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CHARACTERIZATION OF MATERIALS FROM PORT-HARCOURT WASTE DUMPSITES

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ABSTRACT

The leachate quality from the two major dumpsites in Port Harcourt (Eliozu and Buscare) was assessed for its physiochemical parameters. Standard methods for analysis of physiochemical parameters were employed in this assessment. It was observed that leachate from both dumpsites had high Biological Oxygen Demand (1002.35mg/l), ammonia (693.15mg/l), chlorides (1907.50mg/l), sulphates (182.05mg/l), Total Dissolved Solids (4882.5mg/l) etc. However, leachate from Buscare dumpsite showed 11.89% higher concentrations of these pollutants. An Analysis of Variance (ANOVA) test was carried out for the various parameters obtained from the two dumpsites to establish if the variation observed between the leachate qualities was significantly different from each other. A calculated F-value of 0.070936 which was less than the critical F-value of 4.061706 indicated no difference in the data obtained from both dumpsites. The high BOD, ammonia, sulphate and chloride levels possibly suggest that both dumpsites receive wastes that are basically organic in nature.

INTRODUCTION

Municipal solid wastes from various sources such as domestic, industrial and educational wastes can be of diverse nature. The disposal of most waste in landfills is done after proper waste management practice such as source reduction, reuse, recycling and treatment operation have been carried out on it in developed countries, (Edward, 2001). However, the above practice is not prevalent in developing countries (Cunninghams, *et a.,l* 2005). This results to the development of open dumps of diverse materials ranging from perishable food wastes to toxic hazardous chemicals, which pollute and cause poor aesthetic quality of the environment.

Leachate from waste dumpsite can decompose and also increase in volume if exposed to rainfall. Leachates have the potential of polluting groundwater. Consequently due to the above situation in developing nations such as Nigeria, there is the need to investigate the quality of leachate released from Port Harcourt dumpsites. This will assist in the evaluation of the risk or hazards associated with it in the environment.

Port Harcourt, the capital city of Rivers State, Nigeria, lies along Bonny River and is located in the Niger Delta between latitude $4^{O}47$N and longitude $7^{O}00$E. The population of Port Harcourt is 1,320,214 as at 2007.

Port Harcourt, originally known as ‘‘Igwe Ocha’’ was given the name in 1912 by the British in an area traditionally inhabited by the Ikwerre and Ijaw. It was named after Lewis Viscourt Harcourt, the Secretary of State for the colonies. The main city of Port Harcourt has so many waste dump collection centers which are finally transferred by Rivers State Environmental Sanitation Authority (RSESA) to the permanent dumpsites. Only two dumpsites are operated by RSESA because there is no provision yet for standard sanitary landfill.

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MATERIALS AND METHOD

Description of Dumpsites

The two dumpsites in Port Harcourt are located at Eliozu and Buscare (Elelenwo). Figure 1 represent the street/road map of PortHarcourt indicating location of Eliozu dumpsite (51^0 24'N, 1^0 22'W) and Buscare dumpsite at Elelenwo (4^0 49'N, 7^0 3'E) respectively. Types of waste found at both dumpsites range from putrid food waste to toxic hazardous chemicals from industries located at Eleme, Trans Amadi industrial layout etc.

Eliozu and Buscare sites are predominantly containment dumpsites not properly managed by the State Government as its operation does not meet standard practice. Each dumpsite covers about 7-8 hectares of land with solid waste deposit of estimated depth of about 2.5 – 3.0 meters.

These dumpsites had been used for municipal solid waste disposal for over one and half years from the time this study was carried out. They receive domestic, clinic, institutional and industrial wastes from public and private waste management operators.

Leachate sampling and analyses

Leachate was collected during rainy season. Samples were collected in well labeled clean bottles that were rinsed out thrice prior to sample collection. Analytical methods were followed in line with ''standard methods for examination of water and wastewater''. Suspended solids and turbidity were determined using a portable data logging spectrophotometer; colour was determined with lovibond colour comparator while pH was determined by glass electrode method with a standard calibrated pH meter.

