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Characterisation of Solid Waste and Pollution Assessment in University of Benin and University Of Benin Teaching Hospital, Benin City, Nigeria.

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Abstract

This study evaluated the nature of refuse and heavy metals concentrations in the refuse dump soils at the University of Benin and the University of Benin Teaching Hospital, Benin City, Nigeria. Waste characterization was done by sorting the refuse, while the concentrations of heavy metals were determined by collecting soil samples at the randomly selected refuse dumps at 15cm depth using an auger which were taken to the laboratory for analysis. Different types of refuse were encountered such as paper, plastic, rubber, bottles, polythene bags, diapers, foam, food remnants and other combustible miscellaneous waste materials. The findings showed that paper, polythene bags, food remnants, plastics, diapers and glasses were among the most common. It also revealed that Cadmium (Cd) was above the permissible limit of WHO and FEPA in refuse dumps 5, 8 and 9. The concentrations of Zinc were higher than the WHO acceptable limit in all the samples while Chromium in all the samples exceeded FEPA threshold of 0.20 mg/kg. The refuse found in the refuse dumps had the potentials to be recycled and the concentrations of some of the heavy metals found have potentials for health hazards to humans. Therefore, relevant authorities of the institutions should ensure that safe management of refuse is practiced for a safer environment.

1. Introduction

The environment is very crucial for the existence of every creature. In addition to serving as a place of abode to any creature, it also contributes, to a large extent, to the quality of life of creatures [29]. The environment can be seen as the total factors that surround and influence an organism at a given time and place [24]. The failure of the numerous efforts to address the problem of environmental health hazards in developing nations has been attributed to various factors including unhealthy socio-cultural practices, poor environmental sanitation education and awareness, low literacy level, bad governance, disregard to the rule of law and other forms of indiscipline [28]. Solid wastes are abandoned materials and could be garbage, sludge from a waste-treatment plant, discarded materials resulting from industrial, commercial, mining, agricultural operations, and those resulting from community activities such as waste tires, scrap metal, latex paints, furniture, toys, appliances and

vehicles, empty aerosol cans, paint cans and compressed gas cylinders, and construction and demolition debris [8].
For effective solid waste management, it is crucial to estimate the amount of solid trash that is produced in a city. In most developing nations, local authorities provide waste management services, which include waste collection, transportation, and disposal. However, these services are hampered by insufficient documentation of the volume and nature of solid waste generated has hindered developing nations ability to create effective and sustainable waste management systems [25] [26] [27].
The waste management system considers trash characterization heavily, it serves as a foundation for the construction of effective, affordable, and environmentally friendly waste equipment. Based on waste characterization studies, it is necessary to establish the percentage of components in waste that will be burned [9] [13] [5]. According to [23], the main goals of waste characterization include plant optimization, emission monitoring and data, providing the foundation for planning economic analysis, design and later management and operation of a disposal system or material and energy resource recovery facilities. To choose the most affordable collection methods, there is need plan for suitable sanitary landfill sites, design composting plants or grinding plant, accurately forecast the cost and efficiency of operations when selecting a particular method of disposal, and finally forecasting for future demand. It is also necessary to know the composition of the waste [3].

2. Materials and Methods

2.1 Description Of Study Area:

This study was carried out at the University of Benin (UNIBEN) and the University of Benin Teaching Hospital (UBTH) in Benin City, Edo State, Nigeria as shown in Figure 1. University of Benin, established in 1970 is a Federal Government owned University situated on latitude $6^0$20.022'N and longitude $5^0$36.009'E in the Ovia North-East Local Government Area of Edo state, South-South, Nigeria. The institution currently has an estimated number of 77,000 students. In addition to the student’s population are the academic and non-academic staff and other persons carrying out one form of business or the other. The University of Benin Teaching Hospital (UBTH) is a premier and multi-specialty healthcare service in Benin City Nigeria established in 1973. It lies within latitude $6^0$23’26” N and longitude 5^0 36’44” E. It renders both in and out patients services and it is also a research institution.

2.2 Climatic Condition of the Study Area:

The climate of Benin City has the characteristic features of the humid tropical wet and dry climate with heavy rainfall. There are two distinct seasons, rainy season covers from March to October and the dry season begins in November and terminates in April [20].

