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Investigating groundwater quality around Olusosun dumpsite, Lagos State, Nigeria

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Abstract

Olusosun dumpsite, established in 1992 and reputed to be one of Africa's largest open dumps covering an area of 42 hectares, is situated at Ojota in Kosofe Local Government Area (LGA) of Lagos State, Nigeria. Originally, the dumpsite was located on the outskirts of the Lagos metropolis, but due to rapid urban development, the site is now surrounded by residential, commercial and industrial suburbs. Established literature has indicated that water borne diseases such as typhoid, dysentery, fatigue and cholera are amongst the ailments mostly suffered by inhabitants within the vicinity of the dumpsite. Groundwater quality was investigated around Olusosun dumpsite, Lagos State, Nigeria, by collecting nineteen representative water samples from sixteen wells and three boreholes, and a leachate sample from the landfill. The samples were examined in the laboratory for physical, chemical and bacteriological analyses using standard laboratory procedures. The obtained values of concentration of key parameters in all sampled wells were plotted against distances from the Olusosun dumpsite, in scatter diagrams. Unexpectedly, the concentration did not follow any attenuation pattern, with increasing distance up to the farthest sampled well. It is implied from the outcome of the exercise that there are other contributory sources to the pollution of groundwater in the area, which must be discovered. An immediate solution to the groundwater pollution in the area is thus complex, and may require a more drastic and holistic approach. It is therefore recommended that in the interim, the Lagos State Government of Nigeria should urgently provide an alternative source of water supply towards meeting the immediate water needs of inhabitants of the area, while adopting a pragmatic approach to remediate the problem. This will go a long way in reducing the prevalence of waterborne diseases around Olusosun dumpsite.
Keywords: Dumpsite, Groundwater, Landfill, Leachate, Concentration, Pollution.

1.Introduction

The Olusosun dumpsite, according to Manhart (2011), was established in 1992. It is reputed as one of Africa's largest dumpsites comprising an area of around 42 hectares. Figure 1 depicts the major dumpsites in Lagos State, with Olusosun dumpsite indicated. A quantity of 2,400 metric tonnes, equalling 40% of the waste of the city of Lagos, is brought to the dumpsite every day. Roughly 1,000 simple homes have been built on Olusosun – the residents, mainly informal collectors and recyclers, collect and process scrap from the dumpsite and sell it to dealers. There are several chains of businesses on Olusosun. One section of the site is devoted to sorting out bits and pieces of refuse, focussing on all, plastics, metals, glass and other materials. The useful plastics are thoroughly washed up and packed in bags to be sold to the highest bidder, while the damaged pieces are neatly folded to be grinded into small bits. The crushed plastics are also packaged into bags, ready to be sold off to would-be buyers. As the municipal waste stream of the city of Lagos contains significant amounts of e-waste, e-waste is also collected, dismantled and sold by the community. The acrid smell, the constant combustion, the smoke spiralling to the sky and the reduced visibility only reminds you of one place: Olusosun dumpsite. This is the daily scenario at the dumpsite that sits meters away from the Lagos-Ibadan Expressway. The dumpsite, which initially was located on the outskirts of Lagos metropolis, is now surrounded by residential, commercial and industrial surburbs, due to rapid urban development. Oyelola et. al. (2011), assessed the occupational health hazards of solid waste on Olusosun dumpsite residents, and presented the percentage respondents suffering from different

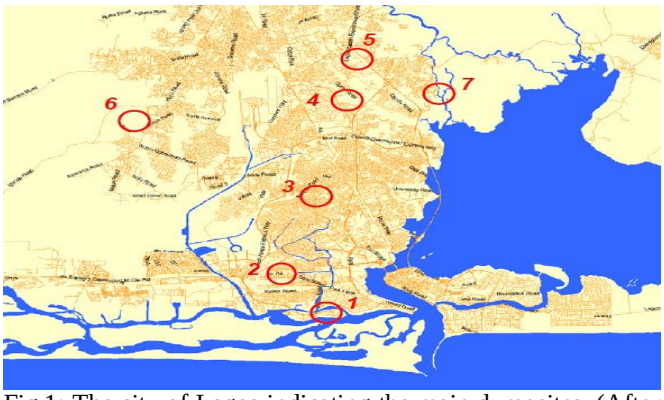

Fig.1: The city of Lagos indicating the main dumpsites. (After Manhart et. al., 2011). 1 = Westminster Market, 2 = Alaba Market, 3 = Lawanson Market, 4 = Ikeja Computer Village 5 = Ojota Scrap Market 6 = Solous Dumpsite

