doi.org/10.54473/IJTRET.2024.8501
International Journal of Trendy Research in Engineering and Technology
Volume 8 Issue 5 October 2024
ISSN No. 2582-0958

EFFECTS OF OPEN DUMPSITE LEACHATE ON GROUNDWATER QUALITY: A CASE STUDY OF OKE-DIYA DUMPSITE, SAGAMU, NIGERIA.

Bidemi Ehimentan[1], Peter Mafimisebi[1], Grace Martins[2]
[1]Department of Environmental Engineering and Hydrogeology, Geoearth Project LTD, Nigeria
[2]Department of Engineering Geology, RFI Integ Service. Nigeria

Corresponding Author email: ehinmetanbidemi1@gmail.com

Received 12 June 2024 Received in Revised form 16 June 2024 Accepted 26 June 2024

ABSTRACT

Six (6) samples were obtained from boreholes and monitoring wells in the vicinity of the Oke-Diya landfill sites in Sagamu, Ogun State. The pH, EC, TDS, Total Hardness, Chloride content, Total Alkalinity, and Nitrate content were examined in both the water samples gathered. The findings were examined and contrasted with the World Health Organization (WHO-2011) and the Nigerian Standard for drinking water quality (NSDWQ-2007). Certain levels of physio-chemical parameters at Oke-Diya dumpsite were discovered to be elevated, especially in EC and TDS, whereas Chloride levels indicated that OD-3 and OD-4 exceeded the established standards (WHO&NSDWQ). The elevated chloride levels found in groundwater samples OD-3 and OD-4 indicate that the contamination is likely originating from sewage sources. The study areas revealed that the pH levels in the ground water samples are slightly acidic in nature. This could be due to dense population and commercial activities in those regions. Total Alkalinity, Dissolved Nitrate, and Total Hardness levels in the water samples comply with NSDWQ and WHO standards except for Total Hardness in OD-4 which is above the permissible limit. The study suggests that poorly designed landfills and hazard waste disposal into water bodies may result in significant groundwater contamination, posing risks to human health and the environment. Hence, it is necessary for both community members and the government to work together to prevent careless waste disposal and to implement effective waste management and monitoring in locations where landfills exist.
Keyword: Physio-chemical parameters, Water quality Standards; Groundwater quality, Oke-Diya.

I. INTRODUCTION

The management of waste produced by people in a city is typically a concern in urban areas. Recognizing the link between human actions and pollution and understanding the importance of safeguarding human health, recreational areas, and fisheries resulted in the inception of early water quality regulations and monitoring techniques [1,2,3]. The presence of trace metals in water sources has raised significant worries regarding their impact on both plant and animal populations [4,5]. While being transported, trace metals experience various alterations in their speciation because of dissolution, precipitation, and complexation processes [6,7,8,9]. Biological magnification, also known as the process of toxins becoming more concentrated in higher trophic levels of a food web, is a major reason for the harmful effects of these substances [10,11,12]. Environmental pollution caused by the disposal of municipal solid waste is a significant worry for environmental scientists and the general population. This occurs due to improper methods of disposing of solid waste and inadequate upkeep of the areas, such as not using impermeable lining systems to stop leachate from seeping into the soil. The condition poses a significant risk of pollution to the groundwater, surface water downstream, and soil, resulting in a negative effect on the environment, public health, and property [13]. In developing nations, the issue of municipal solid waste stems from ineffective management strategies and inappropriate location selection. Most municipal dumpsites are unplanned, open dumpsites that lack proper engineering safeguards to protect the environment. Uncovered landfills are the most basic and initially the least expensive way to dispose of waste, and they are the main approach to managing waste in numerous developing nations. In addition to causing environmental harm, this approach can also result in health problems like cancer [14]. Living near open dumpsites can result in consuming polluted water and experiencing significant adverse health effects [15]. Chemical pollutants in groundwater near open dumps are determined by the materials in the waste and the natural breakdown of waste products. Inorganic metals, volatile organic compounds, polycyclic aromatic hydrocarbons (PAHs), chlorinated solvents, and other substances can also be considered as pollutants [16]. Therefore, inhabitants can meet these harmful substances by absorbing them through the skin, drinking contaminated water, breathing in toxic fumes, and consuming contaminated food. Furthermore, the impact of industrial and domestic waste pollutants on human health has been documented [17].

