ASSESSMENT OF A CLOSED DUMPSITE AND ITS IMPACT ON SURFACE AND GROUNDWATER INTEGRITY: A CASE OF OKE AFA DUMPSITE, LAGOS, NIGERIA

Salami L.[*1],Fadayini M.O.[2]&Madu C.[2]
[1]Department of Chemical and Polymer Engineering, Lagos State University, Epe, Lagos, Nigeria
[2]Department of Chemical Engineering, Lagos State Polytechnic, Ikorodu, Lagos, Nigeria
[*]Corresponding author: SalamiLukumon@yahoo.com

ABSTRACT
The assessment of a closed dumpsite and investigation of its impact on surface and groundwater integrity is very crucial to health and environment. This research work was aimed at assessing OkeAfa dumpsite and its impact on surface and groundwater integrity in the vicinity of the dumpsite. Soil samples were collected from five different locations on the dumpsite at the surface, at a depth of 0.5m and at a depth of 1.0m. Five different groundwater samples were collected at various radial distances from the dumpsite and five different surface water samples along the dumpsite were collected. All the samples were examined for zinc, lead, nickel, copper, chromium, iron, magnesium, calcium, manganese, sodium and potassium as well as biochemical oxygen demand and chemical oxygen demand in the case of ground and surface water. The results showed that closed dumpsite has no serious impact on the ground and surface water quality. It also revealed the concentrations of parameters analysed did not follow a particular tread. The results of the groundwater samples fall within the guideline for drinking water by World Health Organisation and National Agency for Food and Drug Administration and Control but there was a scarcity of guideline for soil of closed dumpsites for the purpose of comparison.

Keywords: *Assessment, dumpsite, impact, groundwater and surface water.*

1. INTRODUCTION

Improper management of solid waste areas has resulted in serious ecological, environmental and health problems. Such practices contribution to widespread environmental pollution as well as spread of diseases (Susu and salami, 2011). Solid waste disposal methods are a major public concern. Majority of the municipal solid waste disposal sites in Nigeria are still open dumps. Solid waste disposal by landfill poses a threat to groundwater and surface water quality through the formation of polluting liquids known as leachate (Mohd, etal, 2011). Leachate generally comes into existence during dissolution in the in the landfill. The environments can be polluted by the leachate, which occurs at the end of decayed solid waste, mixed with precipitates of surface water. As a result, surface water collection system (rivers, creeks, lakes), subsurface collection system (groundwater reservoirs) and solid system (different soil layers) have been seriously polluted by this Leachate.

Landfills are one of the sources of groundwater and soil pollution due to the production of Leachate and transportation of the contamination to farther points in the ecosystem (Susu and salami, 2011). The contaminations of soil, water and air with heavy metals even at low concentrations are known to have potential impact on environment and human health. These metals also pose a long-term risk to groundwater and ecosystem in general (Hunachew and Sandip, 2011and Ebongetal., 2007). Therefore, this research work is aimed to assess the closed dumpsite and its impact on the surface and groundwater within the vicinity of the closed dumpsite. This work will provide basis for further actions to be taken on the closed dumpsite which justifies the reason for the work. Different researchers have worked on the impact of landfill Leachate on the surface and groundwater quality (Saarela, 2003; De Rosaletal,, 1996; Flyhammar, 1995; Abu-Rukah and KoFahi, 2001; Looser etal., 1999; Christensen etal,, 1998; Hunachew and Sandip, 2011; Mohdetal., 2011 and Salami and Susu, 2013) but there is lack of comprehensive study which determines the pollution level created due to closed dumpsite in Lagos State which further justifies this research work.

2. STUDY AREA

OkeAfa dumpsite is a closed dumpsite situated in Isolo/Oshodi Local Government area of Lagos State, Nigeria. The dumpsite covers approximately three hectares of land. It was used as an abattoir before dumping of refuse started in 1990 which was closed in 1998. The dumpsite is located along a flowing river and major road connecting Alimosho Local Government and Isolo/Oshodi Local Government. OkeAfa dumpsite shown in plate1 is a non-engineered dumpsite with a heap of wastes stream made up of domestic, market, commercial, industrial and institutional origins. The surrounding area is now well developed particularly for housing and commercial purposes. During operation of the site, different types of wastes ranging from organic to inorganic, hazardous and non hazardous were dumped in the site. The wastes were dumped without separation but the rag pickers who constituted the informal sector rummaged through the wastes, helped in segregating them by collecting the plastics and metals and sell them to the recycling industries.