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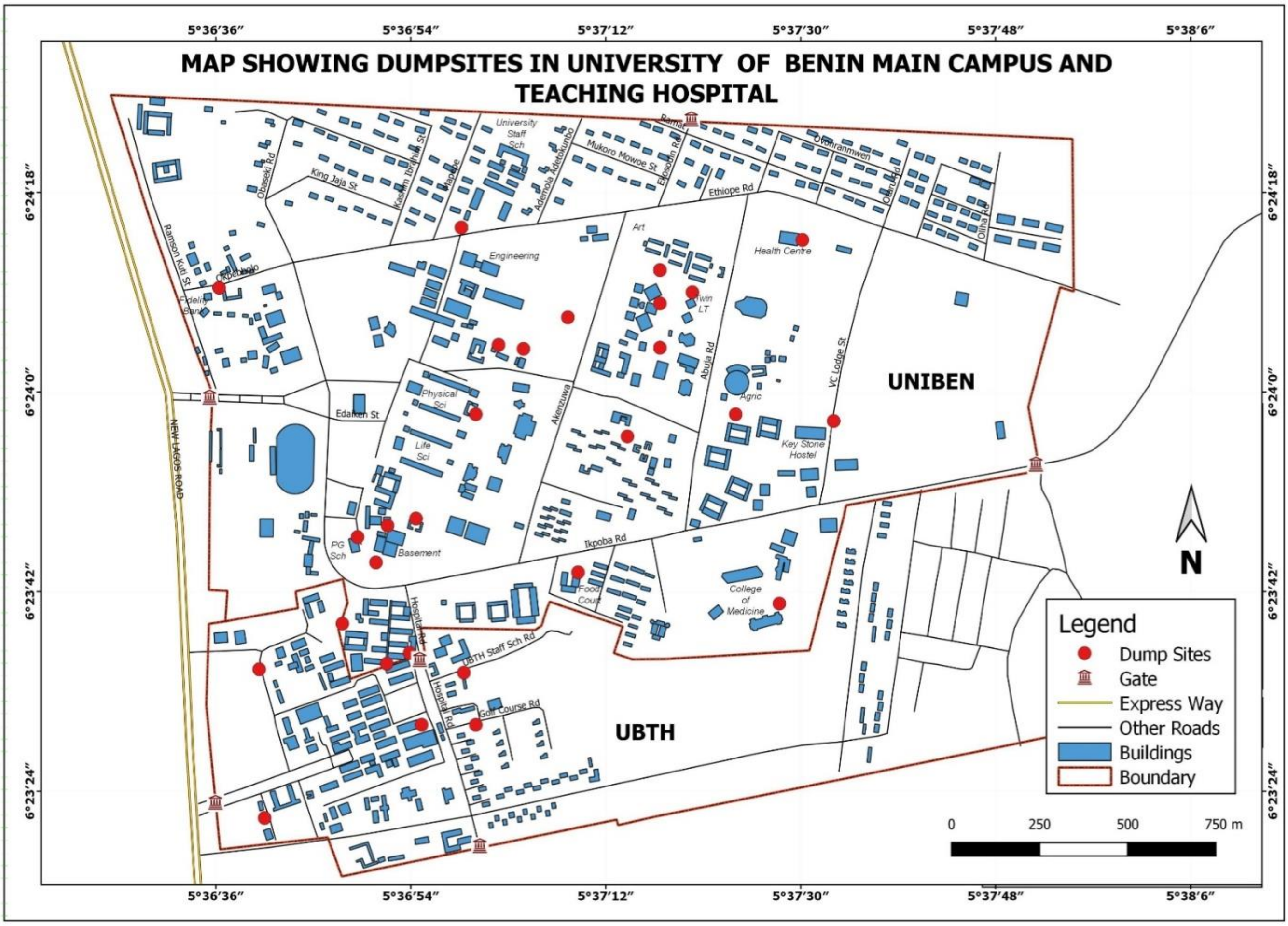

Figure 1: Map of the study area showing the different refuse dumps

2.3 Methods of Waste Characterization

Ten refuse dumps were studied in this work, they are sited all over the two facilities as shown in (Fig.1). Solid waste were obtained from the refuse dumps at different locations in University of Benin (UNIBEN) and University of Benin Teaching Hospital (UBTH). The materials were then sorted according to material types which included paper, plastic/rubber materials, bottles, nylon bags, sacks and other combustible miscellaneous waste materials [8].

2.4Methods of Soil Sample Collection

Ten soil samples were collected with the aid of an auger at 15cm depth from the ten randomly selected refuse dumps in the two institutions. Three different places around the refuse dumps were dug and labelled RD1, RD2, RD3 (1st sampling) and the soils collected from each of the three different places were mixed to become one (1) sample. The collected samples were then stored in polythene bags and labelled with a masking tape. The soil samples were taken to the laboratory for analysis in order to determine the concentrations of heavy metals. The heavy metals examined were Zinc (Zn), Cadmium (Cd), Manganese (Mn), Chromium (Cr), Lead (Pb) and Arsenic (As).

