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Assessment Of The Physiochemical and Metal Contents in Groundwater from Mechanic Workshops in Ozoro, Delta State, Nigeria

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Abstract

The impact of artisan vehicle maintenance activities on the groundwater was evaluated in this research. Groundwater was sampled in nine clusters of vehicle mechanic workshops in Ozoro town, Delta State, Nigeria. The assessment of physicochemical properties and heavy metal contents of groundwater (borehole) quality were evaluated. Nine water samples labeled A-I and a control sample were collected from boreholes at different locations in Ozoro town and subjected to laboratory examination in order to determine the pH, total suspended solid (TS), water temperature (^{0}C), total dissolved solid (TSS), biological oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), hardness, turbidity, electrical conductivity, and concentration of phosphates, nitrates, lead, sodium, calcium, fluoride and chloride. The pH and DO in the water samples are indications of the acidity or alkalinity and portability of drinking water in line with the Nigeria Standard for Drinking Water Quality standards. The NSDWQ, 2017 standards for pH value and DO are specified within the range of 6.5-8.5 and 5mg/l respectively. However, the pH and DO values obtained from the samples are A(6.6, 6.1), B(7.1, 5.5), C(7.5, 6.4), D(6.8, 4.4), E(7.0, 6.8), F(7.2, 6.2), G(7.1, 4.8), H(7.4, 5.1), I(6.7, 4.8) and control (7.7, 5.9). Evidently, the DO values in the water from all the sample points are higher than the 5mg/l set by NSDWQ. The water samples further reveals that, apart from sample points H and I which shows values less than the neutral pH scale of 7, all other samples indicated that the water is more alkaline with values greater than 7 and therefore mean that the suitable for consumption.

1. Introduction

Groundwater is a vital natural resource, needed for various applications ranging from domestic to industrial processes. Even though groundwater has self-cleansing potential, its quality is facing serious problems due to pressure from anthropogenic actions - including discharges from vehicles maintenance centers [1,2].

Environmental pollution resulting from the waste generated from mechanic workshops does not only affect the health performance of plants and animals, but altered the physiochemical properties of the groundwater and the soil geotechnical properties [3].

Some metals are toxic, non-biodegradability and have high mobility under favorable conditions and tend to cause serious harm to the surface and ground water [4]. According to Patra *et al*. 2021 [5], heavy metals that leach from contaminated sources can be persistent in the environment; thus, posing severe risks to human beings through the consumption of the contaminated food and water. The two major sources of freshwater are the surface water and groundwater. The groundwater provides a valued fresh water resource to human population and constitutes about two-third of the fresh water reserves presently occupying various spaces across the world [6]. The deterioration of water quality has led to the destruction of ecosystem balance, contamination of soil and surface water sources [7]. The physical, chemical, and biological parameters were often used to determine the safety of water required for consumption [8, 9, 10, 11].

However, many studies have shown that groundwater can appear clean but contains a wide variety of contaminants [12, 13]. An estimated 80% of all diseases and over one-third of deaths in developing countries are caused by the consumption of contaminated water and on average as much as one-tenth of each person's productive time is sacrificed to water-related diseases [14]. Groundwater contamination occurs when pollutants are released into the environment and make their way down into the ground [6]. Contaminants such as mine dumps, leach residue, landfills, leaking septic tanks, oil spillage, acid rain and other wastes generated from mechanic workshops are capable of polluting the groundwater. In this study, water from mechanical workshops in residential areas and those close to the public institutions like the Delta State University of Science and Technology are of interest because of the high level of groundwater demand from these areas. Due to the effects of contaminants on groundwater, the location of a borehole yet to be drilled should be well assessed in other to avoid water pollution that can pose as a threat to human lives.

2. Materials and Methods

2.1 Study Area

The research was carried out in Ozoro, the headquarters of Isoko North Local Government of Delta State, Nigeria. Ozoro is located in the Delta South Senatorial District of the State with a geographical coordinate of latitude 5'30 and 6'54" north and longitude 6'54" and 7'54" East. Ozoro is one of the fastest developing towns in Delta State and have a lot of public institutions, industrial and commercial activities with a population of about 168,024 people Delta state ministry of economic planning, [15]. The geographical map of Nigeria showing Delta State and Ozoro is presented in Figure 1.

