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Speciation of the Heavy Metals In The Ground waters Of Oshodi/Isolo/Ilasamaja industrial Estate Lagos Nigeria

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Abstract
The study investigated the concentration of heavy metals in the groundwaters of Oshodi/Isolo/Ilasamaja industrial estate for its suitability for domestic use. The study answered 3 research questions and tested a hypothesis. To achieve these, the research area was mapped out into 5 research zones andground water samples were collected from 5 dug wells and tap water sources, bulked and composites drawn fixed with HNO_3 and stored in ice cool boxes for analysis. The analytical standards adopted were USEPA models6010and 6020 and the instrument deployed for determination of the various metals isAgilent ICP-OES model 5800.The mean results obtained were; Pb 0.55±0.17mg/l, Cr, 0.27±0.53 mg/l, Cd,0.06±0.02 mg/l, Hg, 0.02±0.08 mg/l andAs,0.06±0.12 mg/l. The mean concentrations of the heavy metal investigated were subjected to test of significance with SPSS version 29 at 0.05 level of significance and the p-value was 0.03thus rejecting Ho. The study recommends that the industries operating in the industrial estate should adopt world best practices on effluents management, stop the discharge of untreated wastes into the operational environment,embark on remediation of the already impacted environment to restore the aquifer to its hitherto pristine state.Environmental monitoring agencies are enjoined to be on the top of their game in surveillance

Keywords: *industrial estate, industries, heavy metals, groundwater, human health*

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I. Introduction

Water is an essential nutrient to both fauna and flora. It constitutes an average of 55 percent of female and60percent of male adult body and 75 percent of body baby at birth (Mansourri & Madani 2017; Onwuegbu *et al*., 2013; Sobhanardakani, 2017). Water content of plants range between 98 percent for halophytes to 30 percent in wilting land plants (Ogwu *et al*, 2022a; Adjei-Kyereme 2015; Amfo-Out, 2012, Balakrishnan, 2016). The earth is composed of 71 percent water, 95 percent of the earth water is held by the ocean (Chiroma 2014, Aneyo, *et al*., 2016),fresh surface water, lake and land locked seashold 0.013 percent, ground water 1.68 percent and glacier 1.86 percent (Ogwu *et al*., 2022b, Ayeni, 2014; Ghani, 2011), whilethe atmosphere contains 0.001 percent of the total volume of water on earth (Kalavrouziotis, 2013, Koaner *et al*., 2014). Water regulates and moderates body temperature, lubricates and cushions the joints, protects the spinal cordand other sensitive tissues and expels the waste in the body through urination, perspiration, bowl movement, saliva expulsion and so on (Ogwu *et al*., 2021a, World Health Organisation, 2008, Ogwu *et al*., 2020, Wu, 2020; Zhang, 2011).

The groundwater provides 37 percent of man's water need and 98 percent of earth's available fresh water is groundwater (Cheng *et al*.,. 2014, Zheng *et al*., 2011, Tong *et al*., 2021, Ogwu et al., 2020).

