IMPACT OF LEMNA DUMPSITE ON GROUND AND SURFACE WATER QUALITY IN LEMNA DISTRICT, CALABAR MUNICIPALITY LOCAL GOVERNMENT AREA, CROSS RIVER STATE – NIGERIA

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ABSTRACT
This study examined the impact of leachate on ground and surface water quality in Lemna District of Calabar Municipality in Cross River State – Nigeria. Water samples were collected from both surface and groundwater source for physico-chemical and bacteriological analysis. The results showed the mean values of the measured parameters to be: pH = 6.2, Electrical conductivity = 63.38, temperature = 24.43, BOD_5 = 1.08, Do = 5.35 and Zinc = 0.08. Others were coliform = 166.00, turbidity 24.50, lead 0.097 and total hardness = 30.73. The statistical analysis revealed significant differences between the measured parameter of BOD, Do, coliform, zinc, iron, turbidity, potassium, nitrate, copper, total hardness and sodium and the WHO minimum permissible standards for the above measured variables. It was concluded that surface and groundwater in the study area has been significantly affected by leachate. It was recommended that open dumpsite should be sited away from streams and groundwater aquifers that are used for domestic purposes.

Keywords: Open dumpsite, municipality, leachate, contamination, treatments

INTRODUCTION

Water is a highly valuable but finite natural resource, on which all life depends for survival. All faces of the hydrological cycle are utilized by man for multifarious purposes such as for his survival and comfort, in domestic and commercial water supplies, agricultural production, fishing, energy generation, and transportation, industrial and recreational activities. However, many factors including population pressure, rapid urbanization and social-economic development have interfered with or impaired the life supporting characteristics and capacity of water for beneficial uses to the present and future generations and mankind (Eze and Abua 2003 and Abua and Ajake 2014).

The inability of government to holistically manage solid waste in lemna open dumpsite has resulted to the contamination of ground and surface water quality around the study area through the infiltration of leachate from waste. Waste if not properly managed can lead to the contamination of surface and ground water quality and its surroundings. Open dumpsite is a land where, household wastes and debris from the streets are dumped. It is also a disposal site where wastes from industries and markets are indiscriminately disposed without good environmental safety measures.

In recent times, due to the increasing demand for potable water, there is an upsurge in the construction of boreholes by individuals. This situation is caused by inability of government to supply potable water to the people. The poor supply of potable water has led to the indiscriminate sinking of boreholes by private individuals in the area as a way to meet the increasing water needs of the people. Unfortunately, water from these boreholes is pumped and sold to the people for drinking and other household uses without any form of treatment (Ebin, 2016).

Leachate has adverse impact on ground and surface water quality as well as on living beings. It contains high level of organic, inorganic, heavy metals and xenobiotics which peculates through the sub-soil and contaminate the ground and surface water quality. Leachate are composed of organic and inorganic substances that consist of micro-organisms and their metabolic product and materials from living organisms which are undergoing decay and it consist of ammonium, phosphorous, sulphate and metals. Leachate generation is a major problem.

Improper and indiscriminate disposal of municipal solid waste and effluents has led to innumerable environmental disquiet such as water, air and soil pollution (Inah, Obiefuna, Eteng, Iwuanyanwu and Bello, 2022; Obiefuna, Njar and Bisong, 2021a; Obiefuna, Inah, Atsa, and Etim, 2021b; Eni, Onithebor, Uquetan, Obiefuna, Asor, and Egbonyi, 2023). This needs immediate attention to reduce impact of municipal solid waste on environment and health (Rish, Rajiv and Ashok, 2016). Leachate is a contaminated liquid that is generated from water percolating through a solid waste disposal site, accumulating contaminants, and moving into subsurface areas.