The standard methods for disposing of solid waste in the study area include open dumps, non-engineered sanitary landfills, and incineration. When it rains, pollutants are washed out of the waste disposal sites by the rain. Therefore, toxins and contaminants are introduced into the soil, surface water, and groundwater, as well as the plants that grow near the dumpsite [18,19]. This means that the groundwater's hydrochemical facies evolve based on its flow path history, meaning that the quality of underground water is influenced by the pollution levels in its surroundings [20]. This study aims to assess the physio-chemical properties of water samples collected from specific wells and boreholes to gauge the influence of dumpsites on water quality in the region, comparing it to the Nigerian Standard for Drinking Water Quality (NSDWQ) and World Health Organisation (WHO) guidelines.

II. THE STUDY AREA

Oke-Diya dumpsite is at Sagamu in Ogun State (Fig. 1). It is located between longitude 03°38′00″ and Latitude 06°41′00″ in the humid tropical region of Nigeria. It is a study of area of significant interest due to its unique environmental and geological characteristics. The area has been impacted by human activities, including waste deposal and industrial operations, which have led to environmental degradation and affected water quality.

Geologically, Oke-Diya is situated in the Precambrian basement complex of southwestern Nigeria, characterized by gneisses, schists, and quartzites. The study area is drained by the Ogun River, which have received industrial and domestic effluents from nearby towns and industries. The river has been reported to have high levels of heavy metal contamination, posing a risk to aquatic and human health.

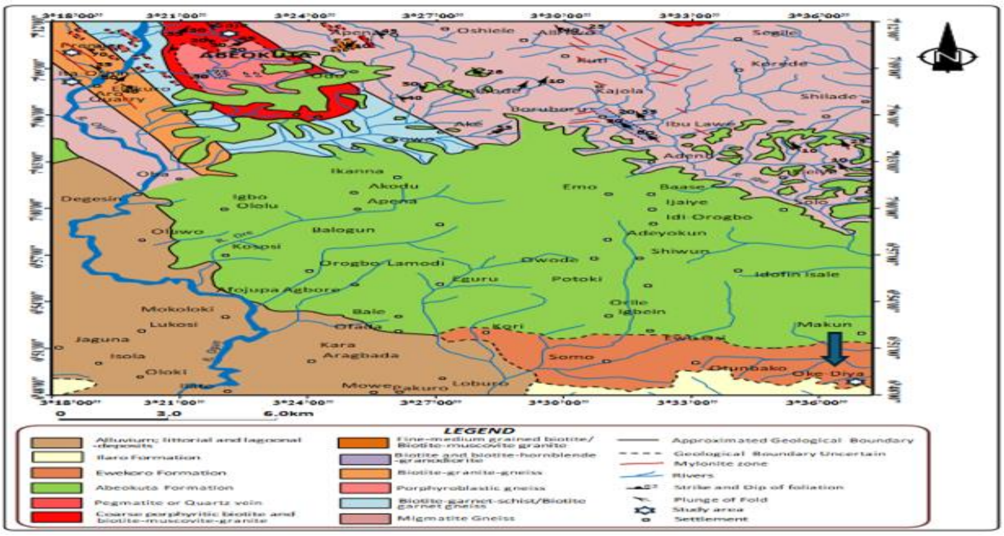

Fig 1. Geological Map of the study areas [21]

III. MATERIAL AND METHODS

Six water samples were gathered from boreholes, and wells in various locations both inside and surrounding the dumping areas. The groundwater samples were gathered in sterilised 75cl plastic sampling containers to reduce impurities before using them. The specimens were correctly identified, kept in cold temperatures, and tested within 5 hours of being collected to ensure they meet laboratory timeframes to preserve sample quality. During on-site sampling, various important physical characteristics of water were measured using specific digital meters like the WTW-conductivity meter model L/92 and WTW-pH meter model pH/91. These parameters include total dissolved solids (TDS), electrical conductivity, appearance, and pH. Approximately 125 mL of water samples were gathered for multielement analysis; then pressured through 0.2 mm Nuclepore membranes and 3 mL of high quality HNO_3^- was mixed in to adjust the water acid solution to a pH of around 2.

The total hardness, total alkalinity, and anions (Cl^- and NO_3^-) analyses were done in Geoearth Project Ltd laboratory. The results were also contrasted with the suggested guidelines, and a pollution index was computed to assess the effects of the dumpsites on water quality. The Nigerian Standard for Drinking Water Quality [22] and the World Health Organisation [23] guideline values were employed as the standard for evaluating the quality of drinking water.