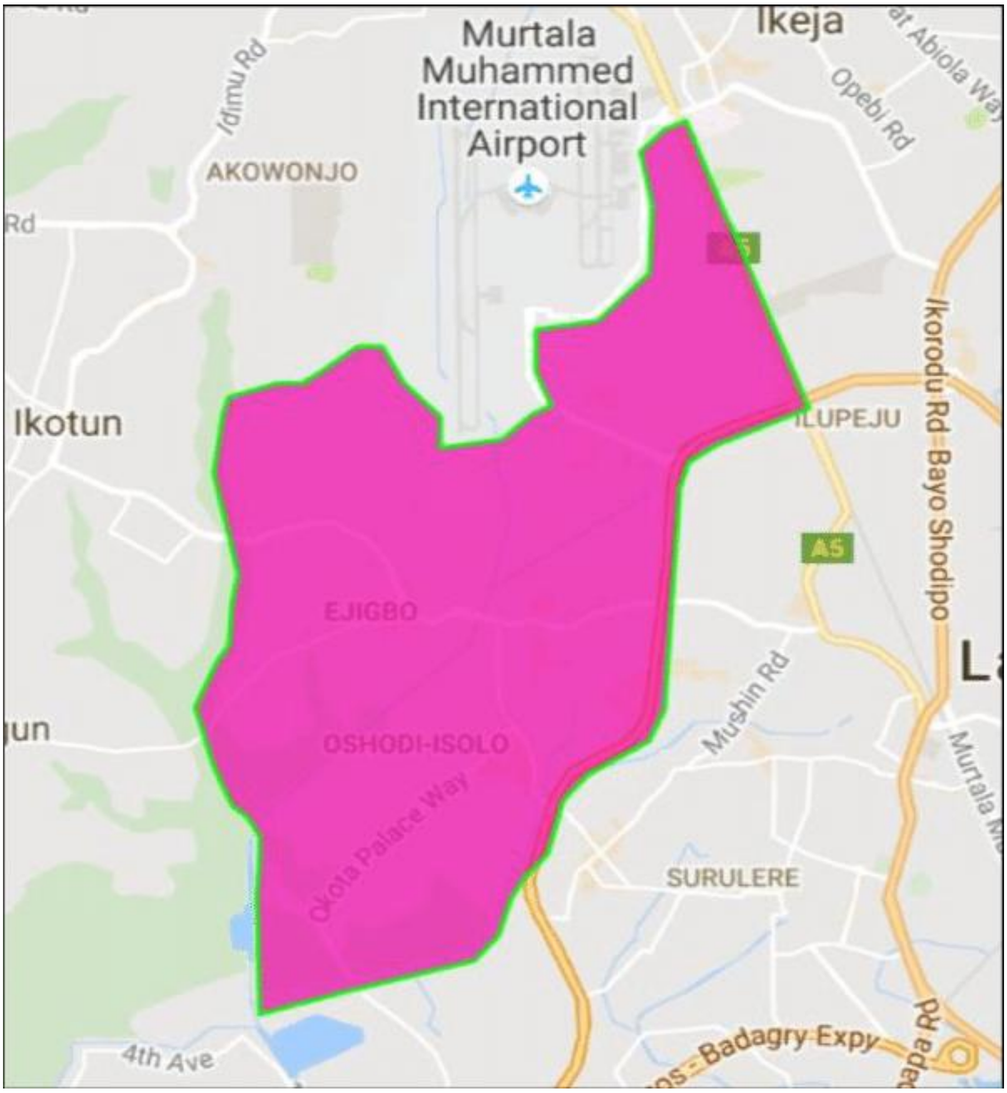
Groundwater pollution has become a global environmental issue since the turn of industrialization (Ogwu 2021; Chen, 2015). Groundwater pollution results from seepage of fertilizers and pesticides used in agriculture and household pest control, wastewater treatment plants, sanitary landfills, leakage from sewers (Ogwu et al., 2021a, Mira *et al*., 2020, Mahamed & Zahir, 2013; Manikannan & Asokan, 2011),urban activities, groundwater pumpage (Kalavrouzrotis, 2011; Nawah, 2015, Abah *et al*., 2017). Groundwater pollution also results from spreading of slurry animal wastes on the land and poorly managed industrial waste containing heavy metals such as (Pb, Cu, P, Ni, Mn, Cr, Cd, Hg, V. As and so on into the environment. The presence of heavy metals in domestic water results in health complications such as short memory to memory loss, cancer, cardiovascular diseases and death (Kalavrouzrotis 2011, Ogwu et al., 2021b, Cheng et al., 2014, Wu, 2020).

The focus of this study is to determine the concentrations of heavy metals in the ground water of Oshodi/Isolo/Ilasamajo industrial Lagos for its suitability human utility.

The heavy metals investigated are Pb, Cr, Cd, Hg and As.

