 mg/L across all wells, which is significantly below the WHO guideline value of 0.3 mg/L. Copper levels varied from 0.000 mg/L to 0.003 mg/L, also remaining well below the permissible limit of 1.3 mg/L. Manganese concentrations ranged from 0.00 to 0.23 mg/L, with some samples slightly exceeding the WHO guideline of 0.2 mg/L. Elevated manganese can impart a bitter taste to water, stain fabrics and metal surfaces, cause food discoloration when used for cooking, and promote algal growth in reservoirs.

Cadmium concentrations were between 0.001 mg/L and 0.005 mg/L, which fall within the WHO guideline of 0.005 mg/L. Lead levels, however, ranged from 0.00 mg/L to 0.05 mg/L, with many samples surpassing the WHO limit of 0.01 mg/L. Lead is highly toxic and tends to accumulate in the skeletal systems of both humans and animals. Zinc concentrations ranged from 0.01 mg/L to 0.03 mg/L, far below the WHO permissible limit of 3.0 mg/L. At these low levels, zinc does not impart a caustic taste, making the water suitable for domestic use and consumption.

Discussion: Water quality assessment has become a pressing issue due to the health risks associated with the consumption of contaminated water. Unsafe water supplies can transmit a wide range of diseases and infections, posing serious threats to millions of people without access to safe drinking water. In many semi-urban areas of Nigeria, including Badagry, access to clean water remains limited. Residents often rely on unreliable sources such as hand-dug wells, rivers, and streams, while only a few households benefit from boreholes or treated water supplies.

In this study, all fifteen sampled wells were hand-dug and located close to septic tanks. None of the wells were cemented or properly maintained, and their surroundings were visibly unclean. Ten of the wells were situated beyond the United States Environmental Protection Agency (USEPA) recommended minimum distance of 15.24 meters from septic tanks. The wells had depths ranging from 1.75 to 5.50 meters, with casing structures varying from 2 to 6 rings. The predominant soil type at all sampling sites was sandy (Table-2). The depth of wells, distance from septic tanks, and adequacy of casing significantly influenced water quality. Poor casing, shallow depths, proximity to septic tanks, and the high permeability of sandy soils collectively increase the risk of contamination. These conditions allow pollutants such as microorganisms, pesticides, and heavy metals from domestic and industrial sources to infiltrate the groundwater through leaching, seepage, or infiltration. Consequently, the water from these wells is rendered unsafe for drinking and domestic purposes[14,24,27,37].

Heavy metals represent one of the most critical categories of environmental pollutants because of their toxicity, persistence, and tendency to bioaccumulate in living organisms. Their presence in water originates from both natural processes and human activities, including indiscriminate waste disposal, the application of agricultural inputs, industrial discharges, sewage, and sludge from diesel generators[4,5,6,38]. Once released into the environment, these metals can infiltrate the soil and percolate into the water table, thereby contaminating groundwater resources. In the present study, iron (Fe), copper (Cu), cadmium (Cd), and zinc (Zn) were detected in all sampled wells. Although their concentrations remained within WHO permissible limits for drinking water, their presence still raises public health concerns due to the potential long-term impacts of continuous exposure. For instance, iron may cause gastrointestinal irritation, promote the growth of iron bacteria that impart an unpleasant taste to water, and lead to staining of laundry, discoloration of metal tanks, and scaling within distribution pipes. The reddish-brown stains observed on water storage tanks and fences in the study area can be attributed to elevated iron levels. Iron contamination can be mitigated by aeration, which facilitates its precipitation.

Cadmium concentrations across all sampled wells were within the WHO guideline value of 0.005 mg/L. However, cadmium remains a significant threat because of its carcinogenic properties and long biological half-life, which allows it to accumulate in organs such as the liver and kidneys. Chronic exposure can cause kidney damage, while acute exposure to high concentrations may trigger immediate health effects. Zinc, though generally regarded as a non-toxic trace element essential for metabolic and physiological processes, can be harmful when present in excess. Elevated zinc levels may disrupt normal biological functions, impair growth and reproduction, and cause systemic disorders. Clinical symptoms of zinc toxicity include vomiting, diarrhea, hematuria, liver and kidney failure, and anemia[21,39,40].