Located within the Ozoro community are: the Delta State University of Science and Technology, Delta State Skill Acquisition Center, Delta State Water Board, several large- and small-scale businesses, oil producing company, etc. The study area has several auto-mobile maintenance workshops. Their maintenance activities include: welding and panel beating, engine repair, spraying/painting and electrical parts repairs. Most of the wastes (scrap metals, petroleum products, carbide, paints and waste acids) generated by these artisans are discarded untreated into the environment thereby altering the state of soil and groundwater.

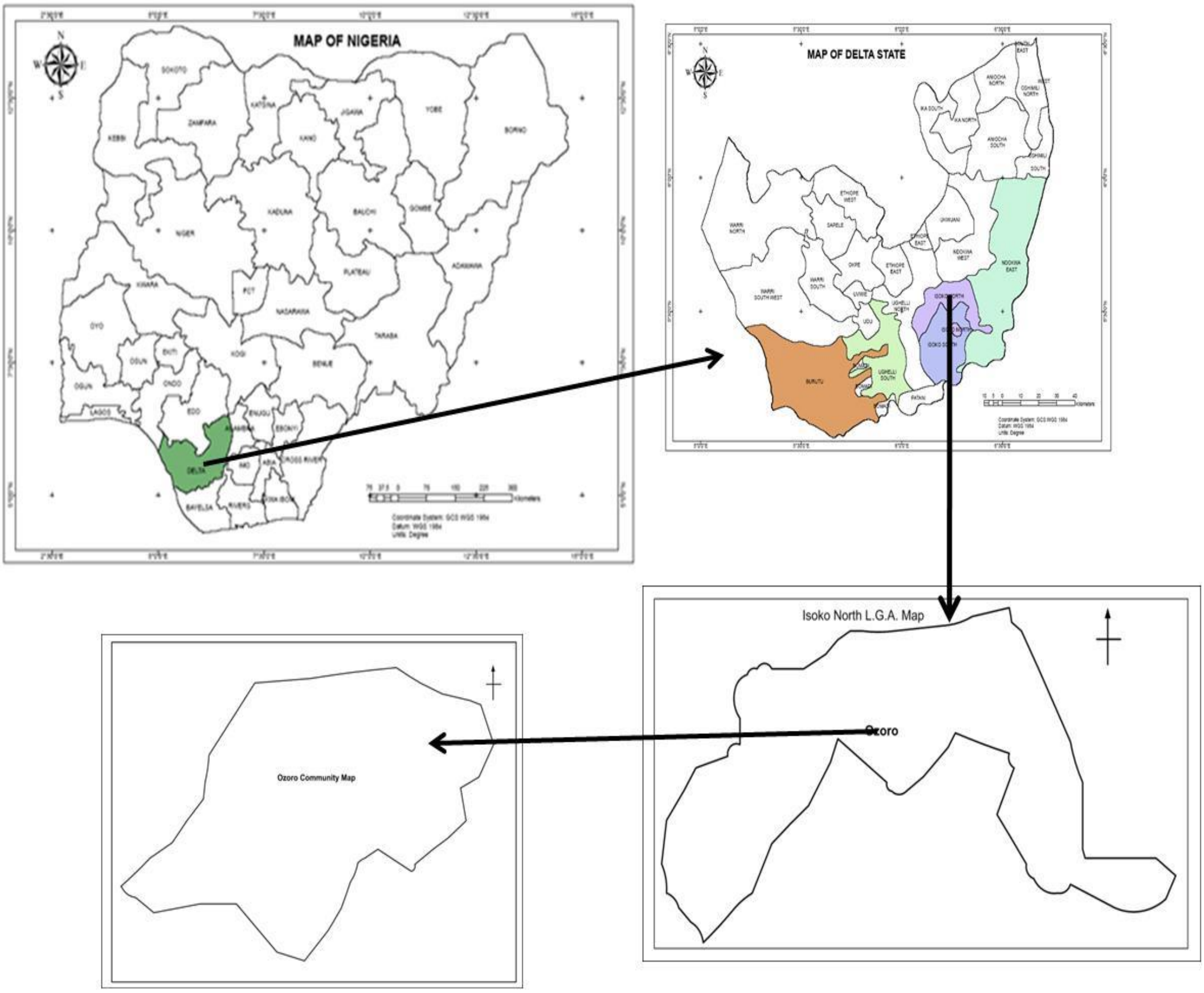

Figure 1; map of Nigeria showing Ozoro Community.

2.2 Sample collection

Nine automobile mechanic workshops within the Ozoro community were randomly selected and sampled for this study. Another point (reference or control point) 3km away from the study area with no history of auto-mobile maintenance workshop activities and oil spill and represents the control point for all samples in the cluster. At each auto mechanic workshop within the study area, boreholes that have been constructed and are in use for over 8-10years with depths between 20m and 32m were sampled. Water was sampled from two boreholes, using pre-sterilized plastic bottles, placed into an ice-box and taken immediately to the laboratory of the Delta State university of Science and Technology for water quality or physiochemical analysis. The parameter assessed were EC, DO, TA, TH, TSS, TDS, BOD, COD, turbidity, pH, temperature, chlorides, nitrates and sulphate**.**

3. Results and Discussion

3.1 Assessment of the Physical Properties of Groundwater

The physical and chemical parameters of water samples were analysed and results obtained were compared with NSDWQ [16] standards. The physical parameters and results obtained from the analysis are presented in Table 1.

3.1.1 Electrical Conductivity (EC): the electrical conductivity is the ability of water to conduct electric current. It is also dependent on the number and types of dissolved solids (DS) in the water. The reduced pH in the mechanic sites is a function of greater availability of H^+ ions thus resulting to more cations Ca^{2+}, Fe^{2+}, Mg^{2+}, Mn^{2+}, Na^{2+}, that are soluble in the water. This will lead to a high level of total dissolve solids (TDS) in the borehole.