3. Results and Discussion

The characteristics of the solid waste generated is shown in Table 1. Paper, polythene bags, food remnants, plastics, diapers, glasses, wood, metal chips, foam, bottle, leaves, were among the commonly found refuse in the dumps. This therefore, revealed the kind of products that are commonly used by persons staying within the vicinities of the refuse dumps and the institutions in general.

TABLE 1: Locations of the selected refuse dumps in the University of Benin and University of Benin Teaching Hospital were as followed:

	Refuse Dumps	**Types Of Solid Waste Generated**
1	Behind Faculty of Arts Building	Paper, polythene bags, rubber, plastics, wood, food remnants, leaves.
2	Behind Department of Philosophy	Leaves, paper, rubber, plastics, polythene bags, food remnants.
3	Beside Keystone Hostel	Food remnants, polythene bags, rubber, plastics, paper, bottles, hair, cartons, weavon.
4	Behind Basement Complex	Paper, food remnants, polythene bags, rubber, plastics.
5	Beside Uniben Table Water Outlet	Paper, polythene bags, food remnants, rubber, plastics, iron.
6	Behind University ICT Centre	Carton, foam, wood, bottles, rubber, plastics, polythene bags, paper.
7	Behind Drug Manufacturing Laboratory (Department of Pharmaceutics & Pharmaceutical Technology).	Sack, bottles, paper, rubber, plastics, polythene bags, food remnants.
8	Behind Uniben Methylated Spirit & Hydrogen Peroxide Production Unit	Sack, polythene bags, bottles, food remnants, glass, rubber, plastics.
9	Beside Medical Laboratory Science Building	Rubber, plastics, polythene bags, paper, carton, food remnants, leaves.
10	Behind Prof. Lilian Salami Office Complex	Leaves, bottle, paper, polythene bags, sack, carton, rubber, plastics, diapers, food remnants.
11	Behind Department of Microbiology Building	Sack, carton, paper, rubber, plastics, food remnants, polythene bags, wood.
12	Behind Faculty of Environmental Sciences	Paper, food remnants, polythene bags, wood, plastics.

13	Behind Centre for Entrepreneur Development Confectionery Building	Rubber, plastics, polythene bags, paper, food remnants.
14	Behind Physical Science Complex	Rubber, plastics, polythene bags, paper, leaves, bottles, glass, sack, food remnants, wood, carton.
15	Behind Faculty of Law	Polythene bags, carton, plastics, paper, food remnants, leaves.
16	Along Golf Course Road	Paper, carton, leaves, food remnants, plastics, nose masks.
17	Behind Catering Service	Paper, plastics, polythene bags, food remnants, basket.
18	Beside UBTH Cooperative Complex	Polythene bags, paper, rubber, plastics, food remnants, gloves.
19	Beside Medical Emergency Ward	Polythene bags, rubber, plastics, paper, food remnants.
20	Along UBTH Staff School Road	Polythene bags, sack, rubber, plastics, paper, carton, nose masks, food remnants, leaves.

The concentrations of heavy metals analysed from ten randomly selected refuse dumps in the study area are shown in Table 2. The result revealed that arsenic had concentrations below permissible limits of both WHO and FEPA. Manganese however was found to be above permissible limits of both WHO and FEPA in all the locations. The concentrations of other heavy metals analysed were below the permissible limits in some locations and above the limits in few locations. The result therefore revealed that more of manganese related contamination is common in the study area. However, contaminations due to arsenic is not common in the locations. But contamination due to other heavy metals varied from one refuse dump to another.

Table 2. Concentrations of heavy metals in the selected refuse dumps

Refuse Dumps Code	**Locations**	**Zn mg/kg**	**Cd mg/kg**	**Mn mg/kg**	**Cr mg/kg**	**Pb mg/kg**	**As mg/kg**
1	Behind Faculty of Environmental Science	4.30	<0.05	30.30	2.00	<0.01	<0.01
2	Behind University ICT Building	4.30	<0.05	26.10	2.10	<0.01	<0.01
3	Behind Physical Science Complex	5.30	<0.05	34.60	2.50	<0.01	<0.01
4	Behind Department of Microbiology Building	12.60	<0.05	111.50	6.03	10.3	<0.01

