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Research Article

ASSESSING THE CONCENTRATIONS OF HEAVY METALS ON THE SURFACE AND GROUND WATER QUALITIES AROUND AN OPEN DUMPSITE IN LAPITE, AKINYELE LOCAL GOVERNMENT, OYO STATE

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Abstract

The exponential increase in human activities due to population growth, industrialization, and urbanization has heightened concerns regarding waste disposal. Due to a lack of hygienic disposal techniques, the majority of city dwellers now rely only on open landfills for waste deposition, which causes leachate buildup. Waste materials that pollute surface water may infiltrate and contaminate the underground water that were closer to the site. This study sought to ascertain the levels of heavy metals and physicochemicals in surface and ground water surrounding an open waste site in Lapite, Akinyele Local Government. The concentrations of the physicochemical analysis of the surface water and ground water were higher in BOD and alkalinity ranging from 22.03±0.00a-28.39±0.01a and 429.90±0.00a-703.90±0.01b respectively when compare with the permissible limits while the levels of heavy metals in groundwater and surface water, which have been achieved with an Atomic Absorption Spectrophotometer (AAS) after appropriate digestion method with higher values in Magnesium (0.953±0.01a-1.996±0.02a), Iron (0.067±0.01a-0.324±0.01a), Maganesse (0.953±0.01a-1.816±0.02a), Cadmium (0.991±0.02a-1.542±0.01a) and Lead (0.211±0.00a-0.412±0.00a). All metal's concentration was compared to the WHO's determined allowable limit. Given these elevated results obtained from this location, it is likely that the surrounding environment is becoming more contaminated and can percoliate more into the groundwater as times goes on.

Keywords: Dumpsite, Physicochemical, Atomic absorbance spectrophotometer (AAS),Ground water, Surface water.

INTRODUCTION

A vital resource for human survival is water. Actually, all living things rely on water for their survival, either directly or indirectly (Agbede, 2013). Water is essential to life, yet if it becomes polluted, it becomes useless. Many investigations have identified various causes of water contamination in bodies of water, which has grown to be a major environmental concern (Akpoveta *et al.,* 2010,Yanidar *et al.,* 2018). There are various water sources, and groundwater is one of the primary sources of clean, dependable water. However, if waste disposal sites are not properly managed and protected, groundwater is extremely vulnerable to pollution from various sources (Barakat *et al.,* 2016, Han *et al.,* 2016). In many developing nations, landfill systems are typically used for disposal of waste, which is far from the recommended technique (Adewole, 2009). According to Abdus-salam *etal.* (2011), most disposal sites are located in close proximity to wetlands and residential areas. Frequently, local landfills lack basement preparation and lining to allow for the selective absorption of harmful materials. As a result, it is likely to emit pollutants into the air through dumpsite gasses and into the neighboring water through leachates. Wet waste breaks down and has an unpleasant stench.Not only does it negatively impact the local populace, the area is also a good place for disease-carrying animals like dogs and pigs. Leachates' effects on groundwater anddifferent sources of water have garnered a lot of interest lately due to their severe environmental issues (Oyelami *et al.,* 2013). Because leachate contains high concentrations of organic compounds, heavy metals, and toxic materials, it can leak into groundwater aquifers through rainfall, which can then pollute nearby river systems. This means that leachate leakage has the greatest impact on the surrounding environment, particularly on surface and ground water bodies. There have been numerous incidents recently documented worldwide involving water body pollution brought on by municipal solid waste landfills (Gzar *et al.,* 2014). The most simple, affordable, and cost-free way for disposal of wastes in both developed and emerging nations worldwide is through landfilling. Inorganic compounds likesulphates, calcium, magnesium, sodium, potassium, ammonium, iron and chlorides, as well as heavy metals likecopper, cadmium, lead, chromium, zinc and nickel, as well as dissolved organic materials and xenobiotic organic substances, are all present in the leachate of municipal landfills. A dumpsite experiences changes mediated by biology, chemistry, and hydrology after a few years. This weathering process causes the waste to become a source of environmental toxins. Groundwater resources are highly vulnerable to the migration of leachates from landfills or debris sites and the discharge of contaminants from sediments and in the absence of a barrier, might move laterally and vertically. Nobody could predict how far this leachate could spread after it leaves the landfill system because it seeps through the soil, contaminates groundwater, and poses a serious risk to its quality. It also contains a wide range of potentially harmful chemicals and carcinogens that could endanger public health.