Dissolved solid (DS), temperature and conductivity were metered in situ. An atomic absorption spectrophotometer was used for metals analyses after samples were digested, using concentrated trioxonitrate(v) and the volume made up to 50ml with deionized water. Dissolved oxygen (DO) was determined by Azide modification of winkler's method. The Biological Oxygen Demand (BOD) was computed from the difference between initial and final Dissolved oxygen. Open reflux method utilizing potassium tetra oxochromate(VI) in boiling concentrated tetra-oxosulphate solution in the presence of silver catalyst was used to determine Chemical Oxygen Demand (COD), while Nessler's method was used to determine ammonia. Nitrate was determined by phenoldisulphonic acid method while phosphate was analyzed by calorimeter using molybdovanadate method. These standard methods are described in APHA (1978).

Data collected from four coordinate points (north, south, east and west ends) at each dumpsite were subjected to statistical analysis to determine range, mean, variance, standard deviation and carryout analysis of variance (ANOVA). The results from each dumpsite were compared with the Federal Environmental Protection Agency (FEPA) regulatory guidelines and standards.

RESULTS

The results of the leachate quality parameters for both Eliozu and Buscare dumpsites after statistical analysis are as presented in Tables 1-2, and Figure 2.

Federal Environmental Protection Agency (FEPA) in Nigeria was established by decree 58 of December 30, 1988 with statutory responsibility for overall protection of the environment, introduced guidelines on effluent limits and standard environmental policy. Statistically analyzed leachate results from Eliozu and Buscare dumpsites were compared with FEPA's standards. (see Table 1).

