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CHARACTERIZATION OF MUNICIPAL SOLID WASTE AND ITS POTENTIAL IMPACTS ON GROUND WATER OF TWO COMMUNITIES IN OBIO/AKPOR LOCAL GOVERNMENT AREA OF RIVERS STATE, NIGERIA

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ABSTRACT: *This study was undertaken to investigate characterization of municipal solid waste and its potential impacts of ground water of two communities (Choba and Rumuosi) in Obio/Akpor Local Government Area of Rivers State. Two commercial borehole close to the dumpsites of each community were analysed for both physico-chemical parameters and heavy metals concentration in water. The result values showed that bottles contributed the highest percentage composition of 29.87% in Rumuosi followed by Cow bones 21.77%, Plastic waste 10.94% while Snail shell and Vegetables had the least percentage composition of 0%. Cow bones, ceramics and bottles had percentage composition of 13.82%, 12.20% and 12.17% in Choba while foil had the least Composition of 0.83%. The results further showed that Choba had the highest total composition of M.S.W generated in (weight kg) 7.007 than that of Rumuosi (3.409kg). The results of physico-chemical parameters showed that Conductivity had the highest mean value of 79.5500(μs), followed by TDS (39.9000mg/L), Temp (27.3500°C), pH (7.15), DO (5.3500), ORP (-11.000mg/L) and Salinity (.0400) all in Choba while in Rumuosi, Conductivity had the highest mean value of 189.1500(μs) followed by TDS (94.1000mg/L), Temp (27.6000°C), pH (7.200), DO (5.6500mg/L), ORP (-10.2750mg/L) and Salinity (.0900‰). The concentrations of heavy metals in Choba borehole water showed that Mercury (Hg) ranges from 0.0017 – 0.0024mg/L, followed by lead (Pb) 0.008 – 0.015mg/L and Copper (Cu) 0.001 – 0.001mg/L while in Rumuosi borehole water, lead (Pb) ranges from 0.012 – 0.009mg/L followed by Mercury (Hg) 0.014 – 0.0016mg/L and Copper (Cu) 0.001 – 0.002mg/L. The data analysis revealed that there was no significant difference in the Composition of waste in the two communities at $p < 0.05$. The characterization study has revealed the make-up of the waste stream of the two communities hence the responsibility of proper management of solid waste should not be left for the government alone or to some certain group of individuals.*

KEYWORDS: dumpsites, heavy metals, weight, composition and pollution.

INTRODUCTION

Solid waste management has emerged as one of the greatest challenges facing municipal authorities worldwide especially in developing countries. The volume of solid waste been generated has continually increased at faster rate than resources available to contain it (Babatunde

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et al., 2013). In developing nations, the situation is more critical since their resources are usually meager and more priority issues like health and education beat municipal solid waste management (MSWM) to the top of the list (Dolan, 1998). The consequence is ill conceived and operated epileptic MSWM systems that leave movements of solid waste adorning the streets of urban centers in countries like Nigeria, posing serious risk in both human and environmental health (Ogunbiyi, 2001).

In Nigeria, at the current level of development, wastes such as municipal solid are particularly of great concern as they are not only unsightly in urban and rural centers, but usually constitute a glory site in the eyes of many local and international visitors. Household garbage and other waste from over 5,000 industries, with some even operating within residential premises are discharged mostly in public places (Senate Report, 2006). Evidence is growing that we are degrading our unsustainable rates due to unsustainable patterns of production and consumption. As the earth's resources are consumed, enormous volumes of waste are generated and there is an increasing problem of how to dispose of these materials in an environmentally safe manner, therefore proper waste management is a necessity for today's civilization (Onibokun, 2000).

The volume and complexity of waste stream generated by the people should be handled using environmentally sound and economically viable methods, recovering and re-using as much of the materials as possible. The rapid growth of our population and level of industrial challenge has provided a timely opportunity for the application of environmental conservation management practices in Nigeria. This is particularly true as the growth in the production of various categories of waste increases (Woke *et al*., 2010). Literature is scare on the characterization of municipal solid waste in relation to potential impacts of underground water in Obio/Akpor, Rivers State, Nigeria. The present study therefore seeks to generate data on the characterizations of municipal solid waste in Obio/Akpor LGA in relation to ground water contamination in two communities namely Rumuosi and Choba.

