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Evaluating the Impacts of Sewage Disposal on Groundwater Composition in the Peri-Urban Community: A Case of Ikoto- Ijebu, Ogun State, Nigeria

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***Abstract:** Groundwater is an essential resource that requires sufficient protection from human-induced pollution sources, assessments of water quality is an essential tool for water resources management strategies. the Physicochemical parameters measured were Hydrogen ion concentration (pH), Temperatures (oC), and electrical conductivity (EC), total bacteria and faecal coliform counts (Tb/fcc) were determined using the membrane-filtration method; pH values was measure using a pH meter (Hach), the pH meter sensitivity was determined using buffers with a pH of 4.0 and pH of 9.0 and electrical conductivity values were taken, the TDS, total dissolved solids, measured using a meter; the SO42-, Fe2+ and NO3- were determined using Hach DR/2000 spectrophotometer. The water sampled temperatures range between 25.80 °C and 27.90 °C and arithmetic mean of 25.85 °C. The pH values of sampled wells and boreholes were in the acceptable pH range of 6.5 – 8.5, electrical conductivity values measured from the samples ranged from 94 µS per cm to 1418 µS per cm, having an arithmetic average of 370 µS/ cm; it is just one well that exceeded the permissible limit of 1000 µS per cm. The Total Dissolved Solids values ranged from 73 mg per Litre to 528 mg per Litre, an arithmetic average of 370 mg per Litre. The maximum value of 528 mg per Litre from zone B exceeded the acceptable limit of 500 mg per Litre. The concentrations are from 5 to 27×10 cfu / mL for total coliform counts and 0 to 12×10 cfu / mL for E. coli.77.2% of the samples fall within BOD values >3 mg per Litre, and 32.8% had BOD > 5 mg per Litre, signifying biogenic pollution and a possible seepage of mildly treated wastewater from sewage tanks near the wells. BOD and*

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the bacteriological studies, for assessing biogenic pollution in water, indicated water samples are contaminated with wastewater.

Keywords: Acidity, Coliform, Electrical Conductivity, Groundwater and Temperature.

1. INTRODUCTION

Groundwater is an essential resource that requires sufficient protection from human-induced pollution sources. Human actions and resultant climate change have affected the standard quality of both surface and underground water [1], [2], especially from newly uptake pollutants through agricultural processes, nitrate, pesticides, other heavy metals and organic products, and volatile organic carbons; are a potential danger to human health and groundwater sustainability [3], [4], [5], [6], [7].

Among other water sources, groundwater is a source of fresh water and a dependable means of water provision in Nigerian communities and was considered less contaminated by pollution to surface running waters [8]; earth's surface groundwater quality relies on other factors:- the quality of inflow water, precipitation, rural-urban dumpsites and landfill systems and significantly, the form of sewerage systems adopted in the population [9] of Nigeria's municipal wastewater treatment systems are not adopted estates and landlords have their installed domestic wastewater platforms.

Water pollution has been a global problem, and groundwater pollution results from industrial effluents cum domestic sewage into watercourses [10]; the results; on health and environmental impacts consequential to water-related disease and the assessments of water quality is an essential tool for water resources management strategies [11]; some findings evaluated and recorded the consequences of drainage systems as adopted in our villages and cities on groundwater quality; hence, we aimed to assess the impacts of sewage disposal on groundwater in Ikoto, Ogun State, Nigeria.

2. MATERIALS AND METHODS

A. Sample collection

Sample- surveyed using direct observation, water sampling and analysis of the water samples; twenty one water wells and boreholes were mark using the global positioning system locations; three replicates of water samples were fetched from each borehole and well into 1 Liter plastic bottles; First twenty one sample were used for the cat-ion determination, another set of twenty-one samples for the anion determination, and the last set for biological analysis; the Physicochemical parameters measured were Hydrogen ion concentration (pH), Temperatures (^oC), and electrical conductivity (EC), total bacteria and faecal coliform counts (Tb/fcc) were determined using the membrane-filtration method; pH values was measure using a pH meter (Hach), the pH meter sensitivity was determined using buffers with a pH of 4.0 and pH of 9.0 and electrical conductivity values were taken, the TDS, total dissolved solids, measured using a meter; the SO_4^{2-}, Fe^{2+} and NO^{3-} were determined using Hach DR/2000 spectrophotometer following Usman, Egboka, and Omali (2014)[12].

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Twenty-one (21) sampling locations (seven from each zone within the community) had hand-dug wells and boreholes less than or equal to 15 m from sewage tank units selected randomly. Samples were collected; in February 2019 aseptic techniques; and quality control measures taken during analysis.
The water samples from the two primary sources, wells and boreholes, were kept in protected bottles with ice packs to maintain cooling while transporting them to the laboratory for further analysis; for metal analysis, sample bottles added with 2 mL of HNO_3(conc.); for microbial analysis, water samples were in sterilized bottles .