Fig 2. One of the selected Dumping Site.

IJTRET "Voice of Innovative Minds"
International Journal of Trendy Research in Engineering and Technology
Volume 8 Issue 5 October 2024
ISSN No. 2582-0958

IV. RESULTS AND DISCUSSION

This study examined the impacts of solid waste disposal on the water quality of Oke-Diya Community. This study showcases the findings of physical and chemical analyses conducted on well water samples in the research location.

Table 1 and Figure 3-8 presented below provide an overview of the descriptive analysis and summarized findings of the measured groundwater parameters in this study.

Table 1 Results of Physical, and Chemical Analysis of Sample

Parameters	OD-1	OD-2	OD-3	OD-4	OD-5	OD-6	Mean	WHO (2011)	NSDWQ (2007)
pH	6.72	6.60	6.81	7.52	7.05	6.90	6.93	6.10 - 8.5	6.5 - 8.5
EC (µs/cm)	956	1751	1321	1443	1510	1210	1365.17	1000	1000
TDS (mg/l)	510	132	630	740	690	775	579.50	500	500
Total Alkalinity (mg/l)	80	93	91	72	89	101	87.67	200	200
Total Hardness (mg/l)	140	131	120	153	139	148	138.50	200	150
Chloride (mg/l)	150	210	260	251	170	230	211.83	250	250
Nitrate (mg/l)	2.97	3.12	2.4	3.23	2.95	4.1	3.13	50	50

4.1 pH

Table 1 displays the recorded pH of the groundwater. The data presented in (Table 1) indicates that the pH levels in well water varied between 6.60 and 7.52, with an average pH of 6.93. The pH values at the dumpsites suggest a slightly acidic concentration when compared to the guidelines set by the WHO and NSDWQ. It can be described as mildly acidic and falls within the water quality standards set by the WHO and within the allowed limit of NSDWQ.

4.2 Electrical Conductivity of Water

conductivity is a measure of how well water can conduct electricity. It is the antithesis of resistance. When salts and other inorganic chemicals dissolve in water, they separate into small, electrically charged particles known as ions. Ions enhance the conductivity of water for electricity. Some typical ions found in water that facilitate the flow of electricity are sodium, chloride, calcium, and magnesium. The data on the electrical conductivity of the well sample is shown in (Fig. 3) in relation to the NSDWQ and WHO standards. The findings shown in Figure 3 suggest that OD-1 meets both the NSDWQ and WHO Standard requirements. The rest of the sampling locations showed electrical conductivity levels higher than what is allowed. This is probably due to OD-1 being situated at a dry landfill, indicating lower levels of inorganic dissolved solids such as nitrate, sulphate, and phosphate anions, as well as cations like sodium, magnesium, and iron.

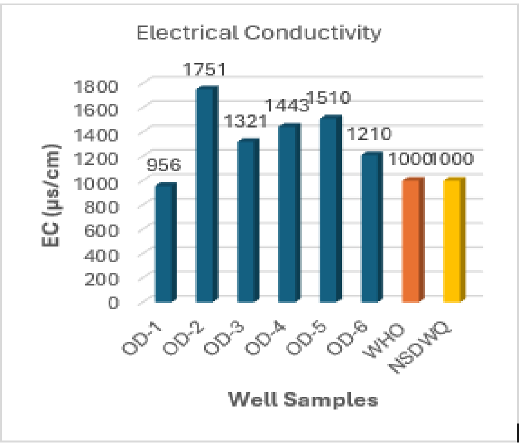

Fig 3. Electrical Conductivity for the Six Samples.

4.3 Total Dissolved Solid

TDS is a result of the presence of inorganic salts and small quantities of organic material dissolved in water. Common elements found in water are typically calcium, magnesium, sodium, and potassium positively charged ions along with carbonate, hydrogen-carbonate, chloride, sulfate, and nitrate negatively charged ions. The water samples have total dissolved solids ranging from 132mg/l to 775mg/l. OD-2 is the only one that complies with the NSDWQ and WHO requirement of 500mg/l (Fig 4). Dissolved solids in water can impact its taste.

