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Evaluation of the Impact of Dumpsite Leachate on Groundwater Quality in a Residential Institution in Ota, Nigeria

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Abstract-The threat of leachate as pollutant on groundwater and soil is of growing concern to human and the environment. The threat is caused by movement of contaminants through leachate from dumpsites and its location to water bodies both at the surface and underground. This research is focused on the impact of leachate from a dumpsite of a residential institution on the groundwater and soil in order to determine the degree of contamination around the institution's environment. The physico- and bio-chemical analysis: BOD, COD, pH, DO, TDS, total hardness, nitrite, chloride, calcium and heavy metals such as Pb, Fe, Zn, and Cu, in line with international standards, were carried out on both soil and water samples obtained from different points on the dumpsite. The results obtained from the tests carried out were compared to the World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ) standards. Heavy metal concentration showed significant variations from one sample point to another. On comparison, most of the parameters checked in the water samples from boreholes and the streams close to the dumpsites were within the allowable limits except for the Salinity, Iron (Fe) and Calcium (Ca) that exceeded the standards. There is a significant level of acidity which would require proper treatment in order to avoid harm to consumers in the future. The soil samples were also tested after digestion and the results showed that Nitrite (NO2-) and BOD5 exceeded the allowable limits. These results show that the dumpsite has slight effects on the adjacent stream and underlying soil. Therefore, the implementation of a properly designed leachate collection system to prevent future risk of continuous contamination of the underlying soil and groundwater is important.

Keywords: Open dumpsite, Residential Institution, Leachate, Soil, Water quality.

I. Introduction

Open dumps as a method of waste disposal are the oldest and most common way of disposing solid wastes in most cities of developing nations [1]. The awakening to the polluting effects of leachate from these dumpsites on the environment as a whole has motivated a number of studies [2]-[7]. One of the serious problems affiliated with the open dumps is the infiltration of the leachate into the surrounding environment, and consequent contamination of land and water [7, 8]. In recent times, dumpsite pose a major threat due to leachate emerging from solid waste disposal which is strongly influenced by the composition of the wastes, the volume of leachate generated and the location of the dumpsite from water bodies [2, 9, 10]. This has turned into a major issue as it influences the environment, wellbeing of the individual concerned and social prosperity.

Most attention over groundwater pollution has been placed round pollution associated with human activities such as haphazard dumping of wastes followed by the burning of the wastes [11, 12, 13, 14]. The practice of waste burning is actually meant to reduce the volume of waste. According to [15], leachate from such dumpsites comprise major sources of heavy metal pollutants to both aquatic and soil environments. Depending on the climatic conditions of the environment, such pollutants get to the groundwater aquifers through the percolation process. The studies on leachate and groundwater characterization show a serious threat to the local aquifer [16, 17, 18,]. [19] made analysis on samples of solid waste, leachate and groundwater and stated that groundwater pollution is as a result of leachate which is imperative over natural processes in the surroundings of the dumpsite.

Studies have shown that the assessment of impact of pollution sources of groundwater, have brought about major concerns both in the past and present [2, 20, 21]. Sources of major concern to the pollution of groundwater such as domestic wastes, landfills, agricultural chemicals and so on, can generate various types of pollutants which include heavy metals, cyanides, bacteria, nitrogen species, chlorinated hydrocarbons phenols, dissolved organic matter, inorganic macro-components, xenobiotic organic compounds among others [22, 23].

Other research findings have shown that leachate and outflow percolation are the sources of groundwater and surface water pollution close to landfill sites [4, 5, 22, 24, 25, 26]. The quality of groundwater is based on the physical and chemical parameters due to weathering from source rocks and anthropogenic activities i.e. changes in nature made by human beings. The principal impact of the landfill leachate is the contamination of both the groundwater and surface water which has led to a number of studies over the years [17, 27]. The factors which affect leachate generation include; topography, climate, vegetation, landfill cover, dumpsite characteristics, type of waste and the solid waste management systems in practice [28]. Several controlling factors for the leachate contamination include; rainfall, leachate mode of transportation, redox controls, topography, influence of unlined irrigation canal, age of the MSW dumping site, induced fracturing, surface and sub-surface flow dynamics [29, 30].