Plate 1. A view of OkeAfa dumpsite in Isolo/Oshodi Local Government of Lagos State, Nigeria

3. METHODOLOGY

3.1SAMPLING OF WATER AND SOIL SAMPLE

3.1.1SAMPLING OF SOIL SAMPLE

Soil samples were collected from five different locations, four extreme and centre, labelled 1, 2, 3, 4 and 5 respectively on the dumpsite at the surface, a depth 0.5m and a depth of 1.0m. At the surface, five soil samples were collected with the aid of stainless knife from different locations using 1 litre plastic bottles that had been cleaned by soaking in 10% nitric acid and rinsed with distilled water. The stainless knife was washed with distill water each time it was used for collection of sample before using it for another sample. The samples were labeled S1A, S2A, S3A, S4A, and S5A. Each location was then dug within 6 inches diameter up to a depth of 0.5m and samples were also collected in treated 1litre plastic bottles labeled S1B, S2B, S3B, S4B and S5B. The different locations were further dug up to a depth of 1m and samples were also collected, labeled S1C, S2C, S3C, S4C, S5C.

3.1.2 SAMPLING OF GROUNDWATER AND SURFACE WATER

In an effort to investigate the impact of the closed dumpsite on groundwater quality, five sampling sites were selected within 600m from the dumpsite where samples were taken. Details of the sampling point are presented in Table 3.1. Groundwater samples were collected using 1 litre plastic bottles which had been cleaned by soaking in 10% nitric acid and rinsedwith distilled water, at the sampling site as well, the bottles were rinsed three times with groundwater to be sampled prior to filling and the bottles were labeled GW1 to GW5.

For sampling of surface water, five different sampling points were selected along the dumpsite. Surface water samples were collected before the dumpsite labeled SW1, at the beginning of the dumpsite labeled SW2, at the centre labeled SW3, at the end of the dumpsite labeled SW4 and after the dumpsite labeled SW5. In each case, 1 litre plastic bottles which had been treated with 10% nitric acid and rinsed with distilled water were used. At the sampling site, the bottles were rinsed three times with surface water to be sampled prior to filling.

Table 3.1. Site specification for samples

Sample Code	Sampling Locations	Distance from dumpsite (m)	Depth (m)
GW1	Dumpsite	15	-
GW2	Residential	113	18
GW3	Commercial	221	90
GW4	Commercial	446	90
GW5	residential	576	90

3.1.3ANALYTICAL METHOD

After sampling the surface and groundwater, they were quickly transferred to the laboratory and stored in a cold room (4^{o}C). The analysis was started without delay in the laboratory based on the priority to analysis parameters as prescribed by the standard methods for the examination of water and wastewater (APHA, 1992). The analysis of heavy metal concentrations such as Mg, Fe, Pb, Cu, Cr, Ni, Zn, Cd, Na, Mn, K, Ca, and Cl of surface and groundwater samples were determined using atomic absorption spectrophotometer (AAS, Perkin-Elmer Model 2380). pH meter was used for the analysis of pH.

For the analysis of soil samples, the method of Gabriel and Stephen, 2009 was used. The soil samples were first air dried overnight in an oven at 32^{o}C. The dried samples were mechanically ground and sieved through 200 mesh size sieve. Five grams of each sieved sample was placed in an Erlenmeyer flask and 2.5ml of extracting solution (0.05NHCl + 0.024 H_2S0_4) was added after which the mixture was placed in a mechanical shaker for 15 minutes. The resulting solution was filtered through whatmann filter paper into a 50ml volumetric flask and diluted to 50ml with the extraction solution. The treated samples were analyzed for heavy metals using an Atomic Absorption spectrophotometer (AAS, Perkin-Elmer, Model 2380). pHmeter was used for the analysis of pH.