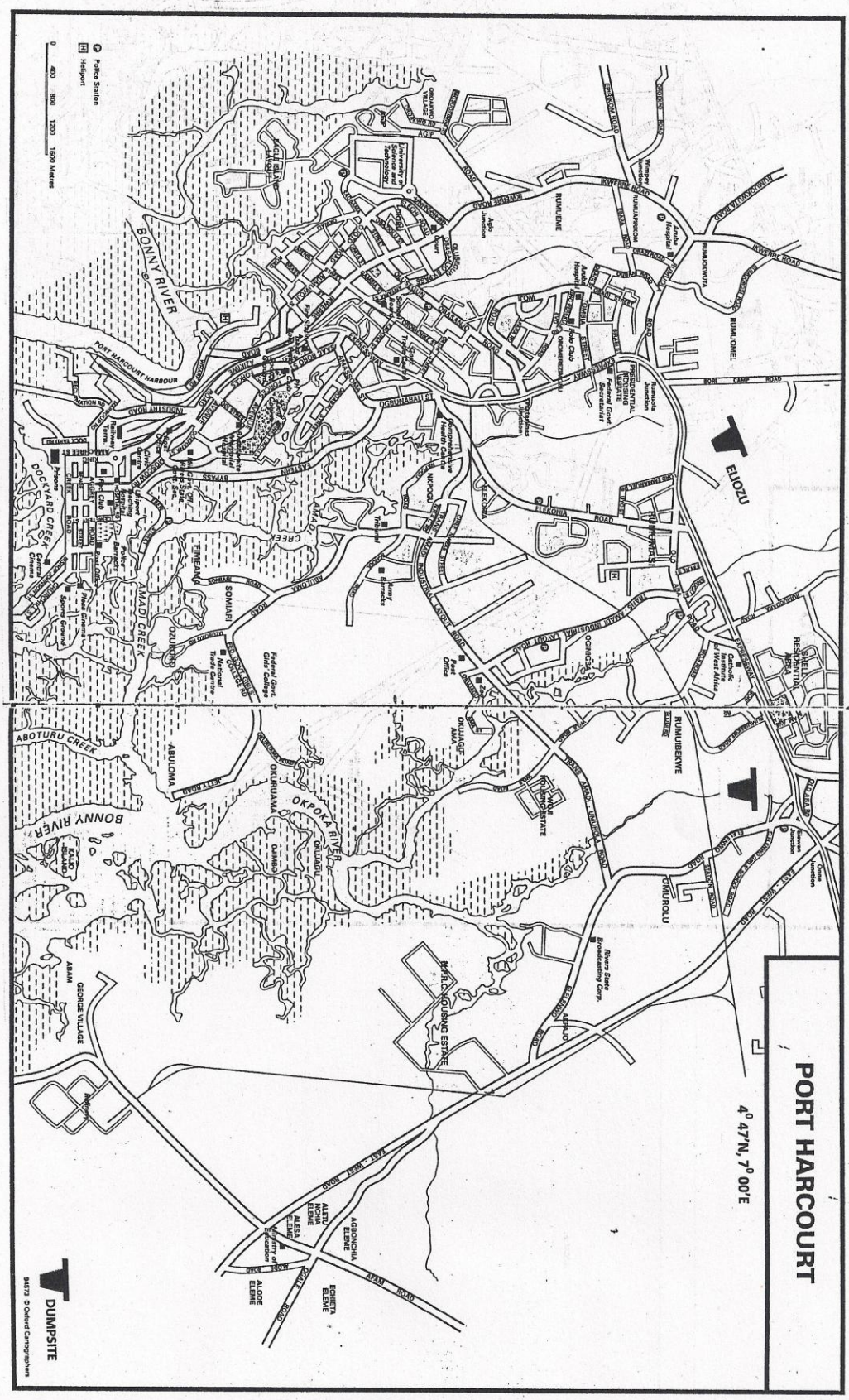

Figure 1 Port Harcourt Street/Road Map indicating Eliozu Dumpsite of 51° 24'N, 1° 22'W and Buscare Dumpsite of 4° 49'N, 7° 3'E

Source: Oxford Cartographer (1999)

Table 1: Comparison of Eliozu and Buscare dumpsites Physiochemical parameters and FEPA's limits.

S/N	Parameter	Mean result at Buscare Dumpsite	Mean result at Eliozu Dumpsite	FEPA'S limit for discharge into surface water	Remarks±
1	Temperature ^{o}C	24.70	25.66	< 40	Low
2	pH	9.64	8.58	6 – 7	High
3	Colour (HU)	424.90	412.70	7	High
4	Turbidity (FTU)	98.50	85.43	5	High
5	Conductivity (µs/cm)	5893.00	5672.00	-	-
6	Total Solid (mg/l)	5004.90	4918.60	-	-
7	Suspended Solid (mg/l)	308.70	223.60	30	High
8	Total Dissolved Solid (mg/l)	5063.00	4702.00	2000	High
9	Alkalinity (mg/l)	2600.80	2309.40	-	-
10	Chloride (mg/l)	2007.00	1808.00	600	High
11	Sulphate (mg/l)	250.82	113.28	500	Low
12	Dissolved Oxygen (mg/l)	5.62	4.66	7.5	Low
13	Biological Oxygen Demand (mg/l)	1009.10	995.60	50	High
14	Chemical Oxygen Demand (mg/l)	5120.70	3266.60	-	-
15	Ammonia (mg/l)	758.20	628.10	-	-
16	Nitrate (mg/l)	0.58	0.49	20	Low
17	Phosphate (mg/l)	3.64	2.45	05	Low
18	Lead (mg/l)	1.824	1.724	< 1	High
19	Nickel (mg/l)	0.832	0.678	< 1	Low
20	Cadmium (mg/l)	0.413	0.114	< 1	Low
21	Iron (mg/l)	209.301	185.84	20	High
22	Manganese (mg/l)	32.742	24.78	05	High
23	Zinc (mg/l)	4.562	2.43	< 1	High

± Low or High with respect to FEPA's specified limits for 2No of dumpsites

Table 2: Summary of the Analysis of Variance for Eliozu and Buscare dumpsites.