The toxic and mobile levels of heavy metals present in soils do not only depend on the total concentrations but also on their specific chemical form, metal properties, binding state, soil properties such as pH , environmental factors and matter content [31]. Soils behave as a natural sink for pollutants released from both natural and anthropogenic sources. The decomposition of organic matter in solid wastes changes the physico-chemical properties of the soil therefore affecting the groundwater sources beneath by the process of leachate percolation. The assessment of soil pollution becomes more complicated as a result of the different sources of the pollutants and their variable distribution [32].

The scope of this research is based on the analysis of the physicochemical parameters of the leachate from the Dumpsite in Covenant University, Ota, Ogun State. The study involves the analysis of the samples obtained from the site: To examine the effects of the leachate from the dumpsite on the groundwater and soil; analyze and determine the physicochemical parameters of the samples in order to assess the pollution effect on soil and groundwater quality; provide general awareness on the effect of leachate from landfill and groundwater and to determine if the quality of water from sources close to the landfill are within the standards of the World Health Organization (WHO)[33].

Description of the Study Area

The study area is the Covenant University dumpsite located right behind Daniel Hall, Ota, Ogun State. The dumpsite is located between latitude 6°40'22.1"N and longitude 3°09'02.4"E. The estimated area of the dumpsite is 18,000m2 or 1.8ha . The total distance of the dumpsite is approximately 636.17m (2087.18ft). All the solid waste generated from the university is usually dumped on this site. The solid waste generated consists primarily of paper waste, human hair waste, packaging waste, glass, plastic bags, leaves from plants, branches from trees, aluminium cans, PVC pipes and condemned water closets. At the site, the dumping and burning of solid waste persist and the dumpsite is not well drained. The site consists of an extensive area that has been in operation since the inception of the institution in 2002. Open dumping is the method of disposal in practice and reduction of waste by incineration is done in order to reduce volume of waste and preserve the life span of the disposal site. There is a stream just downhill from the dumpsite which joins a river at the end of its flow. The Covenant University sewage treatment plant is also located adjacent to the dumpsite and it releases effluents into the stream beside the dumpsite. The water at the site also mixes with that in the stream and further contaminates it either by surface runoff or percolation.

Figure 1 showing the map of Covenant University with dumpsite location.

Figure 2 Solidwaste at the Dumpsite

Climate

Ota has a tropical climate with general humid and hot climatic conditions. It is characterized by high temperatures in the dry season and low temperatures in the wet season. The climatic pattern of the study area includes, the dry season from November to May and the wet season is from June to October. The area experiences maximum rainfall in the wet season. In a year, the average rainfall is 1623 mm. The driest month is December, with 16 mm of rainfall. In June, the precipitation reaches its peak, with an average of 288mm.

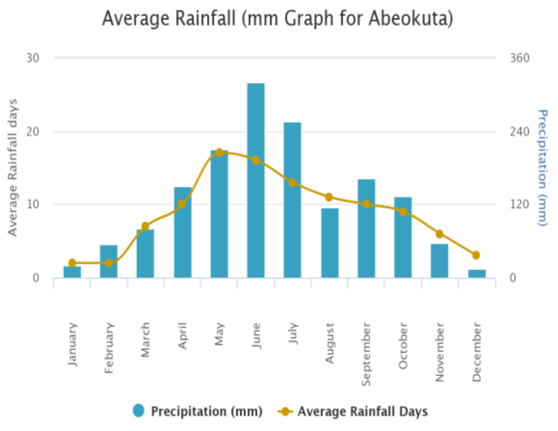

Figure 3: Average monthly rainfall in Ota, Ogun state
Source: [36]

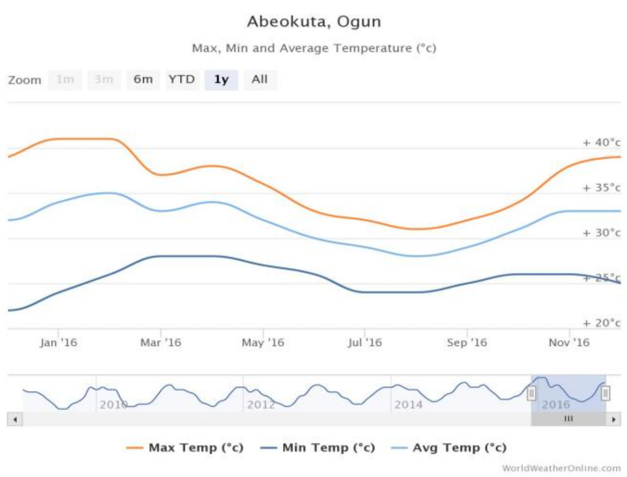

Figure 4: Average monthly temperature in Ota, Ogun State. Source: [36]