The evaluation of manganese (Mn) revealed concentrations slightly exceeding the WHO recommended limit. Elevated manganese levels can impart a bitter taste to water, stain fabrics and metal surfaces, and precipitate in food during cooking. In addition, it can stimulate algal growth in reservoirs and storage tanks. Prolonged intake of excessive manganese has also been linked to health risks, including hypertension in individuals over 40 years of age and neurological symptoms that resemble Parkinson's disease, such as tremors and muscle stiffness[41]. The slightly elevated Mn concentrations in the sampled wells therefore suggest a likelihood of increased algal growth in reservoirs or household collection tanks.

The elevated concentration of lead in the sampled wells during both the rainy and dry seasons, which exceeds the WHO permissible limit for drinking water, is a serious public health concern. Lead has long been recognized as a cumulative metabolic poison[42]. Its heightened levels in the study area may be attributed to factors such as increased traffic density, industrial activities, emissions from automobile exhausts, and ongoing road construction. Lead is a potent neurotoxin and is widely regarded as the most common cause of human metal toxicosis[43]. Even at low concentrations, lead exposure has been associated with elevated blood pressure, reduced intelligence quotient in children, and attention disorders.

Another likely contributor is the prevalence of poorly regulated automobile repair workshops in Badagry. Waste products from these workshops, including used engine oil, brake fluids, discarded tyres, wire carbide, and spent batteries, are often improperly disposed of. These materials can leach through the soil, contaminating groundwater and contributing to elevated lead levels.

Figure-2a to 2i illustrate the spatial and seasonal variations in the concentrations of the six investigated heavy metals (Fe, Cu, Mn, Cd, Pb, and Zn). Each element was categorized into permissible, above permissible, and hazardous or highly toxic ranges. Except for lead, which consistently exceeded the permissible threshold, the concentrations of all other metals remained within WHO acceptable limits.

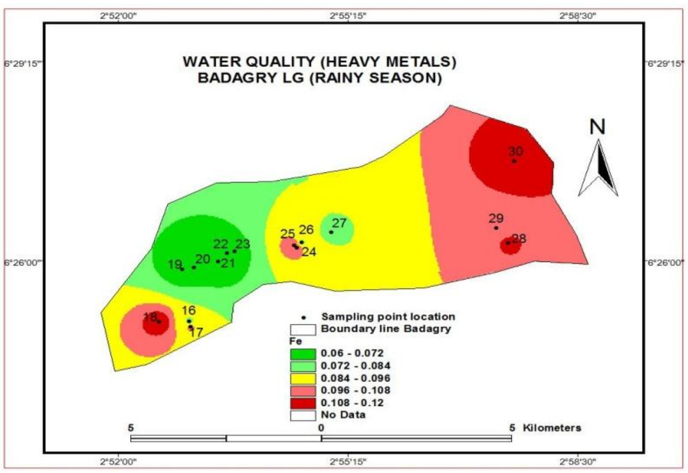

Figure-2a: Spatial distribution of Iron (Fe) in well water in Badagry LG, Lagos.

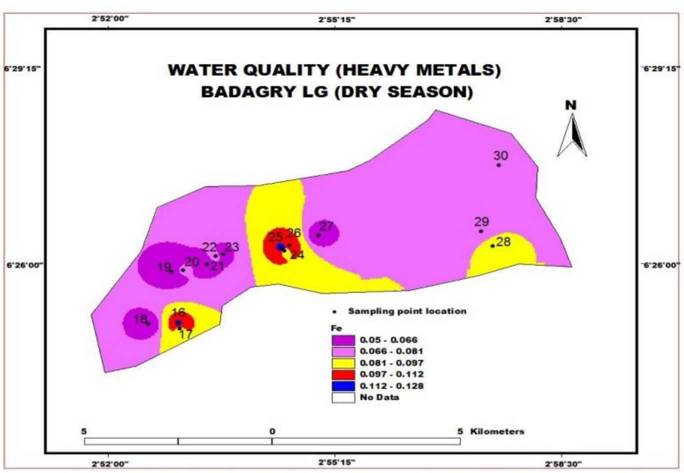

Figure-2b: Spatial distribution of Iron (Fe) in well water in Badagry LG, Lagos.