The present study examined the impact of leachate on ground and surface water quality in Lemna open dumpsite in Calabar

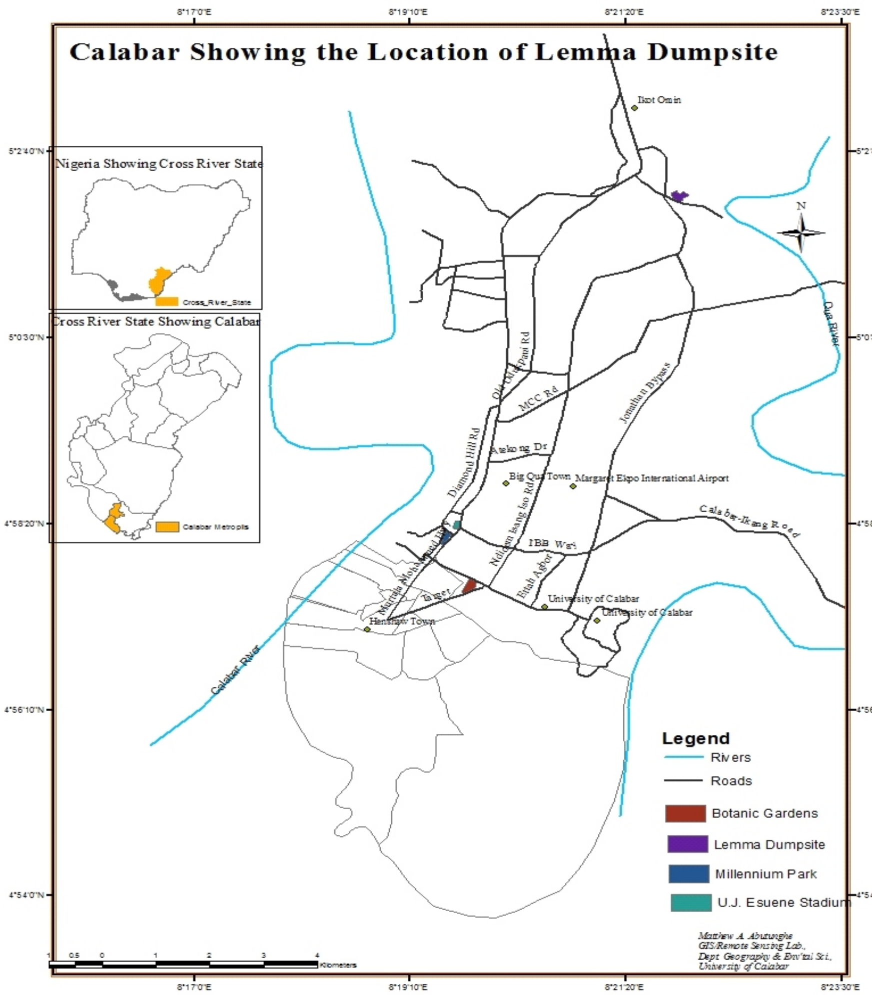

Figure 1. Dumpsites in the Study Area

Municipality, Cross River State, Nigeria. The main aim of the study is to examine the extent of surface and groundwater pollution due to leachate percolation from Lemna open dump site.

MATERIAL AND METHODS

The study was carried out in Lemna, a community found in Calabar Municipality Local Government Area. It is situated between Latitudes 5.0340302^0 & 5.036451^0 and Longitude 8.365722^0 & 8.365442^0. The area has an open and extensive landfill where all forms of wastes are dumped. The Lemna open dumpsite is approximately 6 square meters and the dumpsite has been in existence since 1999 and the dump contains household wastes and a mixture of wastes.