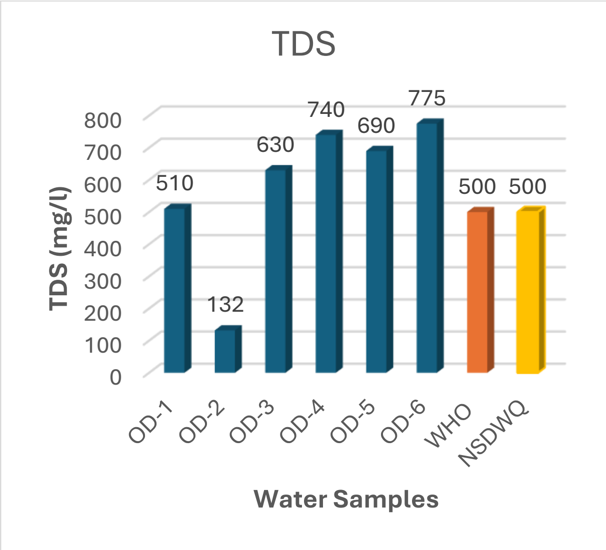

Fig 4. Total Dissolved Solids for the Six Samples.

4.4 Total Alkalinity

The presence of alkalinity in the water maintains the pH level of the water stable. The Figure 5 below displays the total Alkalinity result. The well samples have a concentration range of 72 to 101mg/l. All the water samples comply with the 200mg/l standard set by NSDWQ and WHO.

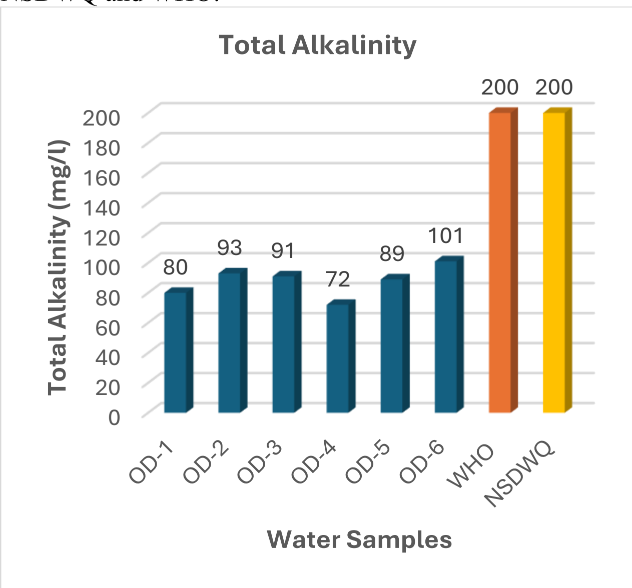

Fig 5. Total Alkalinity for the Six Samples.

4.5 Total Hardness

The total hardness of a water sample is determined by adding the concentrations of calcium and magnesium in the sample. The water sample's values range from 120mg/l to 153mg/l. OD-4 is the only water sample that exceeds NSDWQ at 150mg/l, whereas all other samples meet the WHO standard of 200mg/l (Fig 6).

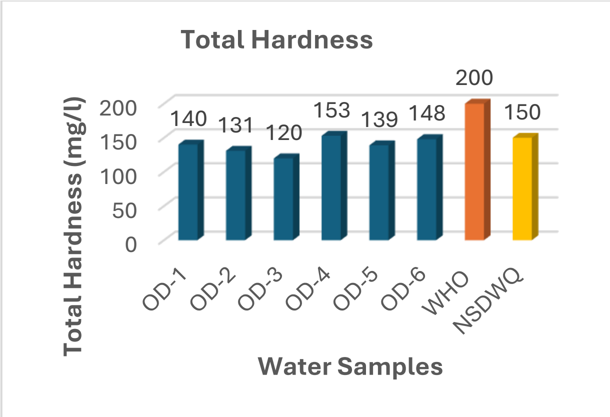

Fig 6. Total Hardness for the Six Samples.

4.6 Chloride

Well water contains chloride levels ranging from 150mg/l to 260mg/l, so only OD-1, OD-2, OD-5, and OD-6 meet the WHO and NSDWQ standards of 250mg/l for drinking water (Fig 7).

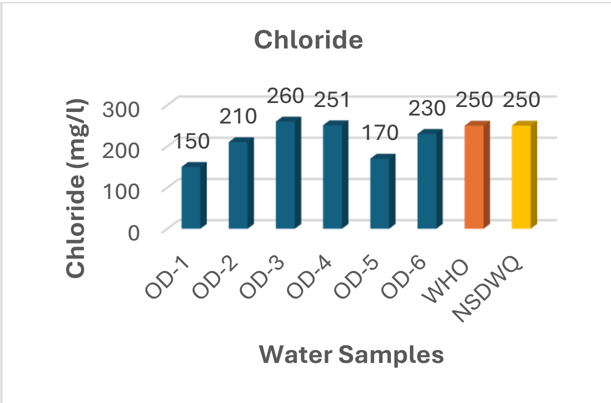

Fig 7. Chloride content for the Six Samples.