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MATERIALS AND METHODS

Study Area

As shown in Figure 1, the waste site is situated inside the Akinyele Local Government area, Ibadan North, Ibadan, Oyo State which is approximately within at 7°34' 08"N and 3°54' 43"E. It is situated 9km away from IITA Forest reserve and surrounded by vegetation on both sides of the road and the wellwaters (Fig 3a) which is situated in the area where the dumpsite is located at different latitude $7^{o}33^{1}48$“N and longitude $3^{o}54^{1}$ 45“E as shown in Fig 2a and 2b.The dumpsite is situated right across from a major road, and the road has greenery on both sides. A river flows fairly near to the research location, as seen in Fig. 3b, and there are a few residential buildings, a re-habitation center, a gas station, and a few huts in the vicinity. A variety of solid waste products, including scrap metal, rubbish, papers, cartons, rubber, nylon, and empty cans, were found on the sites. The dumping zone developed as a result of a large open area. The area's inundation land type is low terrain, which is typically submerged up to 180–300 cm (Solihuddin *et al.,* 2021).

Collection and analysis of water samples

With the goal to examine the physical and chemical characteristics of the samples according to Bhartia *et al*. (2018) and Fekede *et al*. (2020), these factors include conductivity, temperature, pH, total hardness, dissolved oxygen, and biochemical oxygen demand. Water samples were taken at three different locations from the river near the dumpsites and five different wellwaters located around the site. These samples were sent straight to the laboratory for a period of six consecutive months, as indicated in Table 1 for surface water and Table 2 for groundwater. Once each wastewater sample was filtered using a Whatman filter and acidified with strong $HNO_3$to lower the pH, fifty milliliters (50 ml) were taken. The sample was then combined with five milliliters of concentrated HNO_3 in 40 milliliters and allowed to digest for half an hour in a sealed space.

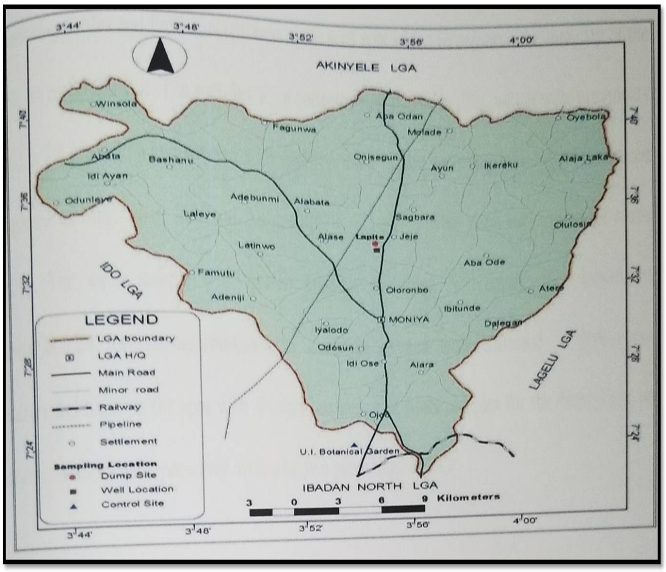

Fig. 1. Map of the Study Site

The metal contents of the digested samples were then achieved using an Atomic Absorbance Spectrophotometer (Perkin Elmer 3110) after it had been diluted to 100 ml with distilled water (Islam *et al.,* 2016). Because heavy metals including Cu, Fe, Pb, Mn, Zn, and Cd are harmful and can enter the bodies of humans and animals through the food chain, it is crucial to analyze their presence in water. Table 3 shows the levels of three distinct surface water sites, and Table 4 shows the levels of heavy metals in the wellwater samples that were collected from the area.