The electrical conductivity values of the borehole samples analyzed are in the form of: WSA 17.13, WSB 22.26, WSC 0.6, WSD 15.40, WSD 17,81 WSE 26.23, WSF 16.23, WSG 16.20 WSH 16.11 and WSI 19.80µs/cm respectively and were greater than the control. It follows the trend WSB>WSH as compare to the control. The statement implies that the electrical conductivity of water sample at point B was higher than that at of point H.
The control values are presented in the last rows of Table 1, 2 and the last column of Table 3.
WS stands for water sample while A-I stands for the various points or locations.

3.1.2 Total Dissolved Solids (TDS): from the result in Table 1, the TDS of the water samples for all the sample location fall below the permissible limit, though TDS values for control samples of 153mg/l fall lower. This decrease in TDS value could be as due to the increase in various human activities carried out in the mechanic sites like metal plating create acidic wastes. However, it was observed that all TDS values of water samples from boreholes and control were generally low and falls below the acceptable permissible limit set by NSDWQ, for drinking water standard of (500mg/L).
Human activities increases the level of TDS but the result of this experiment shows that the TDS was presents in the samples, the level was above the control value but below maximum amount. The human activities did not lower the TDS.

3.1.3 Total Suspended Solid (TSS): The results showed that the least value for total suspended solids (TSS) 49.21mg/l however reveals that the TSS values are very low compared to the approved standard limit of 500mg/l set by [16]. Groundwater from the entire area contains low level of TSS which makes water safe for drinking.

3.1.4 Turbidity (TB): The result shows that turbidity for all he water samples locations were below range of 5.0 [17] and [16]. The values turbidity recorded in groundwater could be attributed to the inorganic particulate matter present in water. Microorganisms can be protected from disinfection and the bacterial growth can go from bad to worse in which case where water is disinfected, disinfection can be effective if turbidity is low.