Groups	*Count*	*Sum*	*Average*	*Variance*
ELIOZU	23	25392.72	1104.031	3244256
BUSCARE	23	28833.47	1253.629	4012045

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F- crit*
Between Groups	257365.2576	1	257365.3	0.070936	0.791223	4.061706
Within Groups	159638613.6	44	3628150			
Total	159895978.8	45				

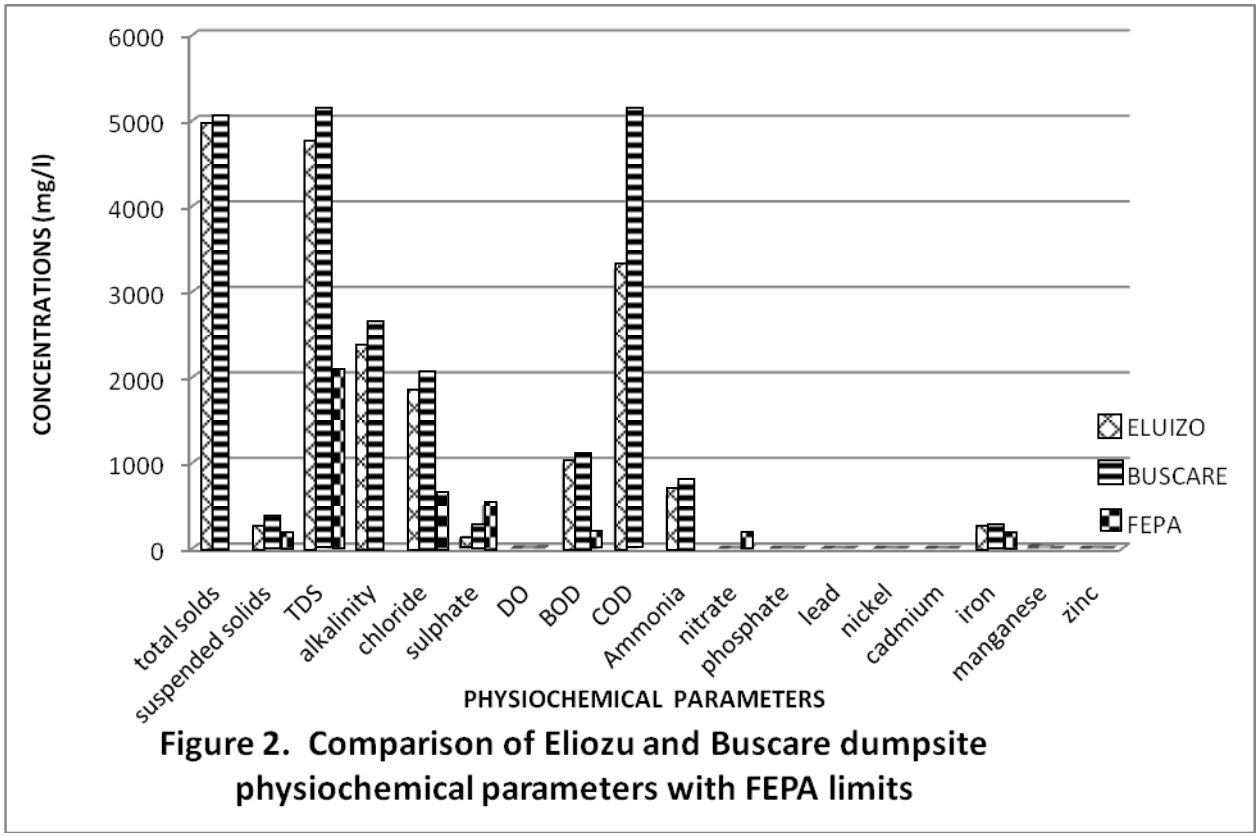

Figure 2. Comparison of Eliozu and Buscare dumpsite physiochemical parameters with FEPA limits

DISCUSSION

Characterization of leachate from dumpsites is important due to the potential hazard it poses to surface and groundwater supply. The leachate characterization for Eliozu and Buscare dumpsites for most of their physiochemical parameters is as presented in Figure 2.

From the result it was observed that most of the physiochemical parameters of the leachate quality exceeded the limits set by the FEPA for discharge of effluent into water body. Leachate wastewater emanates from the dumpsites and finally discharges into the river or seeps into groundwater aquifer.

The leachate of poor quality in excess of the quality set for discharge of wastewater into water body can lead to pollution of the aquatic environment. The physiochemical parameter of leachate from Buscare is 11.89% higher than that of Eliozu. This may be due to either the age of the dumpsites or nature of waste material disposed at this dumpsite. Leachate from older dumpsite seems to have higher organic or physiochemical content than recent dumpsites as a result of decomposition. Also dumpsite which receives domestic wastes may have higher organic content than dumpsite that receives more of construction or medical wastes.