4. RESULTS AND DISCUSSION

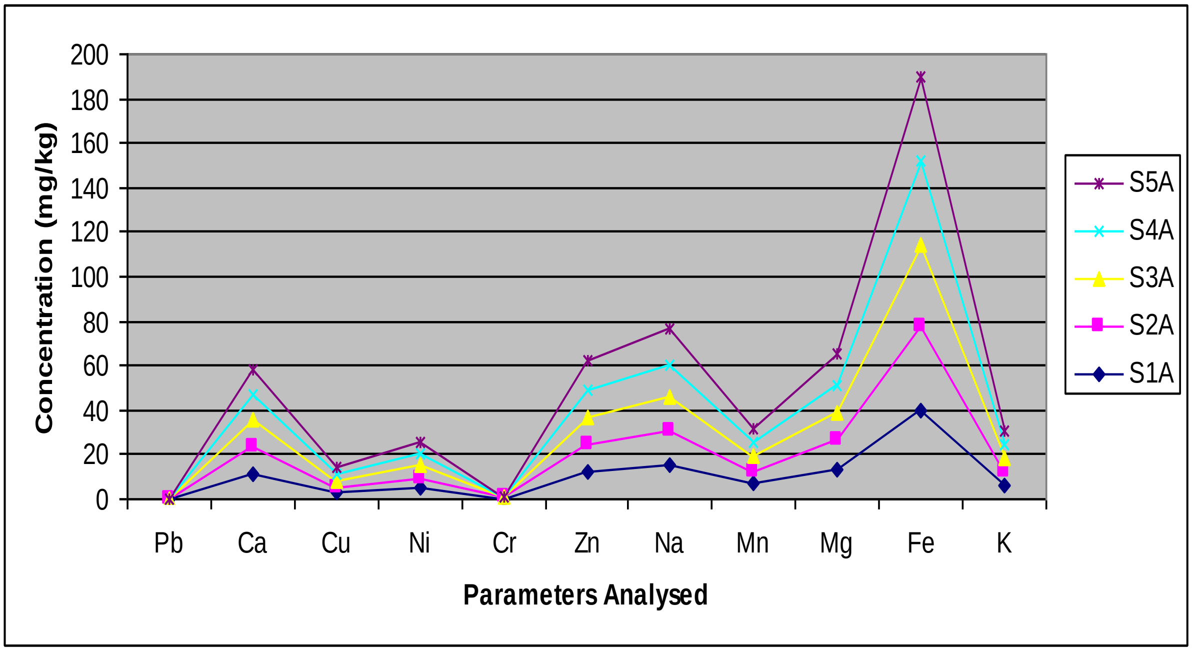

Fig.1.A graph of concentration against parameters analysed at the surface

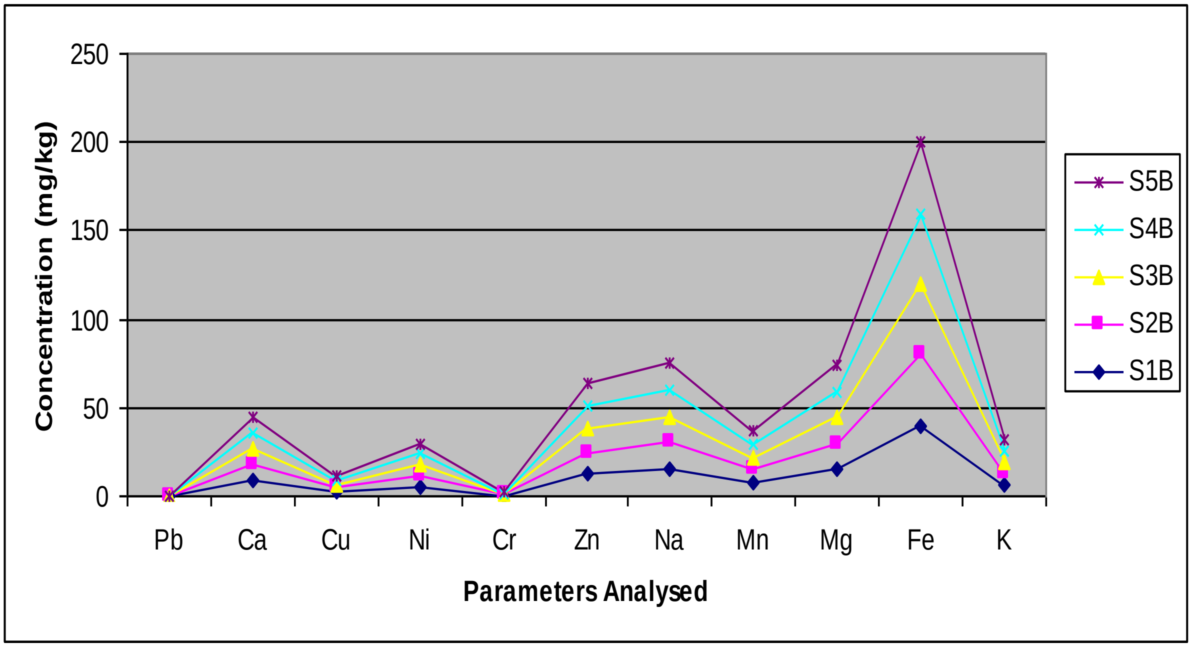

Fig.2. A graph of concentration against parameters analysed at the depth of 0.5m

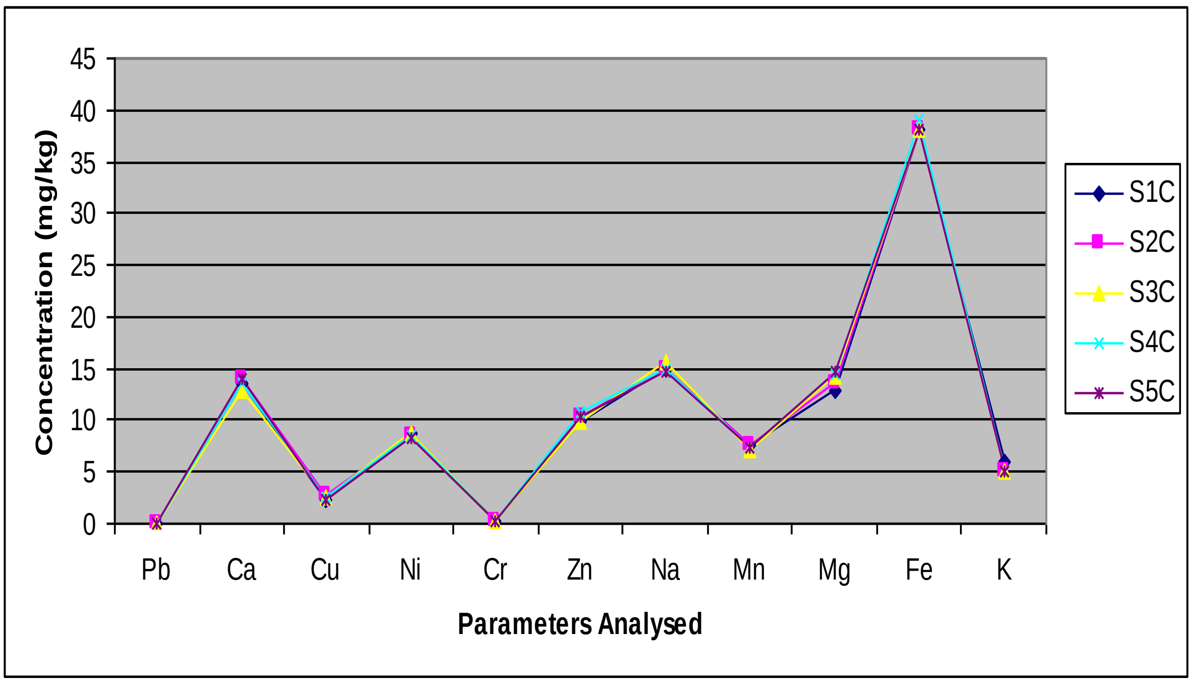

Fig.3. A graph of concentration against parameters analysed at the depth of 1.0m

Table 4.1 and 4.2 showed the characteristics of groundwater and surface water samples respectively while Table 4.6 showed the guideline on drinking water by World Health Organization (WHO) and National Agency for Food and Drug Administration and National Agency for Food and Drug Administration and Control (NAFDAC). Tables 4.3 to 4.5 showed the characteristics of soil samples of OkeAfa dumpsite at the surface, at a depth of 0.5m and at a depth of 0.1m respectively. Figures 1 to 3 showed the concentration of parameters analyzed at the surface, at a depth of 0.5 and at a depth of 1.0m.