II. Materials and Method

Collection of Sampling from the Dumpsite

Systematic random sampling was used for data gathering. Samples were also obtained from a stream located downhill from the dumpsite and also from the borehole water supply at increasing distances from the dumpsite from two nearby houses. Samples were obtained from six (6) different locations; four (4) locations were picked randomly on the dumpsite for sampling. The locations were selected for sampling both on the dumpsite and along the slope of the dumpsite, the 4 locations on the dumpsite were dug down by 3 metres, and 2 soil samples were obtained for every metre dug into the dumpsite leading to a total of 6 soil samples from each of the 4 locations on the dumpsite, while the other two (2) locations along the slope of the dumpsite were dug down by 2 metres, and 2 soil samples were obtained for every metre dug, leading to a total of 2 soil samples from each of the 2 locations along the slope of the dumpsite. The soil samples were then taken to the laboratory for preservation. A total of 32 soil samples were then taken for digestion in order to obtain the liquid samples from the soil. Physical, chemical and microbiological parameters were analyzed at laboratories of Civil Engineering; Chemistry and Microbiology Departments of the university. Soil samples were also taken from the water sampling points to determine the impact of the leachate on soil and ground water quality within the sampled area.

Sampling from the Stream

Samples were obtained from stream at different intervals and placed in already rinsed 750ml plastic bottles. Duplicate samples were obtained at each of the 3 different points along the stream and taken to the laboratory for preservation and analysis.

Sampling from nearby Houses

Samples were obtained from 2 houses located near the dumpsite and placed in already rinsed 750ml plastic bottles. A total of 2 samples were obtained from the borehole water supply from each of the 2 houses and taken to the laboratory for analysis.

Sampling from a Control site

Two locations away from the dumpsite were selected for sampling. Samples were collected from these locations at 1-3 metre depth for 2 soil samples each, leading to a total of 6 samples from each location. A total of 12 soil samples were then taken for digestion in order to obtain the liquid samples from the soil.

In-Situ Measurements for Physical Parameters

The physical parameters such as; pH, temperature, Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Salinity were all determined in the field on the freshly collected water samples. These parameters were measured with the use of a PSCTestr 35 multi-parameter. The probe was dipped into the water samples until a stable reading was obtained and recorded.

Analytical Methods

All the samples were analyzed for the following physicochemical parameters and heavy metals which include; pH, temperature, conductivity, Total Dissolved Solids (TDS), Salinity, Iron, Nitrite, Calcium, Chloride, Copper, Zinc, Total Hardness. The physicochemical analysis of the water samples as well as the digested soil samples were carried out according to the standard analytical methods [34, 35].

III. Results and Discussion

Table 1 shows the results from the physicochemical tests carried out on all the samples from the nearby stream that were collected are shown in Table 1. These results are compared to both the World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ) to ascertain if they are within the permissible standards limits. The pH values of the water samples from the nearby stream and boreholes range from 6.26 to 6.36 and 4.91 to 5.61, respectively. These values are slightly below the WHO and NSDWQ standard values. Water generally becomes more corrosive with decreasing pH; however, excessively alkaline water also may be corrosive.

Table 1: Mean Results of Water Samples from the nearby stream and boreholes

Parameter/ Samples	**Sample 1a**	**Sample 1b**	**Sample 2a**	**Sample 2b**	**Sample 3a**	**Sample 3b**	**Borehole Sample 1**	**Borehole Sample2**	**WHO**	**NSDWQ**
Temp (^{0}C)	**30.5**	**28**	**29.8**	**27.4**	**29.9**	**28.2**	**28**	**36.9**	**-**	**-**
pH	6.28	6.26	6.36	6.36	6.36	6.32	4.91	5.61	6.5-8.5	6.5-8.5
Conductivity	204	201	499	499	501	500	42.9	71.2	-	-
TDS	147	145	353	351	353	350	30	47.7	500	500
Salinity	112	113	268	267	267	267	345	442	-	-
Iron(mg/l)	0.3	0.4	1.15	1.25	1.05	1.05	0.2	0.05	0.3	0.3
Nitrate (mg/l)	0.135	0.185	0.125	0.195	0.195	0.08	0.195	0.165	1	1
Chloride (mg/l)	3.3	1.7	2.6	5.1	3	3.5	4.1	1.7	2.5	2.5
Calcium (mg/l)	67	67	76	74	25	86	420	163	75	75
Copper (mg/l)	0	0	0.05	0.1	0.06	0.3	0.82	0.24	2	1
Zinc (mg/l)	0.04	0.18	0.16	0.33	0.3	0.3	0.25	0.15	-	3
-	-	-	-	-	-	-	-	-	-	-