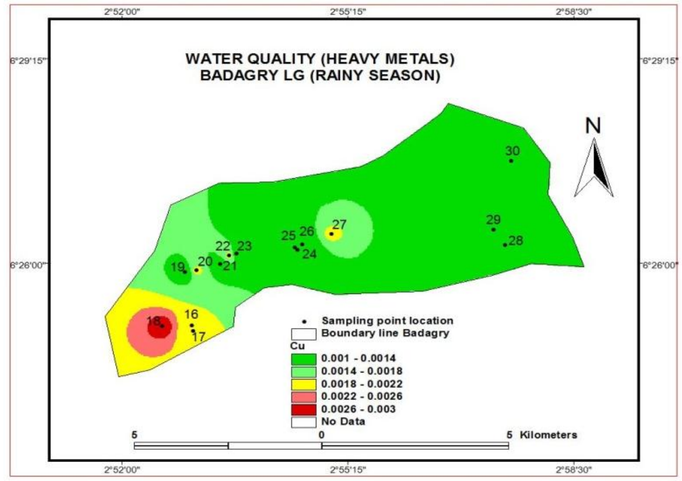

Figure-2c: Spatial distribution of Copper (Cu) in well water in Badagry LG, Lagos.

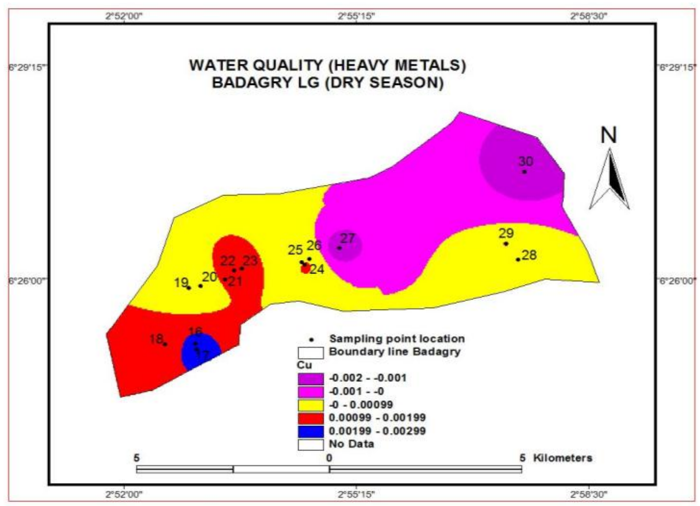

Figure-2d: Spatial distribution of Copper (Cu) in well water in Badagry LG, Lagos.

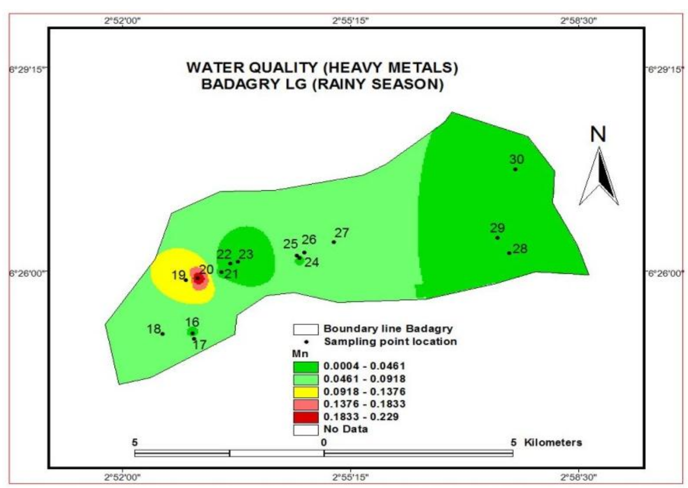

Figure-2e: Spatial distribution of Manganese (Mn) in well water in Badagry LG, Lagos.

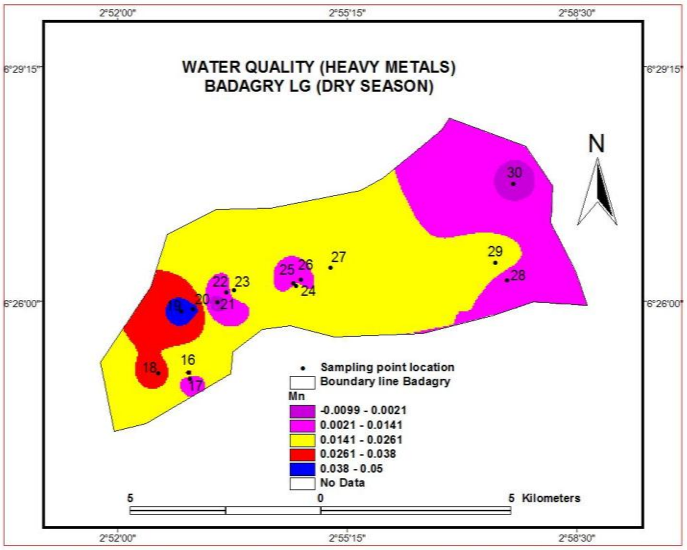

Figure-2f: Spatial distribution of Manganese (Mn) in well water in Badagry LG, Lagos.