Description of Study Area

Obio/Akpor is one of the Local Government Area Councils in Rivers State with an area of 260km^2 and a population of 878,890 from 2006 census. It is located between latitudes 4°45°N and 4°60°N and longitudes 6°50°E and 8°00°E (Fig. 1). The geographical coordinates of the two communities includes:

Rumuosi	04°52′37.7′N, 006°56′19.1′E
Choba	04°53′18.1′N, 006°53′58.0′E

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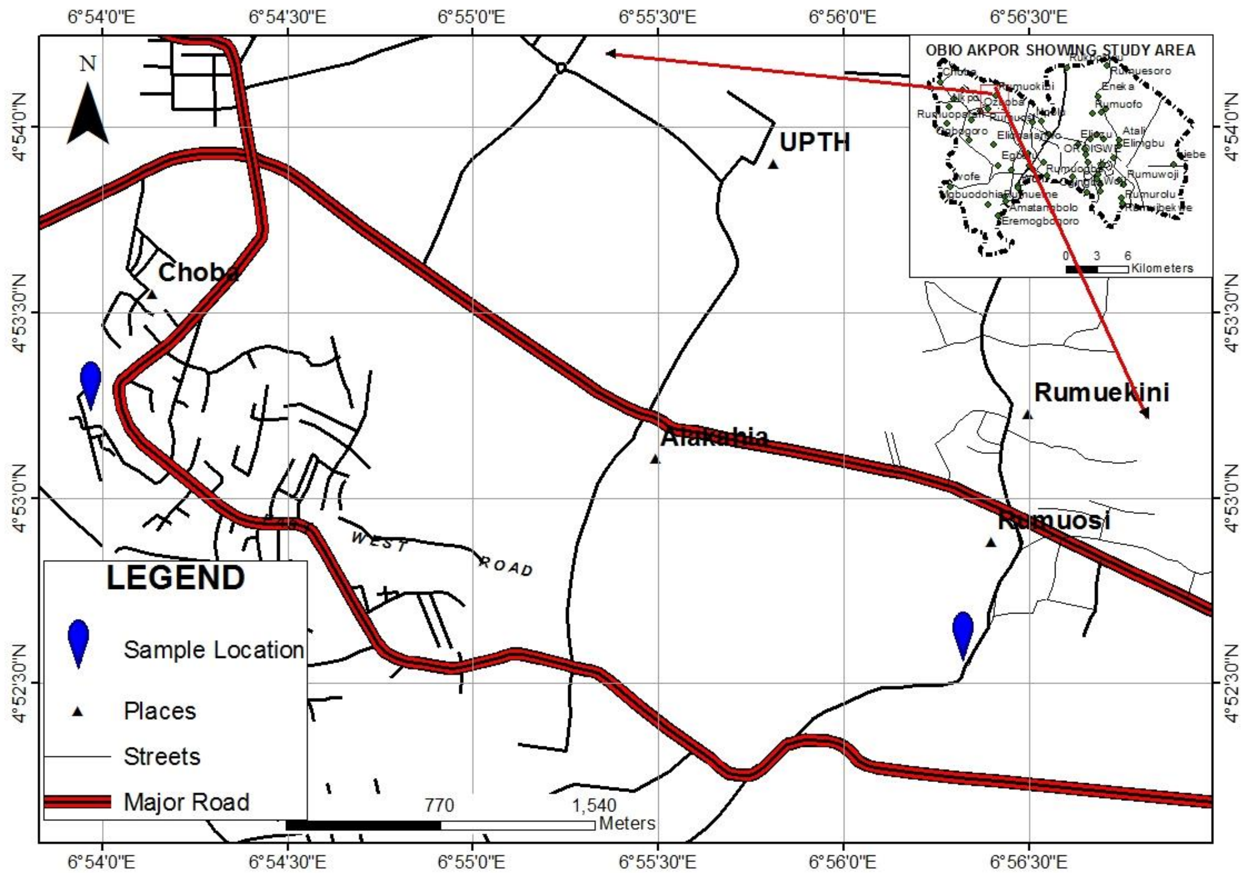

Figure 1: Map showing study area

Field Sampling

Rumuosi Community Dumpsites

This is one of the communities under Obio/Akpor Local Government Area. The activities of the community and their wastes generated were into consumables. The waters were also weighed and the underground water close to the dumpsite was characterized by collecting from borehole and taken to the lab for analysis (Figure 2).