The high level of BOD observed in Table 1 and Figure 2 for both Eliozu and Buscare dumpsites is 95.2% in excess of the regulatory limit and indicates that the nature of waste that are disposed at these dumpsites are organic in nature. This is corroborated by the high Total Dissolved Solids (TDS), ammonia, chlorides and very low level of nickel, lead, cadmium which seem to characterize industrial waste types.

Also, the ammonia level of the leachate from both dumpsites is very high (708.15mg/l), as compared to the nitrate level (0.54mg/l). It is important to note that the formation of ammonia is more favoured under anaerobic condition while nitrates are favoured under aerobic condition. Thus, this indicates that leachate formation occurs in an anaerobic condition.

Similarly, the pH, colour, turbidity, conductivity of the leachate from both dumpsites

far exceed the limits set for discharge into surface water. These attributes indicate that the organic materials are undergoing decomposition. Also, the low levels of nickel, cadmium and lead in the leachate from the two dumpsites indicate that industrial wastes are not the major waste types that are disposed at these dumpsites, see Table 1.

Thus, there may not be threat of groundwater or surface water pollution with these heavy metals because they are of concentration less than the limits set by FEPA.

However, iron and manganese show levels high above the FEPA limits. These metals are more associated with the ground formation terrain which could be lateritic in nature. Iron and manganese are associated with lateritic soil than with waste material dumped at disposal sites.

In order to understand if a significant difference exists between the nature of waste at the two dumpsites, an analysis of variance (ANOVA) was carried out on the mean data set collected from the two dumpsites. The summary of ANOVA results is as presented in Table 2.

A null hypothesis (H_o) of no significant difference in the nature of wastes that are disposed at the two dumpsites; and alternative hypothesis (H_a) of significant difference in the nature of wastes that are disposed at the two dumpsites were made. The result of the analysis showed that the calculated F-value (0.07) was less than the critical F-value (4.06) which led to the rejection of the alternative hypothesis and acceptance of the null hypothesis. Thus, Eliozu and Buscare dumpsites receive the same type of waste materials.

CONCLUSION

The following conclusion can be made from the characterization of leachate at Eliozu and Buscare dumpsites.

(1) The physiochemical parameters such as pH, colour, BOD, nitrates, total dissolved solid etc were observed to be higher for Buscare dumpsite than that of Eliozu dumpsite by 11.89%.

(2) The leachates from both dumpsites have high BOD values which exceeded the regulatory limit set for discharge of wastewater into water body. This high BOD was attributed to organic nature of waste types that are disposed at these dumpsites.

(3) The level of ammonia and nitrates in the leachate sample indicates that wastes at the dumpsite are undergoing anaerobic decomposition. There was also high level of chlorides, sulphates, suspended solids, total dissolved solids, alkalinity, colour, turbidity, conductivity in the leachate collected from both dumpsites which indicates an active decomposition of organic waste materials to release its minerals.

(4) Cadmium, nickel and lead concentrations in the leachate from both dumpsites were very low (0.264mg/l, 0.755mg/l and 1.774mg/l, respectively) below the FEPA regulatory limits, indicating that the nature of waste disposed at these dumpsites are not of industrial origin. The high level of iron and manganese can be related more to the geomorphology of the dumpsite area in question.

(5) A comparative study of the leachate physiochemical parameter indicated that the two dumpsites receive waste of similar nature (that is, organic origin). Age of the waste at the dumpsite was suspected to be responsible for the observed variation.

RECOMMENDATION

The high level of pollutants concentrations in the leachate collected from both Eliozu and Buscare dumpsites indicate that surface and ground water are likely to be polluted by the leachate. We therefore wish to recommend that an engineering landfill be constructed for the management and treatment of leachate derived from such landfill. Treatment plants may be incorporated alongside the landfill design plan. Stabilization ponds may play an important role in the reduction of BOD and other materials before discharge into water body.

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