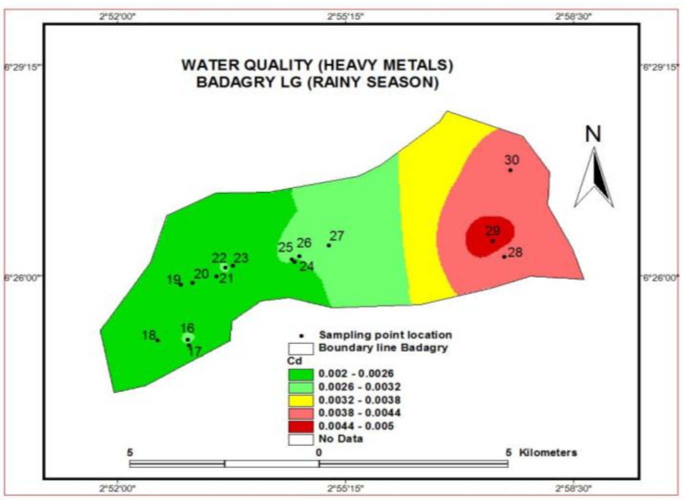

Figure-2g: Spatial distribution of Cadmium (Cd) in well water in Badagry LG, Lagos.

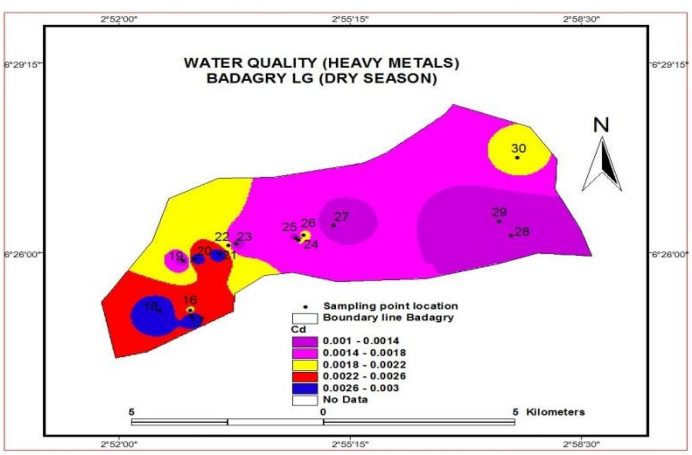

Figure-2h: Spatial distribution of Cadmium (Cd) in well water in Badagry LG, Lagos.

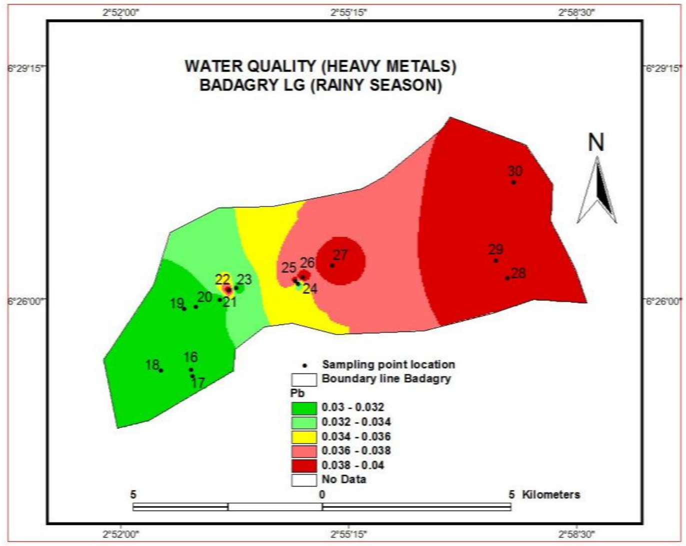

Figure-2i: Spatial distribution of Lead (Pb) in well water in Badagry LG, Lagos.