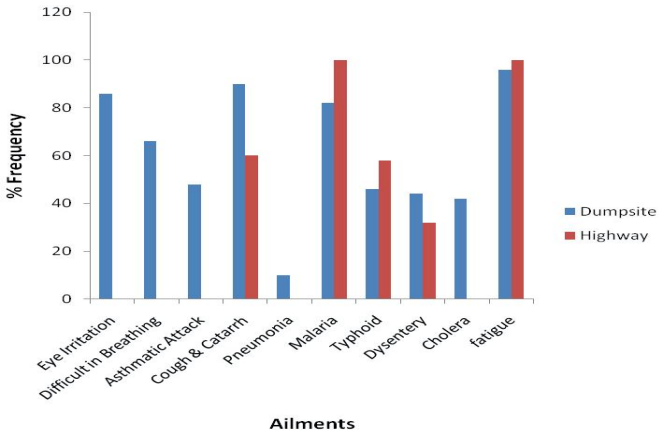

Fig. 2: Percentage of respondents with different ailments (After Oyelola et. al., 2011)

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ailments, as shown in (Fig. 2).

Many authors have worked on the deleterious effects of dumpsites in Lagos State and other parts of the world, including: Medina (1977); Leton and Nweke (2003); Brash (1996); Bhide and Sundaresan (1984) and Goldberg (1995). The present study involved the collection of leachate sample and ground water samples in the vicinity of the landfill for physical, chemical and bacteriological analyses to determine the extent of contamination of groundwater resources with increasing distance from the Olusosun dumpsite.

2. Methodology

Groundwater samples were collected from neighborhood wells down-gradient of the Olusosun landfill, in the direction of groundwater flow. Availability and accessibility of wells played a major role in the selection of number and location of sampled wells. Most wells in the vicinity have motorized pumps installed in them with well-head protection. A total of 16 wells, 3 boreholes and leachate from Olusosun dumpsite were sampled and examined for physical and chemical and biological analyses, using standard procedures, within 24hrs. The representative water samples and leachate sample were taken from the locations presented in Table 1, below.

Table 1: Reference numbers of sampled locations

Reference Number Used	Coded Number (BH=Borehole; WL=Well; LCH=Leach ate	Sampling Location/Address (No.=Number)
1	BH 09	No. 19, Kujore street Ojota
2	WL30	No. 24, Olabisi street Ojota
3	WL 35	No. 12 ,Abebi street Ojota
4	WL 41	No. 15, Ogunleye street Ojota
5	BH 05	No. 9, Oyebola street Ojota
6	WL 22	No. 7, Ayinde Street Off Ogudu Road Ojota
7	WL 10	No. 8, Olusosun Street Off Oregun Road Ojota
8	WL 25	No. 3, Asiata Solarin Crescent Off Oregun Road, Ojota
9	WL 15	No. 9, Taiwo Street Off Ogudu Road Ojota
10	BH 07	No. 2A, Oregun road, Olusosun
11	WL 04	No. 21, Ogunleti Street Ojota
12	WL 64	No. 30, Olatunji Street Ojota
13	WL 40	No. 65, Kujore Street Ojota
14	WL 08	No. 15, Aina Street Ojota
15	WL 23	No. 3, Taiwo Street Off Ogudu Road Ojota
16	WL 05	Ojota Mechanic Village
17	WL 43	No. 30, Aina Street Ojota
18	WL 52	No. 3, Emmanuel Street Ojota
19	WL 27	Ojota Bus Garage Adjacent to Total Filling Station
20	LCH Olusosun	Leachate from Olusosun Dumpsite