Plate 1: Lemna waste dumpsite

Plate 2: Direction of leachate to water bodies

Plate 2: Lemna waste dump

PROCEDURE OF DATA COLLECTION

The study proceeded with a reconnaissance survey to the study area, through which a stream close the dumpsite was identified and water samples were collected from the upper and the middle courses as prescribe by America Public Health APHA (2005), the stream was chosen because of the regular use by inhabitants for domestic use and the closeness of the stream and the boreholes to the flow of leachate down the stream. The water samples were collected during the rainy season May, June and July 2019 and dry season, October, November and December 2019. A composite method of sampling was adopted to make a total of twelve sampling points in both the upper and the middle courses. And two samples were collected from two different boreholes in the study area. Prior to the samples collection, the plastic bottles were washed with diluted Nitric acid and rinsed with distilled water and then dry the bottles and then rinsed with the water to be collected, the water samples were collected and the samples bottles were labeled with date and sources respectively and taken to University of Calabar Oceanography laboratory in a cold box of 4^0C temperature for analysis of physic-chemical and biotechnological parameters and some parameters where measured in-situ like turbidity, temperature, conductivity, Do and PH.

RESULTS

The water quality parameters for surface and ground water quality and acceptable values of World Health Organization (WHO) are presented in Table 1, 2 and 3 respectively.

TABLE 1

T-test difference between W.H.O standard and dry season water quality samples of surface water in Lemna open dumpsite in Calabar Municipal

	sample1	N	Mean	Std. Deviation	Std. Error Mean	t	Sig. (2-tailed)	Remarks
Ph	W.H.O standard	1	6.5000	.	.			Not
	dry season	6	6.2000	.55321	.22585	.502	0.637	Significant
Conductivity	W.H.O standard	1	1.000	.	.			Not
	dry season	6	63.383	23.2941	9.5098	-2.4709	0.056	Significant
Temperature	W.H.O standard	1	25.000	.	.			Not
	dry season	6	24.433	.8189	.3343	.641	0.550	Significant
Bod	W.H.O standard	1	6.000000	.	.			Not
	dry season	6	1.083333	.5706721	.2329759	7.976	0.000	Significant
do	W.H.O standard	1	309.000000	.	.			
	dry season	6	5.350000	.6252999	.2552776	449.585	0.000	Significant
coliform	W.H.O standard	1	.00	.	.			
	dry season	6	166.00	38.262	15.620	-4.017	0.010	Significant
zinc	W.H.O standard	1	3.000000	.	.			
	dry season	6	.076000	.0113842	.0046476	237.794	0.000	Significant
iron	W.H.O standard	1	.300000	.	.			
	dry season	6	.085167	.0262406	.0107127	7.580	0.001	Significant
turbidity	W.H.O standard	1	5.00	.	.			
	dry season	6	24.50	3.017	1.232	-5.985	0.002	Significant
potassium	W.H.O standard	1	12.000000	.	.			
	dry season	6	.574500	.2179686	.0889853	48.530	0.000	Significant
nitrate	W.H.O standard	1	50.000000	.	.			
	dry season	6	.004000	.0020976	.0008563	226066.605	0.000	Significant
copper	W.H.O standard	1	1000.000000	.	.			
	dry season	6	.041833	.0119066	.0048608	77753.755	0.000	Significant
total harsdness	W.H.O standard	1	600.000000	.	.			
	dry season	6	30.733333	16.7554966	6.8404028	31,455	0.000	Significant
sodium	W.H.O standard	1	200.000000	.	.			
	dry season	6	1.594000	.6177475	.2521944	297.352	0.000	Significant
lead	W.H.O standard	1	.010000	.	.			
	dry season	6	.097500	.0398836	.0162824	-2.031	0.098	Not Sig.
manganese	W.H.O standard	1	.100000	.	.			
	dry season	6	.162000	.2842147	.1160302	-202	0.848	Not Sig.

Source: Author, 2019

Result in table 1 shows the significant difference of WHO standard and dry season surface water quality samples for BOD (7.976) DO (449.585) coliform (-4.017) zinc (237.794) Iron (7.580) turbidity (-5.985) potassium (48.530) Nitrate (22066.605) Copper (77753.755) Total hardness (31.455) Sodium (297.352) lead (-2.031) and manganese (-202).