The study was guided by the following research questions.
1. what are the concentrations of Pb, Cr, Cd, Hg and As in the groundwater of Ishode/Isolo/Ilasamaja industrial estate
2. are the concentrations of the heavy metals within the maximum permissible concentrations for heavy metals in water as stipulated by World Health Organisation (WHO) 2014 and United State Environmental Protection Agency (USEPA), 2008
3. can the ground water in the industrial estate be utilized for domestic activities?

Study Area



Map of Oshodi/Isolo/Ilasamaja

Source: Olusina, Joseph & Olaleye, (2017)

Oshodi/Isolo/Ilasamaja industrial estate is one of the 13 industrial estates in Lagos state. It is in OshodI/Isolo local government area which lies within the geographical coordinates of 6°30′50.095″ N and 3°18′32.241″ E. Oshodi/Isolo local government area has a population of 1.0 million (National Population Commission (NPC), 2006) within a land mass of 44.4 Km^2 (Lagos State Fact Sheet, 2021). It plays host to some notable industries in Lagos state amongst these are; Emzor and Afrab Pharmaceuticals, Asuani Textile industries. Daily Need Industries, Toyota Motors, Champion and Guardian Newspapers. Chi Industries. Effluents generated by these industries canfind their way through seepage to aquifersgroundwater resulting in contamination.

II. Materials and Methods

Sampling:Oshodi/Isolo/Ilasamaja industrialestate was mapped out into the research zones (Ajayi, 2018, Abdulmalik, 2019, Nwankwo, 2021). These wereAbimbola zone, Asuani zone, Emzor, Ajao Estate, and Charity/Ladipo Zones. From each of the zones, water samples were collected from 5 wells and taps bulked and composites drawn with plastic sample bottle fixed with nitric acid (Kanulthia et al., 2020) and stored in ice cool box for analysis in the laboratory.

Analysis of Samples

Digestion of samples and metals determination

The United State Environmental Protection Agency (USEPA), model 6010 as described by (Soma 2013) was used in the digestion of water samples for elementalsdetermination. 100ml of each of the samples wereboiled with slow heat in pyrex beakers containing 10ml of concentrated nitric acid (HNO_3). The boiled samples were then evaporated on a hot plate to the possible lowest volume, and this should be 20ml. The heated beakers were allowed to cool and then another 5ml of concentrated nitric acid added. The samples heating were continued with further addition of concentrated nitric acid as necessary until the digestionwere completed. The samples were allowed to evaporate again to dryness though not baked, and the beakers allowed to cool and werethen filled by addition of 5ml of hydrochloric acid (HCl) solution (1:1 v/v). The sample solutions were warmed and 5ml sodium hydroxide (NaOH) added and then filtered. These filtered samples (filtrates) were transferred to volumetric flask 100ml and diluted with distilled water to mark and the various metals under investigation were then determined with Agilent inductively coupled plasma – optical emission spectroscopy ICP-0ES model 5800.