The values for the total dissolve solids in the water samples ranged from 145 mg/l – 353 mg/l, was within the standard (500 mg/l), while the TDS values for the Borehole samples ranged from 30 mg/l – 47.7 mg/l. The salinity values of the water samples ranged from 112 mg/l – 268 mg/l and the values for the borehole samples ranged from 34.5 mg/l – 44.4 mg/l. The values of iron (Fe) detected in the water samples ranged from 0.3 mg/l – 1.25 mg/l was above the standard limits for iron in water (0.3), while for the samples obtained from the boreholes, the iron levels ranged from 0.05 mg/l - 0.2 mg/l which is within the limits. According to the Nigerian Standard for Drinking Water Quality (2007), when Nitrite levels exceed 0.2 mg/l, it causes cyanosis and asphyxia (blue-baby syndrome) in infants less than 3 months. The concentration of nitrite present in the water samples ranged from 0.08 mg/l – 0.195 mg/l which are all within the standard limits, while for the samples obtained from the boreholes, the nitrite concentrations ranged from 0.165 mg/l – 0.195 mg/l was within the limit (0.2 mg/l). Concentrations greater than 1.0 mg/L, as nitrogen, may be injurious to pregnant women, children, and the elder. The values of Chloride detected in the water samples ranged from 1.7 mg/l – 5.1 mg/l is above the limits for Chloride in water (250 mg/l), while for the samples obtained from the boreholes, the Chloride levels ranged from 1.7mg/l–4.1mg/l was within limits. Large concentrations increase the corrosiveness of water and, in combination with sodium, give water a salty taste. The values of copper detected in the water samples ranged from 0 mg/l – 0.3 mg/l is within the limits for copper in water (2), while for the samples obtained from the boreholes, the copper levels ranged from 0.24 mg/l - 0.82 mg/l is also within the WHO and NSDWQ limits. Total hardness detected in the water samples, which ranged from 25 mg/l – 60 mg/l, was also within the WHO and NSDWQ limits.

Table 2: Chemical properties of the digested soil samples from point 1 at various depth from the dumpsite

Point 1	Sample 1a	Sample 1b	Sample 2a	Sample 2b	Sample 3a	Sample 3b	WHO	NSDWQ
Calcium (mg/l)	nd	nd	nd	nd	nd	Nd	75	75
Copper (mg/l)	1.06	0.89	0.85	0.72	0.75	0.8	2	1
Zinc (mg/l)	0.38	0.33	0.13	0.15	0.41	0.38	3	3
Nitrite (mg/l)	0.334	0.326	0.389	0.391	0.875	0.861	0.2	0.2
Iron (mg/l)	0.12	0.1	0.04	0.07	0.43	0.52	0.3	0.3
Chloride (mg/l)	5.1	5.14	6.9	7	38	39.2	250	250
BOD (mg/l)	25.9	25.4	19	19.2	19.4	18.5	25	-
COD (mgO_2/l)	14880	14550	22000	20580	25880	26005	-	-