B. Water quality parameters

Groundwater parameters evaluated include hydrogen ion concentration (pH), Temperature (o C), Electrical Conductivity (EC), Total dissolved solids (TDS), Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, and Cl-, NO_3^{2-}, SO_4^{2}-, PO_4^{3-}, and biochemical oxygen demand (BOD), HI98129 electrode calibrated with buffers of pH 4.0 and 9.0 used to measure pH, Temperature, electrical conductivity, and total dissolved solids (TDS) on site.
Spectrophotometric analysis of the samples was to determine Ca^{2+}, Mg^{2+}, Na^{+} and K^{+} using PinAAcle 500 Flame Atomic Absorption Spectrometer and Hach DR/2000 spectrophotometer for SO_4^{2-}, PO_4^{3-}, and NO_3^{2-}; Escherichia Coli and Total Coliform Count determined using the membrane filtration method and Azide modification of the Winkler method for biological oxygen demand.
Nigerian Standard for Drinking Water and World Health Organization drinking water quality guidelines were the two standards used to compare the water quality parameters results from the study area.

3. RESULTS AND DISCUSSION

The physical parameters with cat ions being Na^{+}, K^{+}, Ca^{2+} and Mg^{2+}, and anions Cl^{-}, NO_3^{-}, SO_4^{2-} and PO_4^{3-} in groundwater for the different zones in the community as shown in Table 1. The water sampled temperatures range between 25.80 °C and 27.90 °C and arithmetic mean of 25.85 °C. A rise in water temperature negatively influences water quality, encouraging microbial population and affecting taste, odour, colour and corrosion of metals [13]. The pH values of sampled wells and boreholes were in the acceptable pH range of 6.5 – 8.5, with a pH of less than 6.32 [14], [15]. A slightly acidic pH of one of the samples Area may be the contribution of human activities and sulphide oxidation in host rocks minerals [16]. The pH mean- value of the samples was 6.89. pH measures hydrogen ion concentration or basicity of H_2O and is for assessing the potability of water. Metal pipes and plumping systems usually corroded with alkaline water, and water having a pH < 6.5 is contamination with microorganisms of gastrointestinal tracts importance leading to diarrhoea [17].
The presence of free ions such as Ca^{2+}, Mg^{2+} and Cl^{-} in water is a potential that the water can transmit electrical conductivity (EC). Electrical conductivity values measured from the samples ranged from 94 µS per cm to 1418 µS per cm, having an arithmetic average of 370 µS/ cm; it is just one well that exceeded the permissible limit of 1000 µS per cm. The electrical conductivity has varied values indicating different levels of inorganic minerals built up from human engagements. Although high electrical conductivity values in H_2O content do

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not pose a danger to human health, except for a noticeable mineral-salt taste in water consumed and exponential production costs for industrial utilization, also, EC values more than 700 µS per cm are not for irrigation of farms due to formation of alkaline soils [18]. Groundwater samples from zone A and B have higher EC than groundwater samples from C in the same communities.

The Total Dissolved Solids values ranged from 73 mg per Litre to 528 mg per Litre, an arithmetic average of 370 mg per Litre. The maximum value of 528 mg per Litre from zone B exceeded the acceptable limit of 500 mg per Litre as prescribed by NSDWQ, 2015.

The biological oxygen demand (BOD) is also an important parameter that measures water quality, indicating the microorganism decomposition of biogenic substances in water. Waters with biological oxygen demand values of 1 and 2 mg per Litre means clean water; 3 to 5 mg per Litre the water is of questionable quality but biological oxygen demand exceeding 5 mg per Litre confirmed biogenic pollution origins [19]Bureau of Indian Standard 2012. In this study, BOD ranged from 0.09 mg per Litre - 10.6 mg per Litre, with an arithmetic average of 4.9 mg per Litre. 77.2% of the samples fall within BOD values >3 mg per Litre, and 32.8% had BOD > 5 mg per Litre, signifying biogenic pollution and a possible seepage of mildly treated wastewater from sewage tanks near the wells.

The cations are in increasing sequence with Ca^{2+} >Mg^{2+} > Na^{+} > K^{+}. The calcium concentrations in the samples range from 36.05 mg per Litre to 163.60 mg per Litre, with an arithmetic average of 32.1 mg per Litre for the study area. Magnesium ions ranged between 2.35 mg per Litre to 52.3 mg per Litre, with a mean value of 23.03 mg per Litre.

Over 58% of the samples had Ca^{2+} > 75 mg per Litre as prescribed by the WHO and NSDWQ for drinking water. Likewise, 61% of groundwater sampled had Mg^{2+} exceeding 20 mg L-1 as recommended by the World Health Organization and Nigerian Standard for Drinking Water. Water samples with both Calcium and Magnesium can be associated with the dissolution of sedimentary rocks; examples are limestone and shale. And they cause hardness in water [20]. Inadequate intake of calcium and magnesium can result in adverse health status, being essential minerals. The high proportion of calcium- ions and magnesium ions in hard water is not a health risk factor except for marginal calcium and magnesium intake [21].