III. Results

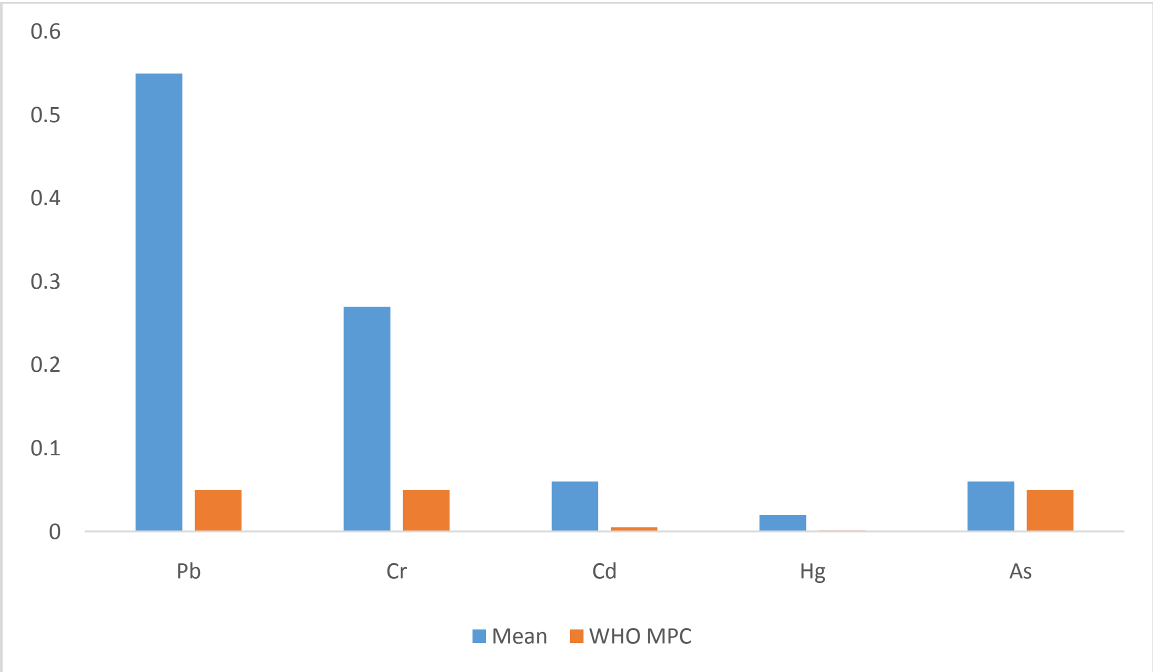
The result of the heavy metals content of the groundwater of Oshodi/Isolo/Ilasamaja industrial estate is as in Table 1.

Table 1: heavy metals concentrations of the groundwater in Oshodi/Isolo/Ilasamaja indsutrial estate and the WHO maximum allowable concentration in mg/l

Heavy metals	Abimbola	Asuani	Emzor	Ajao estate	Charity/Ladipo	$\bar{x}$	sd	WHO MPC
Pb	0.44	0.33	0.64	0.07	0.55	0.55	0.17	0.05
Cr	0.34	0.22	0.24	0.25	0.32	0.27	0.53	0.05
Cd	0.08	0.07	0.03	0.03	0.07	0.06	0.02	0.005
Hg	0.02	0.01	0.01	0.03	0.02	0.02	0.08	0.001
As	0.06	0.07	0.08	0.05	0.06	0.06	0.12	0.05

The concentrations of the heavy metals content of the groundwater in Oshodi/Isolo industrial estate were presented in graph as in Figure 2

Figure 2Graph presentation of the heavy metals concentrations in the groundwater of Oshodi/Isolo/Ilasamaja indsutrial estate and the WHO maximum allowable concentration in mg/l



The mean concentrations of the heavy metals investigated were subjected to test of significance with analysis of variance (ANOVA) deploying statistical package for social science (SPSS) version 29 and the p-value was 0.03 thus rejecting H_0.

IV. Discussion

The analysis of the groundwater in Oshodi/Isolo/Ilamaja industrial estate revealed varying concentrations of the various heavy metals investigated.

The concentration of Pb ranged between 0.07 mg/l in Asuani to 0.55 mg/l in Charity-Ladipo industrial estate, with a mean of 0.41 mg/l. The WHO and maximum permissible concentration for Pb in drinking water is 0.05 mg/l. The increased concentration of Pb in the aquifers of the industrial estate is attributed to seepage from industries effluents.High concentration of Pb in drinking water has been reported (Githarga *et al*., 2021; Wang, 2017).Human exposure to Pb results in abdominal pain, neurological changes, irritability and at higher dose death may result (Huang 2010). Prolonged exposure to Pb also results in high blood pressure, muscle and joint pains, loss of memory and lack of concentration (Mao *et al*., 2019).