Figure 2: Showing Rumuosi community dumpsite

Choba Community Dumpsites

This is one of the communities under Obio/Akpor Local Government Area. The activities of the people are trading, farming, carpentry, etc. The dumpsites of the community is situated close to the river bank and the wastes generated were characterized into consumables. The waters were also weighed and the ground water close to the dumpsite was checked by collecting from borehole and taken to the laboratory for analysis (Figure 3).

Figure 3: Showing Choba community dumpsite

Collection of Water Sample

Water samples were collected from Rumuosi and Choba in Obio/Akpor, in two different borehole of the communities. The samples were collected using sterile 50ml container. The water is used for physico-chemical analysis and stored in an ice box for preservation at a relatively constant temperature. The water samples were desituated as Rumuosi and Choba before taken to the laboratory for further analysis.

Laboratory Procedures

In each community, water sample were collected with one litre sterile screw-capped bottles for analysis. The physico-chemical parameters that were analyzed are temperature in in-situ, Biological Oxygen Demand, Dissolved Oxygen, Chemical Oxygen Demand, Total Dissolved Solids, Hydrogen ion concentration (pH), Salinity, Conductivity and Oxidation Reduction Potential (ORP). All the parameters were measured in mg/L except temperature which was measured in in-situ. The physico-chemical parameters were determined according to the procedure outlined in the standard methods for the examination of water and waste water (APHA, 1998).

Heavy Metal Analysis

Water sample were collected at the two communities at a depth of 50cm below the water surface using 1 titer sterilized jelly can and covered properly at the same depth. The water samples were taken to Giolee Global Resources Laboratory for analysis of heavy metals such as Copper, lead and Mercury in the cooled boxes. The samples were received in good condition and accompanied consistently with the chain of custody form. Samples are refrigerated at less than or equal to 4°C upon receipt at the laboratory. In the laboratory, heavy metals were determined by the API RP standard method (API RP45, 2012). The concentrations of the metals were calculated using the equation:

$$\text{Metal concentration (Nm/L)} = \frac{(x - y)v_1}{v_2}$$

Where x = concentration of metals obtained from atomic absorption spectrophotometer for sample (Nm/L)

y = concentration of metals obtained from atomic absorption spectrophotometer instrument for blank.

v_1 = volume of digest sent for analysis (ml)

v_2 = original volume of sample digested (ml)

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Sorting and Weighting
The sorting process was carried out manually. The waste sample was meticulously sorted into different categories with the use of the hand and shovel. The categories used are food waste, paper, plastics, cow bones, nylon, snail, ceramics, bottles, foil, vegetables and others. The already sorted solid waste components were then placed inside different polythene bags and weighed separately to obtain the weight of the various categories. The weights of different waste categories were recorded. The weight components were weighed using a weighing scale.

RESULTS AND DISCUSSION

The results of waste characterization in the two communities showed that empty bottles in Rumuosi contributed about 1019 grams, Plastic bottle waste 29.9%, Cow bones 21.8%, Paper waste 0.35%, Snail shell 0%, Ceramics 0.73%, Foil 0.41%, Vegetables 0% and others 28.63%, all in Rumuosi community (Table 1). In Choba, Cow bones had 968 grams which amount to plastic waste having percentage composition of 3.11, Cow bones 13.82%, Ceramic 12.20%, Snail shell 0%, Bottles 12.17%, Paper 1.94%, Foil 0.83%, Vegetables 4.51% and others 43.51% (Table 1).