The concentrations of Na^{+} ranged between 7.75 mg per Litre - 48.15 mg per Litre, having Na^{+} conc with an acceptable limit of 200 mg per Litre as recommended by the World Health Organization and Nigerian Standard for Drinking Water. The conc. of Potassium in the sample is between 1 mg Litre to 31.05 mg Litre. Na^{+} in the groundwater is from the resident rock dissociation, and K^{+} is also from resident rock release and as leachate of agricultural residues [18].

The two dominant anions were Cl^{-} and SO_4^{2-} in wells and boreholes studied. The rate of the increasing sequence is Cl^{-} >SO_4^{2-} >NO^{3-} >PO_4^{3-} as shown in Table 1; the presence of Cl^{-} was a good indicator of wastewater effluent discharge to bodies of water. The amount is always high when close to sewage or waste outlets and irrigation drains [19]. Two hundred and fifty milligrams per litre is the maximum limit allowed for drinking water. The chloride content in wells and boreholes water sampled was in the mean of 77.70 mg per Litre and ranged between 23.21 mg per Litre to 224 mg per Litre. The chlorine concentrations are within the allowable limit of 250 mg Litre for potable water. The conc. of SO_4^{2-} in samples was in a

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mean of 33.48 mg per Litre ranging between 16.48 mg Litre - 62.17 mg per Litre and in the limit of 100 mg per Litre as allowed by the authorities.

Table 1: The physicochemical analysis of water samples

Area	**Range**	**Temp (º C)**	**pH**	**TDS(mg/L)**	**BOD (mg/L)**	**EC (µS/cm)**	**K^+ (mg/L)**	**Ca^{2+} (mg/L)**	**Mg^{2+} (mg/L)**	**Na+ (mg/L)**
A	Min Mean Max	26.50 26.90 27.30	6.12 6.89 7.65	121.0 274.5 428.0	0.09 1.67 3.24	485 861 752	2.43 16.74 31.05	84.00 97.50 111.00	37.18 44.91 52.63	10.00 24.50 29.00
B	Min Mean Max	26.45 26.79 27.12	6.32 7.05 7.78	46.0 287.0 528.0	5.23 5.99 6.74	94 756 1418	4.00 14.00 24.00	36.05 94.18 152.30	2.35 23.03 43.70	7.75 27.95 48.15
C	Min Mean Max	25.80 25.852 7.90	7.33 7.60 7.86	73.0 174.0 275.0	4.76 7.68 10.60	167 370 572	3.00 9.50 16.00	43.02 103.31 163.60	15.50 30.95 46.40	14.09 25.12 36.15

Table 1: The Physicochemical analysis of water samples continues

Area	**Range**	**Cl^- (mg/ L)**	**NO_3^-(mg/ L)**	**SO_4^{2-} (mg/ L)**	**PO_4^{3-} (mg/ L)**
A	Min Mean Max	54.05 80.76 107.46	7.43 10.76 14.12	27.10 44.21 61.31	0.30 0.54 0.78
B	Min Mean Max	42.06 77.7 112.87	6.13 10.13 14.24	28.33 45.25 62.17	63.32 32.07 0.81
C	Min Mean Max	23.21 123.6 224.00	5.70 11.67 17.64	16.48 32.01 47.54	0.23 0.46 0.69

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Groundwater should not contain any microorganisms except contamination through some vectors in the soil. Any trace of gastrointestinal bacteria in the groundwater reflects the water is in contact with human excrete or animal faeces; if detected in groundwater, this strongly indicates sewage contamination [22]. The bacteriological evaluation of the samples using Escherichia coli counts. The bacteriological analysis of samples showed a significant concentration of E. coli shown in Table 2. The concentrations are from 5 to 27×10 cfu / mL for total coliform counts and 0 to 12×10 cfu / mL for E. coli. These values are beyond the World Health Organization and Nigerian Standards for drinking water. Eighty per cent of water samples contained E. coli maximum being 27×10 CFU/ mL; thirty-five per cent of the sampled water has E. coli shown in Table 2. These results confirm that groundwater in the studied area was contaminated by sewage.

Table 2: Bacteriological analysis (× 10 cfu mL^{-1}) of groundwater in study area

Area	Range	TCC	E. Coli
A	Min	8	0
	Mean	14	4
	Max	20	4
B	Min	5	3
	Mean	12	6
	Max	18	9
C	Min	11	5
	Mean	19	9
	Max	27	12

4. CONCLUSION

In a peri-urban community such as ikoto - ijebu, being the study area, groundwater is predominantly source of potable water. Evaluating groundwater in the study area is considered as socio-environmental safety study. The water quality parameters were mostly within permissible limits. Although, BOD and the bacteriological studies, for assessing biogenic pollution in water, indicated water samples are contaminated with wastewater.

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