Table 1: Physical Properties of Water Samples Collected from Mechanic Workshops

Sample Points	TB (NTU)	Tem (^{0}C)	TDS (mg/l)	TSS (mg/l)	EC (µs/cm)
A	1.8	30.0	73.23	56.44	17.13
B	2.5	30.1	60.43	68.97	22.26
C	0.6	29.3	73.33	74.34	15.40
D	1.4	30.4	88.13	59.30	17.81
E	3.3	30.9	89.15	81.25	26.23
F	2.0	31.5	89.44	49.21	16.45
G	1.6	29.6	92.39	50.88	16.20
H	2.6	28.0	90.85	90.28	16.11
I	2.5	30.2	66.07	84.60	19.80
Control	1.0	28	153	230	352
Limits	5.0	26-27	500	500	1000

3.2 Oxygen Demand Analysis. (BOD, COD and DO):

From Table 2, the biological oxygen demand (BOD) is the measure of the quantity of oxygen consumed by microorganisms in the course of aerobic processes of decomposition of organic materials caused. Chemical oxygen demand (COD) is the total amount of oxygen required to chemically oxidize both the biodegradable and non-biodegradable organic matter. BOD determines how organic matter affects the concentration of dissolved oxygen (DO) in water. The amount of BOD and COD in water indicates a high content of easily degradable and non-degradable organic matter in the water and causes a reduction in DO due to high demand of oxygen by the bacteria for decomposing the organic material. The BOD and COD values obtained from all the water samples are below the NDSWQ standard. The DO values were relatively higher than the standard set by NDSWQ[16]. This shows that, there is no significant organic material present in the water to be decomposed by bacteria resulting to presence of enough oxygen in all the samples making the water safe for consumption.

3.3 pH Values, Total Alkalinity and Total Hardness Analysis:

Potential hydrogen (pH) refers to how much H^+ that is present in water and it indicates the alkalinity or acidity of water on a logarithmic scale of 14 with 7 been the neutral point. The pH values below and above 7 are acidic and alkaline respectively. The acceptable pH value for drinking water is between the ranges of 6.5-8.5 as specified by NDSWQ[16]. Relating the pH values of the sample results to the NSDWQ standard, it reveals that only points H and I requires treatment before consumption, water from other locations of the study area is safe for drinking. Alkalinity is a measure of the capacity of water to neutralize acids, alkaline compounds like bicarbonates, carbonates, and hydroxides, remove hydrogen ions and lower the acidity of the water while increasing the pH WHO [18]. The total alkalinity of the water samples for the entire sampling points is within the standard of NSDWQ and therefore implies that the drinking water for the study area is safe considerably in terms of alkalinity. The total hardness for all groundwater sample locations falls below the permissible limit of 150mg/l set by NDSWQ[16]. The water is fit for consumption as agreed by Bala [19].

3.4 Analysis of Phosphates, Nitrates and Sulphate Contents:

Phosphate and nitrate in minute quantity is usually not harmful to humans but excess of it in water speeds up eutrophication which in turn reduces the water DO and becomes dangerous to health. Also, extremely high levels of phosphates could lead to digestive problems in humans. As noticed in Table 2, the amount of phosphate, nitrate and sulphate in the water samples range between 0.23-0.58, 4.22-6.83 and 50.8-81.5 mg/L respectively and are below the permissible limit specified by [16] for drinking water. Although, nitrate is an inorganic compound that is found in groundwater through septic systems and fertilizers run-off. Nitrate naturally does not pose any danger with the analyzed water samples from Ozoro town. The idea is that, since the mechanic workshops sampled perform almost the same function or activities, the waste generated and habits could be similar. However, the last rows of Tables 1 and 2 show the various acceptable limits as they relate to the individual results of samples. Above these limits, the individual sample is rejected. But from the results, the individual samples are within the acceptable limits.