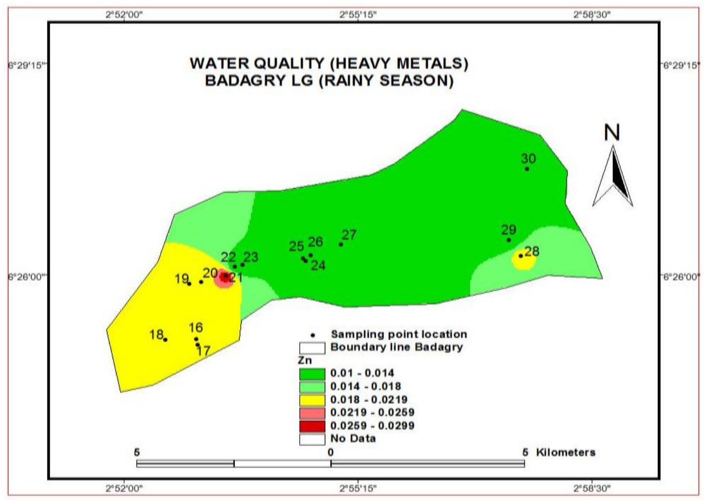

Figure-2j: Spatial distribution of Lead (Pb) in well water in Badagry LG, Lagos.

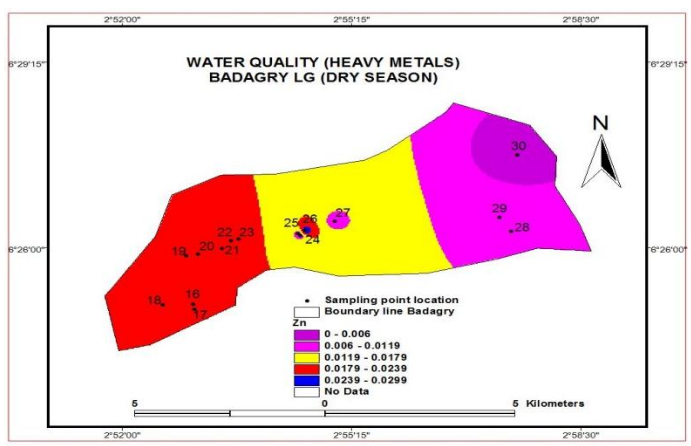

Figure-2k: Spatial distribution of Zinc (Zn) in well water in Badagry LG, Lagos

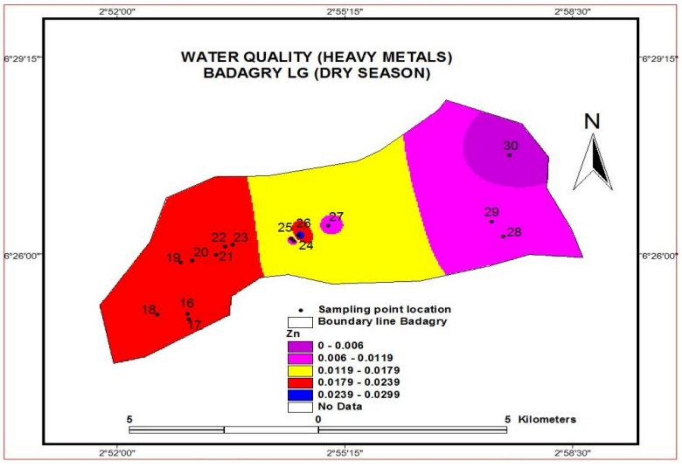

Figure-2l: Spatial distribution of Zinc (Zn) in well water in Badagry LG, Lagos.

Conclusion

For many years, well water has served as an important alternative source of domestic water supply. In this study, water samples from hand-dug wells were analyzed to determine the concentrations of heavy metals including copper, zinc, cadmium, lead, manganese, and iron. The results showed that only lead exceeded the World Health Organization (WHO) permissible limit of 0.01 mg/L, with concentrations ranging from 0.01 to 0.05 mg/L. This finding indicates that wells in the study area are contaminated with lead, rendering the water unsafe for drinking. Even at low levels, lead poses significant health risks, including poisoning and other long-term disorders. The observed spatial and seasonal variations in metal concentrations suggest that contamination likely originates from point sources affecting the hand-dug wells. To protect water quality, routine monitoring and assessment of wells are essential, particularly to prevent the infiltration of chemical pollutants. Several measures are recommended. Existing wells should be properly maintained, with open wells fitted with durable covers and developed according to local standards and best practices. Communities should prioritize sanitation by encouraging homeowners to build and use modern toilet facilities, while adopting improved sewage disposal methods. Furthermore, strict adherence to the WHO guideline that wells be sited at least 50–100 feet away from septic tanks is necessary to ensure safe and sustainable water supply for the population.

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