TABLE 2

T-test differencebetween W.H.O standard and rainy season water quality samples of surface water in Lemna open dumpsite in Calabar Municipal

	samples	N	Mean	Std. Deviation	Std. Error Mean	t	Sig. (2-tailed)	Remark
ph	W.H.O standard	1	6.5000	.	.			Not
	rainy season	6	6.1000	.52356	.21374	.707	.511	Significant
conductivity	W.H.O standard	1	1.000	.	.	.	.	
	rainy season	6	56.817	6.8572	2.7995	-7.536	.001	Significant
temperature	W.H.O standard	1	25.000	.	.	.	.	Not
	rainy season	6	25.867	1.2094	.4937	-.663	.536	Significant
bod	W.H.O standard	1	6.000000	.	.	.	.	
	rainy season	6	1.200000	.6752777	.2756810	6.581	.001	Significant
do	W.H.O standard	1	309.000000	.	.	.	.	
	rainy season	6	4.966667	.2503331	.1021981	1124.422	.000	Significant
coliform	W.H.O standard	1	.00	.	.	.	.	
	rainy season	6	150.67	41.283	16.854	-3.379	.020	Significant
zinc	W.H.O standard	1	3.000000	.	.	.	.	
	rainy season	6	.069000	.0109727	.0044796	247.303	.000	Significant
iron	W.H.O standard	1	.300000	.	.	.	.	
	rainy season	6	.048433	.0282932	.0115507	8.232	.000	Significant
turbidity	W.H.O standard	1	5.00	.	.	.	.	Not
	rainy season	6	16.50	2.881	1.176	-3.696	.014	Significant
potassium	W.H.O standard	1	12.000000	.	.	.	.	
	rainy season	6	.600167	.1678242	.0685139	62.888	.000	Significant
nitrate	W.H.O standard	1	50.000000	.	.	.	.	
	rainy season	6	.013833	.0024014	.0009804	19271.433	.000	Significant
copper	W.H.O standard	1	1000.000000	.	.	.	.	
	rainy season	6	.054833	.0096212	.0039278	96222.243	.000	Significant
total harsdness	W.H.O standard	1	600.000	.	.	.	.	
	rainy season	6	21.250	7.3560	3.0031	72.841	.000	Significant
Sodium	W.H.O standard	1	200.000000	.	.	.	.	
	rainy season	6	2.539667	2.1065137	.8599806	86.785	.000	Significant
Lead	W.H.O standard	1	.010000	.	.	.	.	Not
	rainy season	6	.090500	.0375007	.0153096	-1.987	.104	Significant
manganese	W.H.O standard	1	.100000	.	.	.	.	
	rainy season	6	.040667	.0198461	.0081021	2.768	.039	Significant

Source: Author, 2019

Table 2 above shows the results of the significant difference of WHO standard and rainy season water quality sample analysis for conductivity (-7.536) BOD (6.581) DO (1124.422) Coliform (-3.379) Zinc (247.303) Iron (8.232) turbidity (-3.696) potassium (62.888) Nitrate (19271.433) Copper (96222.243) total hardness (72.841) sodium (86.785) and manganese (2.768).

TABLE 3

T-test difference between W.H.O standard and ground water quality samples of surface water in Lemna open dumpsite in Calabar Municipal