In Table 4.1, lead and cadium were not detected which is a likely indication that less industrial and hazardous wastes were dumped in the site. The pH of the groundwater samples fall within the range of 4.99 to 5.67 which revealed that the groundwater samples are slightly acid and did not fall with the stipulated range recommended by World

Health organization and National Agency for Food and Drug Administration and Control. Among all the heavy metals analyzed in the groundwater sample showed in Table 4.1, only chloride did not fall within the range stipulated by the regulatory bodies. The chloride values in the groundwater samples were in the range of 301.96 to 368.51mg/l while the stipulated limit is 200mg/l.
Moreover, it is expected that the concentrations of contaminates should decrease as the distance from the dumpsite increases (Jhamnani and Singh 2009) but there is a deviation in this work as there is no regular pattern in the results Table 4.1. From Table 4.1, the concentration of heavy metals analyzed among the groundwater samples investigated were at the highest in GW5 except for nickel, Iron and potassium. Lead was detected in the soil samples investigated but was not detected in the groundwater samples investigated which is an indication that the closed dumpsite has no serious impact on the groundwater within the vicinity of the dumpsite. In addition, concentrations of parameters analyzed were within the standard limits of the regulatory bodies which further buttress the point that the closed dumpsite has not impacted negatively on the groundwater in the vicinity of the dumpsite.
Table 4.2 presents results of analysis of surface water quality along the Oke-Afa closed dumpsite. The pH values of the surface water samples investigated ranged from 6.16 to 6.24 which revealed that the surface water is less acidic when compare to groundwater samples which had a pH value of 4.99 to 5.67. SW1 which was the surface water samplewhich was the surface water before the dumpsite has a pH value of 6.22 while SW5 which was the surface water sample after the dumpsite has a pH value of 6.16 which is less than the SW1 value. This is a likely indication that the closed dumpsite has no serious impact on the surface water along the dumpsite. Lead and cadmium were not detected among the surface water samples investigated which also support the fact that the closed dumpsite has no negative impact on the surface water along the dumpsite.
In SW1, sodium has the highest value of 0.42mg/l while chromium has the least value of 0.006mg/l among the heavy metasl analyzed. In SW5, sodium also has the highest value of 0.428mg/l while chromium has the least value of 0.006mg/l among the heavy metals analyzed. This revealed that the tread of surface water before the closed dumpsite was also the tread after the closed dumpsite which again buttresses the non impact of the closed dumpsite on the surface water along it. The BOD in SW1 was 3.4.10mg/l while that of SW5 was 32.80mg/l for COD. In SW1, the COD value was 2.40mg/l while it was 2.00mg/l in SW5. This reduction in BOD and COD suggested there was reduction in both the organic and inorganic activities within the surface water along the dumpsite which is good for the surface water.
Table 4.3 to 4.5 presents the characteristics of soil samples of OkeAfa dumpsite at the surface, at a depth of 0.5m and a depth of 1.0m respectively. In Table 4.3, cadmium was not detected which showed that cadmium made up materials were not dump on the site. The pH values ranged from 5.65 to 5.81 which revealed the surface of the dumpsite is slightly acidic. Heavy metals were detected among the soil samples investigated which is an indication that industrial and hazardous materials were dumped on the site. In Table 4.4, cadmium was not detected which is expected since cadmium was not detected at the surface. The pHvalue ranged from 6.20 to 6.81 which were higher than the pH values range at the surface showed in Table 4.3. This pointed out that as we move from the surface to a depth of 0.5m, the pH tends to neural which can be attributed to sorption among the soil particles in the region. In Table 4.6, cadmium was not again detected. The pH values ranged from 4.70 to 4.99 which was less compare to pH value range in Table 4.3 and 4.4. This may be caused by some acidnogenic activities which may have occurred between the depth of 0.5m and 1.0m.
In this work, the pH values of soil samples investigated fall within the acidic region which is different from a similar study carried out in Addis Ababa city of Ethiopia (Hunachew and Sandip, 2011) where the pH values fall within the basic region. Moreover, there is no definite tread for the parameters analyzed for the soil samples as we move from the surface downward. It is expected the concentrations of heavy metals to decrease as move downward the soil profile if sorption, natural attenuation, dilution and chemical transformation occur (Yadav and Jaiswal, 2011; Xiaolicetal., 2007; Okoronkwoetal., 2006; Marijanetal., 1998; Esakkuetal., 2003; Alukoetal., 2003; Adjiaetal., 2008 and Mohammed and Elsayed, 2007) but that is not the case in this present research work. In S1A the concentration of lead was 0.025mg/kg, in S1B, it was 0.05mg/kg while in S1C, it was 0.026mg/kg. Also, in SIA, the concentration of copper was 2.70mg/kg, in SIB, it was 2.225mg/kg while in S1C, it was 2.249mg/kg. These really revealed the irregular pattern of the heavy metals profile in the closed dumpsite. However, it was difficult to compare the values of the parameters analyzed in the soil samples with standard as there is no guideline for soil of closed dumpsite in the country.