Table 1: Percentage (%) composition of generated municipal solid waste (MSW) in two communities

Waste Category	Rumuosi	Choba
Plastic waste	10.94	3.11
Cow bones	21.77	13.82
Snail shell	0	2.10
Ceramics	0.73	12.20
Bottles	29.89	12.17
Paper	0.35	1.94
Foil	0.41	0.83
Vegetables	0	4.51
Others	28.63	43.51

The results further showed the composition of municipal solid waste generated in weight (g) in Rumuosi and Choba in Table 2 below.

Waste Category	Rumuosi	Choba
Plastic waste	373	218
Cow bones	742	968
Snail shell	248	406
Nylon	248	406
Ceramics	25	855
Bottles	1019	854
Paper	12	136
Foil	14	58
Vegetables	-	316
Others	976	3049

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Spatial variations of the physico-chemical results of Rumuosi and Choba borehole water are presented in Table 3. Temperature had a range of 26.9°C – 27.8°C in Choba but there was an increase in Rumuosi from 27.1°C – 28.1°C. The mean temperature value for Choba was 27.3000 ± 0.6364°C while that of Rumuosi was 27.6000 ± 0.7071°C, the difference in temperature values were not statistically significant ($p > 0.05$). pH values in the Choba borehole water were high with a mean value of 7.15 ± 0.0919, as compared to that of Rumuosi with a mean value of 7.200 ± 0.1414.

Total Dissolved Solids (TDS) were generally lower in Choba (mean 79.9000 ± 0.8485) than Rumuosi water (mean 94.7000 ± 2.2627). Indeed, it was observed that the Rumuosi water was more turbid that Choba as confirmed by the higher values obtained in Rumuosi.
Salinity in the Choba and Rumuosi water were quite low with the mean values of .0400 ± 0.0000[a] (Choba) and .0900 ± 0.0000[a] (Rumuosi).

Furthermore, mean Dissolved Oxygen in Choba was 5.3500 ± 1.6264mg/L while that of Rumuosi was 5.6500 ± 0.2121mg/L (Table 3). However, the mean ORP value was -11.0000 ± 0.8485mg/L in Rumuosi (Table 3) (Fig. 4). Values for Conductivity were lower in Choba water than in Rumuosi water with mean value of 79.5550 ± 1.48 (Ns) in the former and 189.1500 ± 5.0205 in Rumuosi (Table 3).

Table 3: Physico-chemical parameter of water samples in both communities: Choba & Rumuosi

	Physico-chemical Parameters						
Stations	**DO (mg/L)**	**pH**	**TDS (mg/L)**	**Conductivity (µs)**	**ORP (Mu)**	**Salinity (‰)**	**Temp (°C)**
Choba	4.2	7.08	39.3	78.5	-10.4	0.04	26.9
Choba	6.2	7.21	40.5	80.6	-11.6	0.04	27.8
Mean values	5.3500	7.15	39.9000	79.5500	-11.0000	.0400	27.3500
Std. deviation	±1.6264	±0.0917	±0.8485	±1.4849	±0.8485	±0.6364	±0.6361
Rumuosi	5.5	7.10	93.1	185.6	-11.9	0.09	27.1
Rumuosi	5.8	7.30	96.3	192.7	-865	0.009	28.1
Mean values	5.6500	7.200	94.7000	189.1500	-10.275	-0900	27.6000
Std. deviation	±0.2121	±0.1414	±2.2627	±5.0205	±2.2981	±0.0000[a]	±0.7071

The results of the mean value of heavy metals concentration of borehole water in Choba and Rumuosi showed that mercury concentrations in water were higher than the values for the other

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metals. However, mercury concentration ranges from 0.0024 – 0.0017 with the mean value of 0.001500, Copper 0.001 – 0.001 with mean values of 0.001500 and lead had 0.015 – 0.008 with the mean values of 0.010500 all in Choba while Rumuosi had the highest concentrations in the mean values of mercury and lead as compared to that of Choba water (borehole) (0.002050, 0.011500) while Copper had the least mean value of 0.001 in Rumuosi (Table 4, Fig. 5).