Fig. 2a. Front Section of Lapite Dumpsite

Fig. 2b. Back Section of Lapite Dumpsite

Fig 3a.Wellwater cited around the study area

Fig. 3b. Surface water around the area

RESULTS

Table 1. Mean value of physicochemical parameters of Surfacewater sample around Lapite Dumpsite

	S1	S2	S3	WHO,NSDWQ, 2011
Temp (°c)	24.63±0.01a	24.53±0.01a	22.03±0.01a	NS
pH	4.22±0.01a	4.76±0.01a	4.88±0.01a	6.5
EC (µS/cm)	0.36±0.02a	0.42±0.00a	4.12±0.01a	250
BOD (ppm)	20.44±0.00a	10.89±0.00a	22.03±0.00a	<5
Hardness(mg/l)	102.31±0.00a	182.31±0.01a	230.31±0.01b	100
DO(mg/l)	0.54±0.01a	0.49±0.01a	0.46±0.01a	5
Alkalinity (mg/l)	188.30±0.00a	395.50±0.00a	703.90±0.01b	100
Turbidity(NTU)	4.13±0.01a	2.14±0.01a	3.12±0.01a	<5
TDS(mg/l)	7.00±0.02b	7.59±0.01a	8.59±0.02a	500

Table 2. Mean value of physicochemical parameters of Groundwater sample around Lapite Dumpsite

	W1	W2	W3	W4	W5	WHO,NSDWQ, 2011
Temp (°c)	2.13±0.01a	2.91±0.01a	3.15±0.01a	3.12±0.01a	2.14±0.01a	NS
pH	7.05±0.01a	7.21±0.01a	7.15±0.00a	7.07±0.01a	7.03±0.01a	6.5
EC (µS/cm)	0.45±0.02a	0.52±0.00a	0.56±0.00a	0.81±0.00a	0.50±0.01a	600
BOD (ppm)	27.56±0.00a	28.39±0.01a	18.84±0.001	10.89±0.00a	18.19±0.00a	NS
Hardness(mg/l)	307.29±0.00a	387.29±0.00	435.29±0.00	291.29±0.01a	397.69±0.01a	100
DO(mg/l)	0.71±0.01a	0.76±0.00	0.78±0.00a	0.74±0.01a	3.86±0.01a	5
Alkalinity (mg/l)	429.90±0.00a	345.50±0.00	376.90±0.00a	206.90±0.00a	412.30±0.01b	100
Turbidity(NTU)	2.13±0.01a	2.91±0.01a	3.15±0.00a	3.12±0.01a	2.14±0.01a	<5
TDS(mg/l)	28.80±0.02b	14.20±0.00	16.20±0.001a	16.20±±0.01a	29.80±0.02a	500

Table 3. Heavy metal determination of Surfacewater sample around Lapite Dumpsite

	S1	S2	S3	WHO,2011
Fe (mg/kg)	0.064±0.03a	0.067±0.01	a0.145±0.03a	0.300
Cu (mg/kg)	0.012±0.01b	0.017±0.03a	0.008±0.02a	0.020
Zn (mg/kg)	1.172±0.01b	0.659±0.01b	0.081±0.03a	3.000
Cd (mg/kg)	0.822±0.01a	0.991±0.02a	0.805±0.01a	0.500
Cr (mg/kg)	0.278±0.02a	0.129±0.02a	0.215±0.01a	0.003
Pb (mg/kg)	0.211±0.00a	0.110±0.00a	0.112±0.00a	0.010
Ni (mg/kg)	0.113±0.02a	0.153±0.01a	0.171±0.02a	0.020
Mg (mg/kg)	0.953±0.01a	0.832±0.01a	1.241±0.02a	0.500
Mn (mg/kg)	0.990±0.02a	0.851±0.01a	0.78±0.01a	0.020