4.7 Dissolved Nitrates

All the sampling points from the well displayed in Figure 8 indicated lower levels of dissolved nitrates (ranging from 2.40 to 4.1mg/L) compared to the 50mg/L limits set by NSDWQ and WHO guidelines.

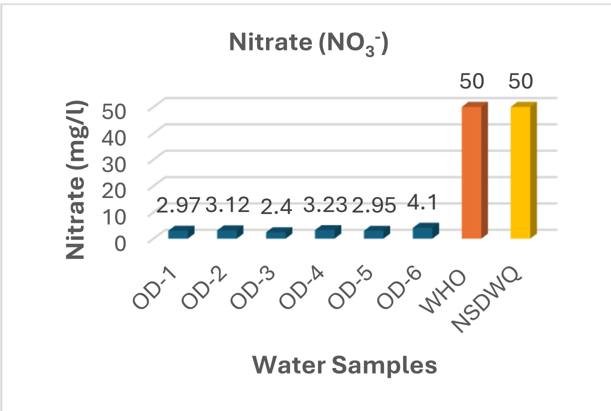

Fig 8. Nitrate content for the Six Samples.

V. CONCLUSIONS

Physio-chemical parameters were utilized in the research to assess the quality and variability of Groundwater in Oke-Diya based on its distance from the solid waste landfill. The quality of drinking water is being put at risk by contaminants from solid waste disposal, wastewater discharge, and run-off, endangering the progress made in improving access to drinking water globally.

Some physio-chemical parameters at the Oke-Diya dumpsite exhibited elevated levels, particularly in EC and TDS, with higher levels of Chloride observed in OD-3 and OD-4 samples. The presence of elevated chloride levels in groundwater samples OD-3 and OD-4 indicates contamination likely originating from sewage. This also raises the risk of water corrosion, impacting infrastructure, drinking water quality, and ultimately affecting mortality and aquatic life due to stream acidification in the surrounding area.

The study areas' groundwater samples were found to have slightly acidic pH levels. This can be explained by the high population density and commercial activity in those regions. The Total Alkalinity, Dissolved Nitrate, and Total Hardness levels in the water sample meet the permissible limits set by NSDWQ and WHO, except for OD-4 in Total Hardness which exceeds the allowable limit.

It is clear from this research that poor quality engineered landfills and hazard waste dumping into waterways can result in significant groundwater contamination, endangering human health and the environment. Therefore, it is necessary for both the community residents and the government to work together to prevent random waste dumping and to establish effective waste management and monitoring in areas where landfills are located.

REFERENCES

[1] Hem, J. D., (1985). Study and interpretation of the chemical characteristics of natural water. USGS. 3 rd. Ed., Water supply paper, 2254.

[2] Jenkins, P.; Southern, T.; Truesdale, V.; Jeary, A., (1996). Waters. Watts S., Halliwell L., (Eds.). Essential environmental science. Methods and Techniques London: Routledge, 336-350.

[3] USEPA, (2007). Recent recommended water quality criteria. United States Environmental Protection Agency, http:// www.epa.gov/waterscience/criteria/wqcriteria.html

[4] Samarghandi, M. R.; Nouri, J.; Mesdaghinia, A. R.; Mahvi, A. H.; Naseri, S.; Vaezi, F., (20 07). Efficiency removal of phenol, lead and cadmium by means of UV/TiO2 /H2O2 processes. Int. J. Environ. Sci. Tech., 4 (1), 1 0 -2 5 (1 6 pages).

[5] Zvinowanda, C. M.; Okonkwo, J. O.; Shabalala, P. N.; Agyei, N. M., (200 9). A novel adsorbent for heavy metal remediationin aqueous environments. Int. J. Environ. Sci.Tech., 6 (3), 425-434 (11 pages).

[6] Akcay, H.; Oguz, A.; Karapire, C., (2003). Study of heavy metal pollution and speciation in Bu yak Menderes and Gediz river sediments. Water Res., 3 7 (4), 8 13 -82 2 (10 pages).