nd: not detected

Chemical Parameters of sample at different points

At point 1, Calcium was not detected in the leachate sample. Copper showed a variation from 0.72 to 1.06mg/l which is below the WHO standard of 2.0mg/l but the values from Sample 1a at 1 meter (1.06mg/l) is greater than the NSDWQ standard of 1mg/l. The remaining parameters fell below the standard limits. The result for zinc varied from 0.13 to 0.41mg/l and fell below the standard of 3.0 mg/l. Nitrite concentration varied from 0.326 to 0.875 mg/l which is far higher than the standard limit of 0.2 mg/l. Iron concentration varied from 0.07 to 0.52mg/l. The values from 1 meter and 2 meter depth for iron fell below the recommended standard of WHO and NSDWQ (0.3mg/l), but for the samples taken at 3.0 meter depth, the concentrations of iron were 0.43mg/l and 0.52mg/l which are greater than the recommended standard (0.3 mg/l). Chloride concentration shows variation from 5.1 to 39.2mg/l which implies that it falls below the standard of 250mg/l. The BOD values in the leachate vary from 19.0 to 25.9mg/l. At 1.0 meter depth, the values for BOD were 25.9mg/l and 25.4mg/l which is greater than the WHO standard of 25.0mg/l and at 2.0meters, the values were 19mg/l and 19.2mg/l. At 3meters the values were 19.4 and 18.5mg/l which are all below the recommended value of 25.0mg/l prescribed by WHO. The result for COD in the leachate varied from 14550 to 26005mg/l.

Table 3: Mean Results of Water Samples from Three Boreholes

Point 2	Sample 1a	Sample 1b	Sample 2a	Sample 2b	Sample 3a	Sample 3b	WHO	NSDWQ
Calcium (mg/l)	nd	nd	nd	nd	nd	Nd	75	75
Copper (mg/l)	1	0.9	0.74	0.69	0.5	0.35	2	1
Zinc (mg/l)	0.14	0.09	0.42	0.44	0.09	0.11	3	3
Nitrite (mg/l)	0.125	0.127	0.115	0.11	0.1	0.109	0.2	0.2
Iron (mg/l)	0.06	0.05	0.23	0.25	0.1	0.11	0.3	0.3
Chloride (mg/l)	4.2	3.92	15.5	15.61	14	16.2	250	250
BOD (mg/l)	18.6	18.9	28.2	27.6	22.1	22.2	25	-
COD (mgO_2/l)		21280	22000	14880	14500	19680	18600	-

nd: not detected

At point 2, Copper (Cu) concentration in the samples varied from 0.35 to 1.0mg/l is below the WHO standard of 2.0 mg/l but the values from Sample 1a at 1 meter is 1.0mg/l is the same as NSDWQ standard of 1mg/l. The remaining samples fell below the standard. Zinc concentration show that it varies from 0.09 to 0.44mg/l which fell below the WHO and the NSDWQ standard (3mg/l). Nitrite concentration varied from 0.1 to 0.127mg/l and is below the standard limit (0.2 mg/l). Iron (Fe) concentration varied from 0.06 to 0.25mg/l is below the standard limit (0.3 mg/l). Chloride concentration in the sample varied from 4.2 to 16.2mg/l which implied that it fell below the WHO and the NSDWQ standard of 250mg/l. The BOD results in the leachate vary from 18.6 to 28.2mg/l. At 1meter depth, the value for BOD was 18.6mg/l and 18.9mg/l, which is less than the WHO standard of 25mg/l and at 2meters the values was 28.2mg/l and 27.6mg/l is greater than the WHO standard of 25mg/l. At 3 meters, the values are 22.1 and 22.2mg/l which is below the recommended value of the WHO (25mg/l). The result for COD in the leachate varies from 14500 to 21280$mg0_2$/l.

Table 4: Chemical properties of the digested soil samples from point 2 at various depth from the dumpsite

POINT 3	Sample 1a	Sample 1b	Sample 2a	Sample 2b	Sample 3a	Sample 3b	WHO	NSDWQ
Calcium (mg/l)	nd	nd	nd	nd	nd	nd	75	75
Copper (mg/l)	0.66	0.72	0.89	0.92	0.36	0.41	2	1
Zinc (mg/l)	0.36	0.34	0.18	0.22	0.23	0.19	3	3
Nitrite (mg/l)	0.086	0.076	0.145	0.15	`0.135	0.126	0.2	0.2
Iron (mg/l)	0.08	0.1	0.24	0.2	0.14	0.17	0.3	0.3
Chloride (mg/l)	6.3	5.9	8.2	7.6	7.2	6.81	250	250
BOD (mg/l)	19.7	20.7	25.1	24.8	46.4	47.1	25	-