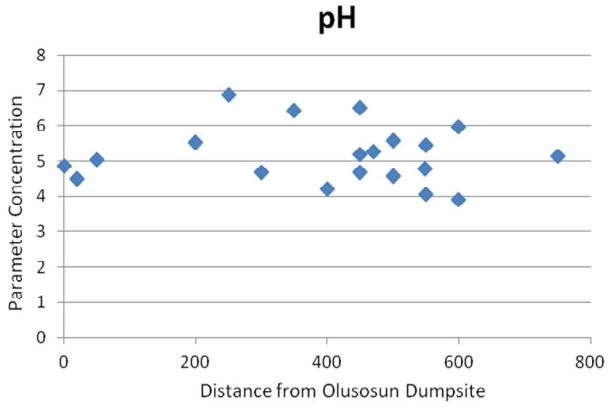

Fig. 3: Scatter diagram of distance travelled with concentration of pH

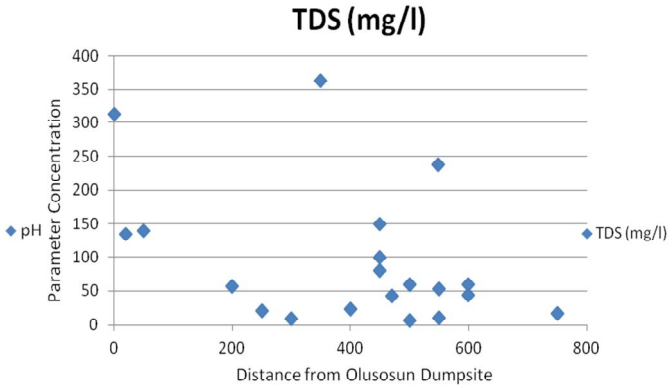

Fig 4: Scatter diagram of distance travelled with Concentration of TDS

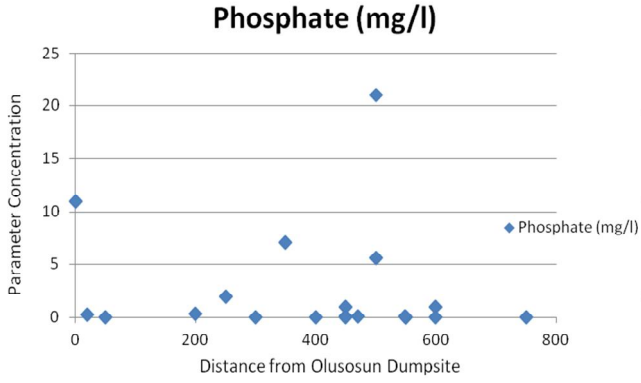

Fig. 5: Scatter diagram of distance travelled with concentration of TDS.

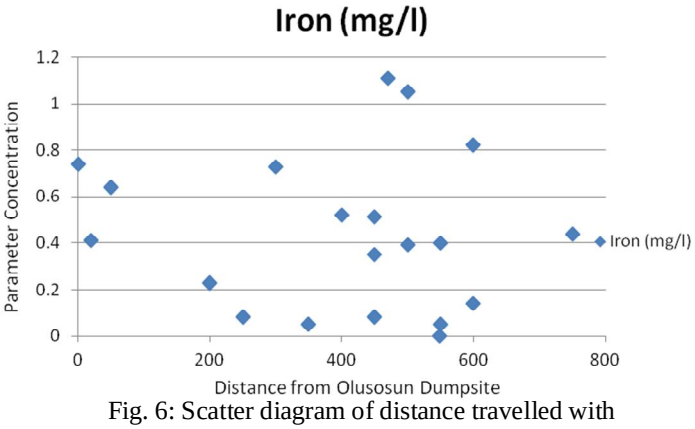

Fig. 6: Scatter diagram of distance travelled with concentration of TDS

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3. Results and Discussion

The results of the physical, chemical and biological analyses carried out on Olusosun leachate sample and the water samples from wells and boreholes around the landfill are presented in Tables 2, 3, and 4, respectively. The results were compared with the World Health Organisation (WHO) drinking water standard. Five (5) out of the parameters, namely: pH; Total dissolved solids (TDS); total suspended Solids (TSS); Phosphate; Iron and Chloride, were selected as indicators to investigate the extent of migration of pollutants with distance travelled from Olusosun dumpsite to sampled locations. The results compiled for all the twenty (20) sampled locations are provided in Table 5. The scatter diagrams of distance travelled with concentration of selected parameters are depicted in Fig. 3 to 7.