Table 4. Heavy metal determination of Groundwater sample around Lapite Dumpsite

	W1	W2	W3	W4	W5
Fe (mg/kg)	0.160±0.01a	0.262±0.01a	0.123±0.01a	0.292±0.01a	0.324±0.01a
Cu (mg/kg)	0.014±0.00b	0.018±0.02a	0.011±0.01a	0.028±0.01a	0.031±0.01a
Zn (mg/kg)	1.972±0.01b	1.109±0.01a	0.870±0.02a	1.139±0.01a	0.899±0.01a
Cd (mg/kg)	1.412±0.01a	1.203±0.01a	1.542±0.01a	1.243±0.01a	1.862±0.01a
Cr (mg/kg)	0.352±0.01a	0.290±0.01a	0.262±0.01a	0.341±0.01a	0.422±0.01a
Pb (mg/kg)	0.412±0.00a	0.231±0.00a	0.210±0.00a	0.251±0.00a	0.383±0.00a
Ni (mg/kg)	0.153±0.01a	0.133±0.02a	0.130±0.02a	0.134±0.002a	0.182±0.02a
Mg (mg/kg)	1.002±0.02a	1.210±0.01a	1.816±0.02a	1.231±0.01a	1.996±0.02a
Mn (mg/kg)	1.460±0.01a	0.936±0.01a	1.003±0.02a	0.949±0.01a	1.013±0.01a

DISCUSSION

Physicochemical parameters like alkalinity and BOD in the surface water was higher than the permissible limit while other characteristics such as total dissolved solids, pH, temperature, electrical conductivity, dissolved oxygen, hardness and turbidity were still within the permissible limit of WHO at all the samples sites of surface water (Table 1). The higher BOD in the surface water indicating that the water contains excessive organic matter which has pecoliated or washed into the aquatic bodies by stormwater runoff, sewage, agricultural wastes, or increases in microbial decomposition from the wastes and also the higher alkalinity was due to the increase of bicarbonate contaminations and some discharges from the wastes deposited. Also the ground water has higher concentrations of heavy metals in BOD, hardness pH and alkalinity in all the water samples when compared with the permissible standard of WHO as represented in Table 2.

Table 3 showed the estimation results with regard to the level of concentration of heavy metals in surface water. The results show that nearly all of the water samples have some amount of metals or heavy metals in them, and when compared to the WHO's permissible standard, the concentrations of highly toxic metals like Cd and Pb as well as other heavy metals like Mg, Fe, and Mn were higher. The metal concentrations in all the water samples do not differ significantly from one another. This suggests that the presence of metals in water samples could contaminate them when they are consumed, potentially leading to major health issues for humans. According to earlier research, heavy metals may readily enter the food chain through water, and drinking more of them than is safe may have a negative impact on human health. The human body may become toxically exposed to some heavy metals even at low quantities (Nordberg, 2010), and the amounts of Mn, Fe, Mg, Cd, and Pb in groundwater are higher than in surface water (Table 4).

Conclusion

The metal concentration and distribution in surface and wellwater within a multi-ringe buffer zone from the Lapite dump site were demonstrated in this study. These findings may have an effect on human health through the food chain. The water's Fe, Mn, Cd, and Pb concentrations exceeded the allowable limit. Pollutant percolation, leachate migration, and the area's low elevation were the major causes of heavy metal contamination in surface and groundwater samples.

Recommendation

Inhabitants of Lapite environs in Akinyele Local Government area, Oyo state and the general public who depends on the water around the area should be enlightened about the danger inherent in using this water for drinking or for domesticated use. Prohibition of waste disposal and monitoring should be implemented by the government and measures or treatment of the polluted water should be done with immediate effect. Further studies should also be carried out on the wells from time to time to monitor the pollution levels if there could be accumulation effects and remediation plans until the water is totally treated for domesticated use.

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