Table 2: Chemical Properties of Groundwater from the Mechanic Workshops

Sample Points	pH	TA (mg/l)	TH (mg/l)	BOD (mg/l)	DO (mg/l)	COD (mg/l)	CL (mg/l)	FL (mg/l)	NO_3 (mg/l)	SO_4 (mg/l)
A	7.6	9.0	18	4.2	6.1	8.7	77.2	0.41	6.20	50.8
B	7.1	8.5	16	3.8	5.5	9.2	63.0	0.64	4.64	61.3
C	7.5	9.0	13	4.8	6.4	8.9	84.7	0.83	4.59	51.8

D	7.4	7.9	24	3.2	5.4	7.2	69.8	0.65	4.22	73.4
E	7.3	8.8	26	4.4	6.8	6.4	91.2	0.71	6.40	81.5
F	7.2	9.3	17	4.8	6.2	8.4	71.6	0.66	6.12	64.6
G	7.1	7.3	16	3.6	5.8	7.5	82.1	0.74	6.83	55.5
H	7.4	9.1	19	3.4	5.1	8.4	76.6	0.66	4.26	68.4
I	6.8	8.6	15	3.3	5.8	5.5	74.3	0.59	6.54	75.4
Control	7.7	8.0	15	3.2	6.9	6.0	88.1	0.55	6.5	40.5
Limits	6.5-8.5	10	150	6	5	10	100	1	10	100

3.5 Analysis of Sodium, Calcium and Lead contents

Sodium is important for proper functioning of the body by regulating blood pressure and flow but it can create concerns when it appears at high concentration in drinking water. NSDWQ standard for sodium in drinking water on the basis of taste is 20mg/l. Although, the intake of sodium varies in individuals associated with heart and kidney problems. However, sodium contents in all the water samples within the study area are below the standard of 20mg/l.

Calcium is considered to be an essential nutrient for healthy growth and protection of bones. It prevents blood coagulation, reduces stress, weariness and improves immunity. Insufficient calcium in the body causes migraine, brittle nails and weak bones while excessive supply can result to kidney stones. The permissible value of Calcium according to NDSWQ [16] is 75mg/l. The result in Table 3 implies that Ozoro groundwater is soft and it is within the NSDWQ standard. Furthermore, the permissible limit set by NDSWQ [16] for lead in drinking water is 0.01mg/l. Lead content in all the samples analysed fell below the standard. Thus, the water from Ozoro town is safe for drinking.

3.6 Analysis of Chloride and Fluoride

Chloride occurs naturally as elements and it is common in natural water. Chloride in drinking water is not harmful, however, higher amount above 100mg/l set out by NSDWQ can cause unpleasant taste and corrosion which results to leaching of metals from the pipes used for water system distribution. The chloride levels in all water samples obtained are within the permissible limit NSDWQ standard. Also, fluorides presence in drinking water helps in the prevention of human tooth decay. However, excess of above the NSDWQ standard of 1.0mg/l become an issue. Table 3 shows the chloride, fluoride and the control values of the various samples.

Table 3: Groundwater Metal Contents and Control Values

	POINT A	POINT B	POINT C	POINT D	POINT E	POINT F	POINT G	POINT H	POINT I	Control
Na	8.4	5.9	7.1	6.4	7.4	8.1	9.0	8.1	7.1	5.6
Ca	15.3	11.4	19.9	20.2	19.8	19.2	12.9	11.1	20.3	40.2
Cl	18.5	33.8	22.5	27.8	23.4	21.7	31.5	22.5	23.8	11.4
Fl	0.32	0.28	0.37	0.43	0.41	0.31	0.21	0.31	0.35	0.5
Pb	0.008	0.007	0.009	0.006	0.09	0.006	0.006	0.008	0.007	0.003

4. Conclusion

This study assessed the physicochemical properties and metal contents of groundwater from boreholes in different locations in Ozoro town. A total of ten water samples were collected from different locations in the study area for laboratory analysis. Evidence of the results obtained shows that the concentrations of the properties of water were found to be within the recommended limits of [16] standard. The study reveals that the borehole water mostly consumed for drinking in Ozoro town is safe. However, further study could be carried out to assess the biological properties of the borehole water.