Table 4.1. Characteristics of groundwater samples nearby OkeAfa dumpsite

Parameters(mg/l)	GW1	GW2	GW3	GW4	GW5
pH	5.67	4.99	5.01	5.49	5.31
Pb	ND	ND	ND	ND	ND
Cd	ND	ND	ND	ND	ND
Ca	0.286	0.301	0.391	0.298	0.321
Cu	0.011	0.012	0.010	0.009	0.011
Ni	0.006	0.009	0.005	0.004	0.003
Cr	0.001	0.004	0.010	0.009	0.006
Zn	0.064	0.058	0.049	0.076	0.086
Na	0.049	0.053	0.061	0.056	0.049
Mn	0.011	0.016	0.014	0.012	0.010
Mg	0.056	0.052	0.053	0.042	0.059
Fe	0.129	0.102	0.098	0.109	0.122
K	0.046	0.041	0.039	0.036	0.032
Cl	301.96	368.24	310.61	368.51	341.01
BOD	20.900	20.600	19.800	20.000	19.600
COD	1.410	1.680	2.000	1.900	1.400

ND: Not detected Note: pH has no unit

Table 4.2. Characteristics of surface water samples alongOkeAfa dumpsite

Parameters(mg/l)	SW1	SW2	SW3	SW4	SW5
pH	6.22	6.20	6.18	6.24	6.16
Pb	ND	ND	ND	ND	ND
Cd	ND	ND	ND	ND	ND
Ca	0.098	0.146	0.096	0.089	0.128
Cu	0.016	0.014	0.019	0.016	0.014
Ni	0.010	0.009	0.011	0.016	0.014
Cr	0.006	0.004	0.010	0.011	0.006
Zn	0.086	0.089	0.074	0.082	0.096
Na	0.429	0.660	0.541	0.431	0.428
Mn	0.019	0.017	0.017	0.014	0.016
Mg	0.044	0.046	0.039	0.046	0.036
Fe	0.089	0.096	0.128	0.099	0.108
K	0.029	0.023	0.036	0.041	0.023
Cl	641.86	624.16	596.41	601.81	504.46
BOD	34.100	34.600	36.900	34.400	32.800
COD	2.400	1.900	2.460	1.810	2.000