Table 4: Heavy metal concentration of the borehole water in two communities (Choba & Rumuosi)

	Heavy Metals (mg/L)		
Stations Communities	**Mercury (Hg)**	**Copper (Cu)**	**Lead (Pb)**
Choba	0.0024	0.001	0.015
Choba	0.0017	0.001	0.008
Mean values	0.001500	0.001500	0.010500
Rumuosi	0.0016	0.002	0.012
Rumuosi	0.0014	0.001	0.009
Mean values	0.002050	0.001	0.011500

DISCUSSION

The waste characterization study revealed that the composition of solid waste was dominated by bottle waste and cow bones in Rumuosi and Choba, followed by paper waste which is the least for both communities. But that of Cow bones is as a result of the market environment which involves people going to buy meat (Igoni *et al*., 2007). Thus discarded Cow bones become much available in waste dumpsites in the two communities as compared to other wastes generated in the both communities.

The result of this research is quite similar to the characterization study carried out by Okeniyi and Anwan (2012). They reported that, of the average weight generated per day in the community, bottle waste exhibited the higher percentage generation at 29.9% followed by Cow bones waste at 13.8%, Ceramics 12.20%, Nylon 5.79%, Plastics 10.94%, Vegetables 4.51%, Snail shell 2.10%, Foil 0.83%, Paper 194% and others 43.5%.

The results showed that the municipal solid wastes generated at the study locations were heterogenous and can be sorted at source to ease collection, transportation and ultimate disposal problem allowing the municipalities to adequately recover and utilize the resources abundant in the waste stream (Oresanya, 1998).

The variation in mean values for mercury and lead were statistically significant ($p < 0.05$) and the values recorded were all within the standard limits for survival of aquatic lives (WHO, 2006). Choba and Rumuosi recorded the least values of Copper while Mercury recorded highest in Choba community. The concentrations of mercury, copper and lead are low and within the standard limit for survival (WHO, 2006). It is possible that toxic pollutant can endanger public health when being incorporated into food chain or when released into the overlying waters at the level higher than

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WHO permissible limit. The graph of the mean heavy metals shows fluctuation. This may be a result of human activities, industrial activities and environmental changes (Woke & Babatunde, 2016). Hence, there is need for us to checkmate activities that will elevate the ranges of these metals because this water serves as major sources water to communities around the study area (Xing & Liu, 2011). WHO (2006) and NLS (2007) reported that there will be no injurious effect when the water is used for household purpose at the level obtained in this study, hence the recorded mean values for mercury and lead were constant for the two communities and the values were within the standard limits for drinking (WHO, 2006).

Conductivity recorded the highest values in most parameters in Rumuosi although most of them were still within permissible limits, the pH value in the study area conforms WHO and NSDWE standard for drinking water. Although pH usually has no direct impact on consumers, it is one of the most important operational water quality parameter (WHO, 2003). Most of the values obtained in the present study were not far from similar studies in the Niger Delta area (Ohagi and Akujieze, 1989). However, the study of borehole water in Port Harcourt by Woke and Babatunde (2015) and in Yenegoa by Agbalagba *et al*. (2011) showed more acidic ground water samples. TDS and ORP values were within the range of values obtained from the studies (Igoni *et al*., 2007) on drinking water in Abeokuta. The levels of Dissolved Oxygen recorded agreed with the report of Akhionbare, (1998) and was higher than the minimum 5mg/L acceptable for safe drinking water by NLS and FEPA. Ohwo and Abel (2014) opined that dissolved oxygen is necessary for good water quality and lack of oxygen in body tissues creates a defect of real blood cells. Therefore oxygen availability in an aquatic ecosystem is an indication of the system health and general well-being. This is further supported by the Xing & Liu (2011) scale of classifying safe water.

CONCLUSION

The elevation of physico-chemical parameters of borehole water sample in Choba and Rumuosi show that most of the result were below the federal international standard of drinking water which do not pose any harm for human consumption, although some were within required limit. The characterization study has revealed the make-up of the waste stream of the two communities (Rumuosi and Choba) and thus it is necessary to be used in formulating a better and sustainable waste management system. These would not only drastically change the look of community environment, but will also add to the community reputations. It is therefore recommended that, the waste should not totally be regarded as waste, which a proper system should be set out for waste segregation and sorting.

Finally, more studies should be carried out to determine the power generating potentials of these solid waste that are generated in a very high qualities per day as it is evidence that there is wealth in waste.

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