COD (mgO_2/l)	21400	19900	15080	15450	22488	22550	-	-

At point 3, Copper concentration varied from 0.36 to 0.92mg/l and is below the WHO standard of 2.0 mg/l and NSDWQ standard of 1.0mg/l. Zinc concentration in the samples varied from 0.19 to 0.36mg/l, which falls below the WHO and the NSDWQ standard (3mg/l). Nitrite concentration varies from 0.076 to 0.145mg/l and falls below the WHO and the NSDWQ standard which was 0.2 mg/l. Iron concentration varies from 0.08 to 0.24mg/l is below the recommended WHO and NSDWQ standards of 0.3 mg/l. The result for chloride varied from 5.9 to 8.2mg/l. The BOD value in the leachate varied from 19.7 to 47.1mg/l. at 1meter depth. The value for BOD was 19.7mg/l and 20.7mg/l is less than the WHO standard of 25mg/l and at 2meters the values was 25.1 mg/l and 24.8 mg/l. At 3meters, the BOD value was 46.4 and 47.1 mg/l are greater than the recommended value of the WHO (25mg/l). The result for COD in the leachate varied from 14080 to 22550mgO_2/l.

Table 5: Chemical properties of the digested soil samples from point 4 at various depth from the dumpsite

POINT 4	Sample 1a	Sample 1b	Sample 2a	Sample 2b	WHO	NSDWQ
Calcium (mg/l)	nd	nd	nd	nd	75	75
Copper (mg/l)	0.52	0.47	0.7	0.68	2	1
Zinc (mg/l)	0.25	0.2	0.38	0.41	3	3
Nitrite (mg/l)	0.195	0.187	0.21	0.199	0.2	0.2
Iron (mg/l)	0.08	0.05	0.06	0.08	0.3	0.3
Chloride (mg/l)	6.6	7	4.5	3.98	250	250
BOD (mg/l)	19.4	19.1	23.6	23.1	25	-
COD (mgO_2/l)	22550	22600	17880	16800	-	-

Nd: not detected

At point 4, Copper concentration varied from 0.47 to 0.7mg/l and was below the WHO standard of 2.0mg/l and the NSDWQ standard of 1mg/l while zinc concentration varied from 0.2 to 0.41mg/l was lower than standard limits of 3.0mg/l. Nitrate concentration varied from 0.187 to 0.199mg/l and was less than the WHO and the NSDWQ standard (0.2 mg/l). Iron (Fe) concentration varies from 0.05 to 0.08mg/l. The samples from 1 m and 2 m depths for Fe fall below the recommended standards of WHO and NSDWQ (0.3mg/l). The result for chloride varied from 4.5 to 7.0mg/l which was below the WHO and the NSDWQ standards (250mg/l). The result for BOD in the leachate varied from 19.1 to 23.6mg/l at 1.0m depth. While at 2 m depth, the BOD values were 19.4 mg/l and 19.1 mg/l which is less than the WHO standard of 25.0 mg/l. At 3 m depth, the values were 23.1 mg/l and 23.6 mg/l which are all below the recommended value of the WHO (25.0 mg/l). The result for COD in the leachate varies from 16880 to 22600 mgO_2/l.

Table 6: chemical properties of the digested soil samples from point 5 at various depth from the dumpsite

POINT 5	Sample 1a	Sample 1b	Sample 2a	Sample 2b	WHO	NSDWQ
Calcium (mg/l)	nd	nd	nd	nd	75	75
Copper (mg/l)	0.42	0.45	0.9	1	2	1
Zinc (mg/l)	0.19	0.16	0.25	0.28	3	3
Nitrite (mg/l)	0.195	0.2	0.205	0.21	0.2	0.2
Iron (mg/l)	0.09	0.11	0.07	0.08	0.3	0.3
Chloride (mg/l)	5	4.96	10.5	11	250	250
BOD (mg/l)	22	21.6	29.1	28.5	25	-
COD (mgO_2/l)	21280	22060	15440	15550	-	-

nd: not detected

At point 5, Copper concentration varied from 0.42 to 1.0mg/l and while zinc concentration varied from 0.16 to 0.28mg/l. Both assessment values were lower than the standard limits. Nitrate showed a variation from 0.195 to 0.205mg/l, and at 1.0m depth, the value for nitrate was 0.195mg/l and 2.0mg/l which were greater than the WHO and the NSDWQ standard (0.2 mg/l). At 2.0m, the value for nitrate is 0.205mg/l and 0.21mg/l which is greater than the WHO and the NSDWQ standard. Fe concentration varied from 0.07 to 0.11mg/l. The samples from 1 m and 2 m for Fe fell below he recommended standard of WHO and NSDWQ (0.3mg/l). Chloride concentration varied from 5 to 11.0mg/l which was below the WHO and the NSDWQ standard of 250mg/l. The result for BOD in the leachate varies from 21.6 to 29.1mg/l. At 1.0m depth, the value for BOD was 22mg/l and 21.6mg/l which is less than the WHO standard of 25.0mg/l. At 2.0 m depth, the values were 29.1mg/l and 28.5mg/l which are all above the recommended standard (25.0mg/l). The result for COD in the leachate varied from 15440 to 21280 mgO2/l.