	sample2	N	Mean	Std. Deviation	Std. Error Mean	t	Sig. (2-tailed)	Remark
Ph	W.H.O Standard	1	6.5000	.	.			
	BW sample	2	5.1750	.03536	.02500	30.600	.021	Significant
Copper	W.H.O Standard	1	1000.000000	.	.	.	.	
	BW sample	2	.056500	.0077782	.0055000	104966.845	.000	Significant
Temperature	W.H.O Standard	1	25.000	.	.	.	.	Not
	BW sample	2	27.700	1.1314	.8000	-1.949	.302	Significant
Bod	W.H.O Standard	1	6.000000	.	.	.	.	Not
	BW sample	2	28.752000	4.4561869	3.1510000	-4.169	.150	Significant
Do	W.H.O Standard	1	309.000000	.	.	.	.	
	BW sample	2	1.972500	.6399316	.4525000	391.740	.002	Significant
f.coliform	W.H.O Standard	1	.00	.	.	.	.	
	BW sample	2	183.50	13.435	9.500	-11.152	.057	Significant
Zinc	W.H.O Standard	1	3.000000	.	.	.	.	
	BW sample	2	.077500	.0035355	.0025000	674.922	.001	Significant
Iron	W.H.O Standard	1	.300000	.	.	.	.	
	BW sample	2	.078000	.0042426	.0030000	42.724	.015	Significant
Turbidity	W.H.O Standard	1	5.00	.	.	.	.	
	BW sample	2	19.50	.707	.500	-16.743	.038	Significant
Potassium	W.H.O Standard	1	12.000000	.	.	.	.	
	BW sample	2	.568000	.0664680	.0470000	140.431	.005	Significant
Nitrate	W.H.O Standard	1	50.000000	.	.	.	.	
	BW sample	2	.012500	.0035355	.0025000	11544.119	.000	Significant
t.hardness	W.H.O Standard	1	600.000	.	.	.	.	
	BW sample	2	32.450	1.4849	1.0500	312.072	.002	Significant
Sodium	W.H.O Standard	1	200.000000	.	.	.	.	
	BW sample	2	1.866500	.9128749	.6455000	177.215	.004	Significant
Lead	W.H.O Standard	1	.010000	.	.	.	.	Not
	BW sample	2	.012500	.0007071	.0005000	-2.887	.212	Significant
Manganese	W.H.O Standard	1	.100000	.	.	.	.	Not
	BW sample	2	.059000	.0042426	.0030000	7.890	.080	Significant

Source: Author, 2019

The computed results of table 3 above shows a significant difference of WHO standard and ground water (Gw1 & Gw2) quality samples in the study area of pH at (30.600) copper (104966.845) DO (391.740) Zinc (674.922) iron (42.724) turbidity (-16.743) potassium (140.431) nitrate (11544.119) total hardness (312.072) and sodium (177.215).

DISCUSSION OF FINDINGS

The findings of this research are in consonance with the work of Eja and Ebin (2016) who work in Ugep on evaluating the activities of festival on surface water quality, and Rishi, Rajiv and Ashok (2016) who work on the impact of leachate from non-engineered landfill sites on groundwater quality in Northern India.

From findings, electrical conductivity = 63.38, temperature = 24.43, BOD5 = 1.08, Do = 5.35 and Zinc = 0.08. Furthermore, others were coliform = 166.00, turbidity 24.50, lead 0.097 and total hardness = 30.73. The statistical analysis revealed significant differences between the measured parameter of BOD, Do, coliform, zinc, iron, turbidity, potassium, nitrate, copper, total hardness and sodium and the WHO minimum permissible standards for the above measured variables. These mean that surface and groundwater in the study area has been significantly affected by leachate, giving credence to Obiefuna and Obiefuna (2023), who ascertained that there is a correlatioon between solid waste management techniques and the quality of water, air or land environment attainable in any environment.

CONCLUSION

The study examined the impact of leachate on ground and surface water quality in

Lemna District of Calabar Municipality Local Government Area in Cross River State, Nigeria and the results of the physico-chemical and bacteriological analysis show that open dumpsite has discharge leachates on both ground and surface water quality that makes the stream and ground water (borehole) unfit for direct human consumption and the contamination shows higher in rainy season due to rainfall that enhance speedy movement of leachate to the water bodies. We recommended that open dumpsite leachate should be treated before is accelerated to water bodies either surface or ground water quality and government should ensure palliative measures to protect surface and ground water quality around the study area and open dumpsite should be sited far away from standard streams and human inhabitance and also leachates samples should be sampled for treatment before it will be drained into streams and infiltrate into groundwater quality.

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