ND: Not detected Note: pH has no unit

Table 4.3. Characteristics of soil samples of OkeAfa dumpsite at the surface

Parameters(mg/kg)	S1A	S2A	S3A	S4A	S5A
pH	5.81	5.70	5.69	5.67	5.65
Pb	0.025	0.029	0.021	0.019	0.028
Cd	ND	ND	ND	ND	ND
Ca	11.53	11.69	12.18	11.59	11.61
Cu	2.700	2.816	2.981	3.001	2.860
Ni	4.650	4.780	5.611	4.990	5.086
Cr	0.275	0.269	0.279	0.271	0.276
Zn	12.400	12.560	11.980	12.390	12.460
Na	15.35	14.98	15.61	14.68	15.46
Mn	6.700	5.996	6.421	6.226	5.981
Mg	13.050	13.025	12.525	12.750	13.525
Fe	39.650	37.475	37.525	37.775	37.800
K	6.100	6.050	6.020	6.000	6.031

ND: Not detected Note: pH has no unit

Table 4.4. Characteristics of soil samples of OkeAfa dumpsite at the depth of 0.5m

Parameters(mg/kg)	S1B	S2B	S3B	S4B	S5B
pH	6.81	6.42	6.39	6.24	6.20
Pb	0.05	0.056	0.049	0.050	0.048
Cd	ND	ND	ND	ND	ND
Ca	8.73	9.14	8.96	9.41	8.98
Cu	2.225	2.318	2.162	2.226	2.249
Ni	5.670	6.025	5.986	6.149	5.881
Cr	0.400	0.398	0.401	0.400	0.397
Zn	12.330	12.460	13.000	12.980	12.640
Na	14.95	15.28	14.68	15.20	14.96
Mn	7.458	7.268	7.541	7.061	7.114
Mg	14.700	14.400	14.975	14.675	14.70
Fe	40.025	40.000	39.975	40.000	40.075
K	6.275	6.358	6.300	6.275	6.375

ND: Not detected Note: pH has no unit

Table 4.5. Characteristics of soil samples of OkeAfa dumpsite at the depth of 1.0m

Parameters(mg/kg)	S1C	S2C	S3C	S4C	S5C
pH	4.99	4.98	4.92	4.74	4.70
Pb	0.026	0.026	0.024	0.022	0.021
Cd	ND	ND	ND	ND	ND
Ca	13.56	13.98	12.91	13.61	14.08
Cu	2.400	2.641	2.582	2.461	2.381
Ni	8.625	8.561	8.636	8.499	8.341
Cr	0.250	0.266	0.268	0.251	0.268
Zn	9.975	10.246	9.894	10.816	10.281
Na	14.975	14.841	15.641	14.981	14.600
Mn	7.500	7.475	7.150	7.300	7.291
Mg	12.775	13.575	14.225	14.450	14.675
Fe	38.075	38.000	38.016	39.001	38.081
K	5.975	5.050	5.100	5.125	5.019
Cl	724.975	725.000	724.650	728.600	731.189

ND: Not detected Note: pH has no unit

Table 4.6. Guideline on drinking water by World Health Organization (W.H.O) and National Agency for Food and Drug administration and Control (NAFDAC)

S/N	Parameters	Maximum Acceptable Concentration by W.H.O mg/l	Maximum Acceptable Concentration by NAFDAC mg/l
1.	Pb	0.01	0.01
2.	Cd	0.003	–
3.	Zn	5.0	5.0
4.	Cu	2.0	–
5.	Ni	–	–
6.	Cr	0.05	–
7.	Fe	0.05 – 0.30	–
8.	Mn	0.5	–
9.	Mg	50	30
10.	Ca	50	75
11.	Na	–	–
12.	K	1.0 – 2.0	10
13.	Cl	200	200

5. CONCLUSION

This research work assessed the closed dumpsite and investigated its impact on the groundwater in the vicinity of the closed dumpsite and surface water along the closed dumpsite. The groundwater analysis revealed that the concentrations of the analysed parameters fall within the guideline for drinking water by World Health Organisation and National Agency for Food and Drug administration and Control. The surface water analysis indicated that the closed dumpsite has no serious effect on the surface water by comparing the analysis of the surface water samples before and after the dumpsite. For soil of the dumpsite, there was a scarcity of standard for comparison. The analysis of the soil samples investigated showed they were slightly acidic which differ from a similar study carried out in Ethiopia which revealed the soil samples were basic. The concentrations of analysed parameters did not follow a definite pattern for samples of soil, surface and groundwater investigated which is also in line with the similar study carried out in Ethiopia.

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