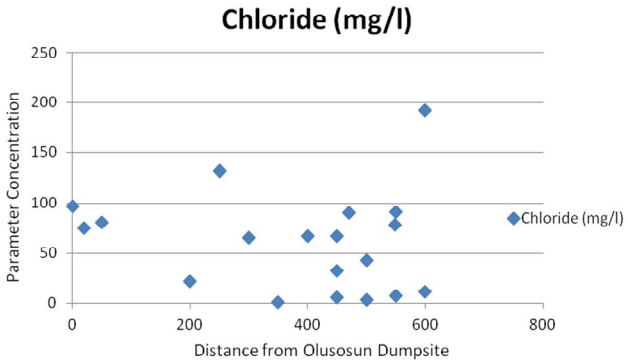

Fig.7: Scatter diagram of distance travelled with concentration of TDS

Unexpectedly, the concentration of parameters did not follow any attenuation pattern, with increasing distance up to the farthest well. It is implied from the outcome of the exercise that there are other contributory sources to the pollution of groundwater in the area, which must be discovered. An immediate solution to the groundwater pollution in the area is complex, and may require a more drastic and holistic approach.

4. Conclusions and recommendation

The following conclusions are drawn from the present study:

(i) Trace elements of pollution from leachate emanating from Olusosun dumpsite were found in most of the sampled locations in the vicinity.

(ii) The results of physical, chemical and biological analyses confirm the observation in Oyelola et. al. (2011), that inhabitants of the area were suffering from ailments, among others, related to exposure to contaminated groundwater from leachates from the Olusosun dumpsite.

(iii) The scatter diagrams of concentration of selected parameters with distance indicate unexpectedly, that the concentration did not follow any attenuation pattern, with increasing distance up to the farthest sampled well.

(v) It is implied from the outcome of the exercise that there are other contributory sources to the pollution of groundwater in the area, which must be investigated.

It is recommended that in the interim, the Lagos State Government of Nigeria should urgently provide an alternative source of water supply towards meeting the immediate water needs of inhabitants of the area, while adopting a pragmatic approach to remediate the contaminated groundwater. This will go a long way in reducing the prevalence of waterborne diseases around Olusosun dumpsite.

Table. 2: Physical analysis of Water samples

Sample	Appearance	Odour	Temp. ^0C	Turbidity	pH	Electrical Conductivity ($mscm^{-1}$)	Total Solids (mg/l)	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)
1	Colourless	Odourless	34	Clear	5.58	0.015	63	4	59
2	Colourless	Odourless	32	Clear	5.19	0.083	82	2	80
3	Colourless	Odourless	30.2	Clear	6.43	0.101	369	6	363
4	Colourless	Odourless	28	Clear	5.98	0.045	53	9	44
5	Colourless	Odourless	31	Clear	6.50	0.058	150	0	150
6	Colourless	Odourless	27.3	Clear	5.44	0.076	13	3	10
7	Colourless	Odourless	27.2	Clear	5.52	0.162	61	4	57

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8	Yellow Tint	Odour	29.9	Clear	6.88	1.336	29	8	21
9	Colourless	Odourless	31	slightlyturbid	4.55	0.101	7	0	7
10	Brownish	Odour	30.5	Has Particles	4.87	0.876	334	21	313
11	Colourless	Odourless	30.4	Clear	4.68	0.418	18	19	9
12	Colourless	Odourless	29.2	Clear	4.22	0.407	29	6	23
13	Colourless	Odourless	30.2	Clear	4.06	0.584	103	5	53
14	Colourless	Odourless	30.4	Clear	3.90	0.123	92	32	60
15	Colourless	Odourless	29.4	Clear	5.27	0.580	53	10	43
16	Colourless	Odourless	30.6	Clear	4.77	0.501	250	12.5	237.5
17	Colourless	Odourless	30.7	Clear	4.50	0.480	150	15	135
18	Colourless	Odourless	28.8	Clear	4.69	0.430	120	20	100
19	Colourless	Odourless	30.9	Clear	5.14	0.550	19	2.5	16.5
20	Colourless	Odourless	30.6	Clear	5.03	0.518	150	10.2	139.2
WHO Standard	Colourless	Odourless	35 - 40	Clear	6 - 8	1.0	1000	10	500