The analysis of the of the groundwater in Oshodi/Isolo/Ilasamaja industrial estate also showed that the concentration of Cd range from 0.03 mg/l in Emzor to 0.08mg/l in Abimbola with a mean of 0.06 mg/l. WHO MPC for Cd in drinking water is 0.005 mg/l. The elevated concentration of Cd in the area is the concomitant effect of industrial waste discharges into the environment. Increased Cd in drinking water was reported in (Bellinger *et al*., 2015) and the exposure of human to Cd is associated with damage to lungs resulting in death (Ogwu et al., 2020). It also causes cancer (Tang *et al*., 2016).

The groundwater analysis of Oshodi/Isolo/Ilasamaja industrial estate gave varying concentrations of Cr which range from 0.22mg/l in Asuani to 0.34 mg/l in Abimbola with a mean of 0.27 mg/l. The WHO MPC for Cr in drinking water is 0.05 mg/l. The concentration of Cr in the aquifers of Oshodi/Isolo/Ilasamaja industrial estate is higher than the acceptable level stipulated by both WHO and USEPA. HIgh concentration of Cr in drinking water was documented in (Ogwu *et al*., 2021; Tang et al., 2021). Cr contamination in drinking water results in cancer of the lungs, nasal and sinuses (Xiao *et al*., 2019; Cheng *et al*., 2014).

The analysis of the ground of Oshodi/Isolo/Ilasamaja industrial estate also revealed that the concentration of Hg in the aquifers range from 0.01 mg/l in Emzor to 0.03 mg/l in Ajao estate with a mean concentration of 0.02 mg/l. WHO/USEPA MPC for Hg in drinking water is 0.001 mg/l and 0.002 mg/l respectively. The mean concentration of Hg in the ground water of Oshodi/Isolo/Ilasamaja industrial estate is higher than recommended and this the result of poor waste handling by the industries in the estate. Exposure of human to Hg above acceptable limit results in varying health complications such as cognitive and motor dysfunctions (Humood, 2073, Naveedullah *et al*., 2014). Cardiovascular disease and death (Cheng et al., 2014), increased concentration of Hg in drinking water was reported in (Letcort *et al*., 2016, Mushra *et al*., 2021).

The concentration of As in the groundwater of Oshodi/Isolo/Ilasamaja industrial estate as revealed by the analysis was between 0.05 mg/l and in Ajao estateto 0.08 mg/l in Emzor with a mean of 0.06 mg/l. The WHO and USEPA maximum permissible concentration for As in drinking water is 0.05 mg/l. The concentration of As in the aquifer of Oshodi/Isolo/Ilasamaja industrial estate is higher than recommended.High concentration of As in human system results in poor cognitive development and increased death in young adults (Cheng *et al*., 2013). It also results in cardiovascular complication,, skin cancer and also affects the kidney liver, bladder and prostate (Wu *et al*., 2020; Liu *et al*., 2013). Elevated concentration of As in drinking water was reported in (Bellinger *et al*., 2015, Gao *et al*., 2020).

V. Conclusion

Human quest for improved standards of living resulted in industrial revolution with environmental degradationasconcomitant effect of the poor effluents management. The situation in Oshodi/Isolo/Ilasamaja industrial estate is in tandem with global recurrence which have been impacting heavily on public health. It is pertinent for industriesoperators to incorporate United Nations Sustainable Development philosophies into their operational module for the general wellbeing of the environment and its components.

The results of the analysis of the groundwater of Oshodi/Isolo/Ilasamaja industrial estate revealed marked deviation from the environmental ethics of operation of industries as spelt by the monitoring agency, Federal Environmental Protection Agency(FEPA) and this is antithesis to human health.

Against the backdrop of the outcome of study, it is recommendedthat the industries operating in Oshodi/Isolo/Ilasamaja industrial estate should:

i. stop the discharge of untreated effluents into the environment
ii. embark on remediation of the already impacted environment and
iii. the monitoring agency is advised to up its game and increase their surveillance on the industries operating in Oshodi/Isolo/Ilasamaja industrial estate for the wellbeing of the ecosystem for improved ecosystem services.

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