References

[1]. Longe, E.O. and Balogun, M.R. (2010) Groundwater Quality Assessment near a Manucipal Landfill, Lagos, Nigeria . Research Journal of Applied Science, Engineering and Technology,2,39-44

[2]. Uguru, H., Akpokodje, O.I., Rokayya, S., Amani, H.A., Almasoudi, A. and Almasoudi, A.G. (2022a). Comprehensive assessment of the effect of various anthropogenic activities on the groundwater quality. *Science of Advanced Materials*. 4:462–474

[3]. Muze, N.E., Opara, A.I., Ibe, F.C. and Njoku, O.C. (2020). Assessment of the geo-environmental effects of activities of auto-mechanic workships at Alaoji Aba and Elekahia Port Harcourt, Niger Delta, Nigeria. *Environmental Analysis Health and Toxicology*. 35(2):1-12

[4]. Lashen , Z.M., Shams, M.S., El-Sheshtway, H.S., Slany, M., Antoniadis, V., Yang, X., Sharma, G., Rinklebe, J., Shaheen, S.M. and Elmahdy, S.M, (2022) Remediation of Cd and Cu contaminated water and soil using novel nanomaterials derived from sugar beet processing and clay brick factory-solid wastes. J. Hazard. Master, 428, 128205and eco-restoration in contaminated mining sites. Environ. Technol. Innov. 21, 101293

[5]. Patra, D.K., Acharya., S., Pradhan, C., and Patra, H,K. (2021) Poaceae plants as potential photoremediators of heavy metals

[6]. Adeyemi, O; Opeyemi , A; Olufemi , D (2017). Groundwater: Quality Levels and Human Exposure, SW Nigeria. *Journal of Environmental Geography.* 10 (1–2); 23–29

[7]. Faiza ,T; Yenny, R, Sasmito ,D; Bagyo, Y; Amin ,SL (2018).The Analysis of the Physical and Chemical Properties of the Water Quality in the Rainy Season in the Sumber Maron River - Kepanjen, Malang –*Indonesia, Resources and Environment*. 8(1): 1-5

[8]. Sivaranjani S; Amitava, R; Samrath, S (2015). Water Quality Assessment with Water Quality Indices. *Inter. J. of Biores. Sci*. 2(2): 85-89.

[9]. Muhammad, M; Samira S; Faryal, A; Farrukh, J (2013). Assessment of Drinking Water Quality and its Impact on Residents Health in Bahawalpur City**.**

[10]. Gorde, S. P., Jadhav, M. V. (2013). Assessment of Water Quality Parameters: A Review *Int. Journal of Engineering Research and Applications*, 3(6):2029-2035

[11]. Loukas, A., (2010). Surface water quantity and quality assessment in Pinios River,Thessaly, Greece. *Desalination*, 250(1): 266–273.

[12]. Vijaya L; Sai TK (2017). A study on assessment of groundwater quality and it suitability for drinking in Vuyyuru, Krishna (dist.), Andhra Pradesh. *Inter. J. of Engrg. Development and Research*. 5(2): 1662-1668.

[13]. Rossiter, HMA; Owusu, PA; Awuah, E; Macdonald, A; Schäfer, AI (2010). Chemical Drinking Water Quality in Ghana: Water Costs and Scope for Advanced Treatment. *The Sci. of the Total Environ*. 408: 2378–2386

[14]. WHO, World Health Organization, (2011). Practising Groundwater for Health

[15]. Delta State Ministry of Economic Planning, (2021). Pg 4

[16]. NSDWQ (2017): Nigerian Standard for Drinking Water Quality, 2017.

[17]. WHO,World Health Organization, (2004). Practising Groundwater for Health

[18]. WHO, World Health Organization (2006). Practising Groundwater for Health

[19]. Bala M., Shuhu R.A. and Lawal M. (2008) Determination of Level of Some Heavy Metals in Water Collected from two Pollution-prone Irrigation Area around Kano Metropolis. Bayero *Journal of Pure and Applied Science*, 1, 36-38. https://doi.org/10.4314/bajopas.vlil.57511