[7] Abdel-Ghani, N. T.; Hegazy, A. K.; El-Chaghaby, G. A., (2009). Typha domingensis leaf powder for decontamination of aluminium, iron, zinc and lead: Biosorption kinetics and equilibrium modeling. Int. J. Environ. Sci. Tech., 6 (2), 243-2 48 (6 pages).

[8] Abdel-Ghani, N. T.; Elchaghaby, G. A., (2007). Influence of operating conditions on the removal of Cu, Zn, Cd and Pb ions from wastewater by adsorption. Int. J. Environ. Sci. Tech., 4 (4), 451-456 (6 pages).

[9] Mohiuddin, K. M.; Zakir, H. M.; Otomo, K.; Sharmoh, S.; Shikazono, N., (2010). Geochemical distribution of trace metal pollutants in water and sediments of downstream of an Urba n river. Int. J. Environ. Sci. Tech., 7 (1) 17 -28 (1 2 pages).

[10] Grimanis, A. P.; Zafiropoulos, D.; Vassilaki, R.; Grimanis, M., (1978). Trace elements in the flesh and liver of two fish species from polluted and unpolluted areas in the Aegean Sea. Environ. Sci. Tech., 12 (6), 723-726 (4 pages).

[11] Adams, W. J.; Kimerle, R. A.; Barnet, J. W., (1992). Sediment quality and aquatic life assessment. Environ. Sci. Tech., 26 (10), 186 5-1875 (11 pages).

[12] Kaonga, C. C.; Kumwenda, J.; Mapoma, H. T., (20 1 0). Accumulation of lead, cadmium, manganese, copper, and zinc by sludge worms; Tubifex tubifex in sewage sludge. Int. J. Environ. Sci. Tech., 7 (1), 119-126 (8 pages).

[13] A.N. Amadi, M.I. Ameh, J. Jisa, The impact of dumpsites on groundwater quality in markurdi metropolis, Benue State, Nat. Appl. Sci. J. 11 (1) (2012) 90–102.

[14] O.O. Ige, Geological and geotechnical evaluation of an open landfill for sanitary landfill construction in Ilorin, Southwestern Nigeria, J. Environ. Earth Sci. 3 (3) (2014) 9–17.

[15] R.G. Taylor, A. Allen, Waste disposal and landfill information needs, in: W.H.O., Protecting Groundwater for Health: Managing the Quality of Drinking Water Sources, IWA, London, 2006, pp. 339–362.

[16] C.M. Iwegbue, G.E. Nwajwei, J.E. Ogala, C.L. Overah, Determination of trace metal concentrations in soil profiles of municipal waste dumps in Nigeria, Environ. Geochem. Health 32 (5) (2010) 415–430. O.I. Popoola and O.A. Adenuga / Scientific African 6 (2019) e00208 15

[17] E. Moore, E. Matalon, J. Clary, L. Firestone, S.D. Anda, The Human Costs of Nitrate Contaminated Drinking Water in the San Joaquin Valley, 1st edn, Pacific Institute for Studies in Development, Oakland, 2011 ISBN-10:1893790312, 45.

[18] Awofolu, O. R.; Mbolekwa, Z.; Mtshemla, V.; Fatoki, O. S.; (2005). Levels of trace metals in water and sediment from Tyume river and its effects on an irrigated farmland. Water S. Afr., 31 (1), 87-94 (8 pages).

[19] Daka, E. R.; Molson, M.; Ekeh, C. A.; Ekweozor, I. K. E., (2007). Sediment quality status of two creeks in the upper bonny estuary, Niger delta, in relation to urban/industrial activities. Bull. Environ. Contam. Toxicol., 78 (6), 515-521 (7 pages).

[20] Olobaniyi, S. B., Owoyemi, F. B., (2006). Characterization by factor analysis of the chemical facies of ground water in the deltaic plain sands' aquifer of Warri, Western Niger delta, Nigeria. Afr. J. Sci. Tech., 7 (1), 73-81 (9 pages).

[21] Ojo, A.O., Olurin, O.T., Ganiyu, S.A., Badmus, B.S., Idowu, O.A. An integrated geophysical and geochemical investigation of an open dumpsite in a sedimentary formation. The Journal of Solid Waste Technology and Management, 2020, 46, 409–430.

[22] NSDWQ (2007) Nigerian Standard for Drinking Water Quality. Committee on Drinking Water Quality in Nigeria, Lagos.

[23] WHO. (2011). Guidelines for drinking water quality. 4th ed. WHO Press Geneva, Switzerland. 541p.Available at www.who.int/ Water_sanitation_health/ publications.