Table 7: Chemical properties of the digested soil samples from point 6 at various depth from the dumpsite

Point 6	Sample 1a	Sample 1b	Sample 2a	Sample 2b	WHO	NSDWQ
Calcium (mg/l)	nd	Nd	Nd	nd	75	75
Copper (mg/l)	0.68	0.74	0.66	0.62	2	1
Zinc (mg/l)	0.32	0.36	0.38	0.41	3	3
Nitrite (mg/l)	0.215	0.211	0.17	0.173	0.2	0.2
Iron (mg/l)	0.16	0.12	0.25	0.2	0.3	0.3
Chloride (mg/l)	5.6	5.8	6.9	6.34	250	250
BOD (mg/l)	52.2	51.6	26.1	26.4	25	-

COD (mgO_2/l)	3480	3660	14880	15065	-	-

nd: not detected

At point 6, copper (Cu) concentration varied from 0.62 to 0.74mg/l and was below the WHO standard of 2.0 mg/l and the NSDWQ standard of 1 mg/l. The result for zinc at various points varied from 0.32 to 0.41mg/l which falls below standard limits (3.0mg/l). Nitrate concentration varies from 0.17 to 0.215 mg/l. At 1.0 m depth, the nitrate concentration varies from 0.17 to 0.215 mg/l which is greater than the WHO and the NSDWQ standard (0.2 mg/l). At 2 m, the values for nitrate were 0.17 mg/l and 0.173 mg/l which was less than WHO and NSDWQ standards. The result for Fe varies from 0.12 to 0.25 mg/l. The samples from 1 m and 2 m depths for Fe fell below the recommended standard of 0.3mg/l. Chloride concentration varied from 5.6 to 6.9mg/l which was below the WHO and NSDWQ standard of 250mg/l. The result for BOD in the leachate shows that it varied from 26.1 to 52.2mg/l. At 1.0m depth, the value for BOD was 52.2mg/l and 51.6mg/l which were above WHO standard of 25.0mg/l and at 2.0m, the values were 26.1 mg/l and 26.4 mg/l which are all above the recommended value of the WHO (25.0 mg/l). The result for COD in the leachate varies from 3480 to 15065 mgO2/l.

Table 8: Chemical properties of the digested soil samples from the control site at various depth from the dumpsite.

Parameters/Sample	Sample 1a	Sample 1b	Sample 1c	Sample 2a	Sample 2b	Sample 2c
Calcium (mg/l)	nd	nd	nd	nd	nd	nd
Copper (mg/l)	1.5	1.3	0.98	1	0.68	0.4
Zinc (mg/l)	0.4	0.25	0.32	0.23	0.18	0.2
Nitrite (mg/l)	0.3	0.13	0.08	0.2	0.2	0.2
Iron (mg/l)	0.1	0.09	0.08	0.12	0.07	0.13
Chloride (mg/l)	5.1	4.6	6.2	6.8	5.3	6.5

Conclusion

One of the major impacts on the environment is the release of leachate from disposed waste on dumpsites. Wastes from various sources find their way into the environment and end up in dumpsites which pose a severe threat to the soil as a result of the homogeneity of these wastes. The wastes undergo series of decomposition, thereby generating leachate by excess of stormwater infiltrating it. The content of heavy metals in the leachate is generally very low because of attenuating processes (sorption and precipitation) that take place within the disposed waste. The pH values of the water samples from the nearby stream and boreholes range from 6.26 to 6.36 and 4.91 to 5.61, respectively. These values are slightly below the WHO and NSDWQ standard values. The values indicate that the water from both sources are slightly acidic in nature and if consumed without proper treatment, may be harmful to the consumers. These results show that the dumpsite has slight effects on the adjacent stream and underlying soil. The research therefore recommends the implementation of a properly designed leachate collection system to prevent future risk of continuous contamination of the underlying soil and groundwater.

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