Table 3: Chemical analysis of water samples

Parameters	**WHO Std.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Total Acidity	**NS**	11	10	15	9	12	21	32	94	63	140	19	10	8	52	31	25	15	9	19	30
TotalAlkalinity (mg/l)	**200**	20	50	15	20	55	25	20	115	10	54	170	9	10	0	25	15	10	9	34	17
TotalHardness (mg/l)	**100**	6	12	18	12	20	10	11	210	50	76	330	160	150	200	360	300	145	155	400	325
Chloride (mg/l)	**250**	3	6	1	11	32	7	22	132	43	97	65.31	62.66	91.25	192	90.46	78.28	75.47	67.03	85.16	80.5
Nitrates (mg/l)	**10**	1	9	1.1	2.4	5.9	4.2	6.8	0.7	9.3	6.4	0.33	0.21	0.32	0.21	0.12	0.21	0.12	0.31	0.22	0.21
Phosphates (mg/l)	**5**	5.6	0.06	7	1.01	1	0.04	0.34	1.93	21	11	0.04	0.01	0.03	0.02	0.01	0.05	0.21	0.03	0.03	0.04
Dissolved O_2 (mg/l)	**2**	2.74	3.8	3.09	3.14	3.65	2.94	3.14	2.1	4.3	1.98	7.37	3.65	3.96	4.4	4.47	4.27	5.08	9.14	3.35	4.78
Sulphates (mg/l)	**250**	0.09	1.08	0.31	0	10	6	0	40	28	54	21.77	20.88	30.42	64	30.15	26.09	25.15	22.34	28.39	26.76
Zinc (mg/l)	**1**	0.08	1.05	0.03	0.12	0.22	0.41	0.39	0.08	0.18	0.34	0.03	0.05	0.4	0.15	2	0.85	1.75	1.55	0.1	0.25
Iron (mg/l)	**0.3**	1.05	1.08	0.05	0.14	0.35	0.05	0.23	0.08	0.39	0.74	0.73	0.52	0.4	0.82	1.11	ND	0.41	0.51	0.44	4.8
Mercury (mg/l)	**0.001**	ND	ND	ND	ND	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead (mg/l)	**0.001**	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium (mg/l)	**0.01**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.76	0.95	1.67	0.34	0.85	0.2	1.13	0.74	1.03	0.3

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Table 4: Biological analysis of Water samples			
Sample	Total Plate Count	Total Coliform count	Confirmation Faecal Coliform test
1	>100	Nil	+ve
2	Nil	0	-ve
3	Nil	>2400	+ve
4	54	34	+ve
5	49	65	+ve
6	75	20	+ve
7	>100	67	+ve
8	0	NIL	-ve
9	40	Nil	-ve
10	>100	>2400	+ve
11	>100	Nil	-ve
12	Nil	1	-ve
13	Nil	8	-ve
14	54	8	-ve
15	49	Nil	-ve
16	75	5	-ve
17	>100	6	-ve
18	0	2	-ve
19	40	2	-ve
20	Nil	3	+ve
WHO Standard	100fcu/ml	Nil	-ve

Table 5: Landfill pollutants related to distance from wells							
Samples	Distance	pH	TDS (mg/l)	TSS (mg/l)	Phosphate (mg/l)	Iron (mg/l)	Chloride (mg/l)
Leach ate	0	4.87	313	21	11	0.74	97
1	500	5.58	59	4	5.6	1.05	3
2	450	5.19	80	2	0.06	0.08	6
3	350	6.43	363	6	7	0.05	1
4	600	5.98	44	9	1.01	0.14	11
5	450	6.5	150	0	1	0.35	32
6	550	5.44	10	3	0.04	0.05	7
7	200	5.52	57	4	0.34	0.23	22
8	250	6.88	21	8	1.93	0.08	132
9	500	4.58	7	0	21	0.39	43
10	300	4.68	9	9	0.04	0.73	65.3
11	400	4.22	23	6	0.01	0.52	66.7
12	550	4.06	53	50	0.03	0.4	91.3
13	600	3.9	60	32	0.02	0.82	192
14	470	5.27	43	10	0.07	1.11	90.5
15	549	4.77	237.5	12.5	0.05	0	78.3
16	20	4.5	135	15	0.21	0.41	75.5
17	450	4.69	100	2	0.03	0.51	67
18	750	5.14	16.5	2.5	0.03	0.44	85.2
19	50	5.03	139.2	10.2	0.04	0.64	81

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