5	Behind Basement Complex	97.80	0.90	73.10	8.05	<0.01	<0.01
6	Behind Drug Manufacturing Laboratory	29.20	<0.05	68.80	6.02	<0.01	<0.01
7	Beside Medical Laboratory Science	18.08	<0.05	124.40	4.02	<0.01	<0.01
8	Behind Keystone Hostel	4.30	0.90	30.30	1.70	10.3	<0.01
9	Behind Centre for Entrepreneur Development Building	39.60	2.70	98.70	7.20	<0.01	<0.01
10	Behind Faculty of Social Sciences	5.30	<0.05	47.40	3.20	35.90	<0.01
	WHO permissible Limits (mg/kg)	**50**	**0.8**	**12**	**100**	**85**	**NA**
	FEPA permissible Limits (mg/kg)	**NA**	**<1**	**0.05**	**0.20**	**0.05**	**0.1**

The common waste encountered in the refuse dumps were paper, metals, polythene bags, food remnants, plastics, diapers, wood, leaves and glasses. This is consistent with the work of [1] and [16]. This therefore, revealed the kind of products that are commonly used by persons staying within the vicinities of the refuse dumps and the institutions in general. Biodegradable waste constituted substantial part of the solid wastes in the refuse dumps. Therefore, composting or biodegradation can be carried out on the refuse instead of disposing them out-rightly thereby increasing the volume of the waste in the refuse dumps and exacerbating the menace associated with organic solid wastes. The composting or biodegradation is advantageous because it will help in producing manure which can be used in gardens and farmlands. This could serve as sources of employment and incomes to persons or institutions. Furthermore, management of this kind of waste by biodegradation can be easily done. The non-degradable ones however can be re-used and recycled leaving very little that would eventually be disposed of. If the biodegradables are sorted out, it will reduce the incidences of breeding and proliferation of pathogens thereby controlling the spread of infectious diseases.

In each soil sample taken from refuse dumps 5, 8, and 9, the concentration of cadmium was found to be higher than the maximum permissible level established by [35] and [17]. The concentration of cadmium obtained in this study ranges from 0.05 to 2.70 mg/ kg with a mean of 0.49 $\pm$ 0.810mg/ kg. This range of concentrations were quite lower than those reported by [34] as 1.28 – 21.31 mg/kg. Due to human activity, including but not limited to the combustion and cremation of metal ore, cadmium is present and remains in the environment [2] and [14].

Zinc (Zn) levels in the ten refuse dumps, on the other hand, range from 4.30 to 97.80 mg/kg. In waste dump 5, the zinc (Zn) concentration was higher than the 50 mg/kg permissible limit established by [35]. Zinc is essential for maximum plant growth and development as it is a component of several proteins and an enzyme cofactor [11]. However, Zinc is phytotoxic at high soil concentrations, and plants that ingest it or deposit it through their roots endangers human health [10].

Chromium concentrations in this study vary from 1.70 to 8.05 mg/kg, with a mean of 4.28 ± 2.23 mg/ kg. This range of concentrations are below those reported by [4] as 8.59 – 9.20 mg/dm3. The [17] permissible limit for chromium was exceeded in this study. According to [21], lead-chromium batteries, colored polythene bags, abandoned plastic products, and empty paint containers could all be sources of chromium in the soils. Chromium is a crucial micronutrient for both humans and animals [6]. However, when levels of chromium exceed a threshold level, it becomes toxic, mutagenic, and carcinogenic [18] [31] [7] [19] [36] [16] [32]. Reduced Plants production and nutritional content toxicity are also seen because of chromium buildup [30] [22].
Lead (Pb) is primarily targeted at the brain, although it also damages other body organs and builds up over time. Children are the primary victims, according to [35]. [35], exposure to Lead (Pb) during pregnancy increases the risk of birth defects and high blood pressure in both adults and children. In this study, the lead concentration ranged from 0.01 mg/kg to 35.90 mg/kg which is within the threshold set by [34]. However [4] reported a much lower value of 8.59 – 9.20 mg/kg.
The concentration of Manganese (Mn) ranges from 26.10 to 124.40 mg/kg exceeding the permissible limits of both [34] and [17]. Manganese is rapidly absorbed by roots and accumulates in plant tissues. However, at higher concentrations it becomes poisonous for the growth and development of plants [37].

4. Conclusion and Recommendation

Refuse found disposed at the various refuse dumps in the University of Benin and the University of Benin Teaching Hospital were mainly items that are biodegradable which could help in manure production for farm use. The non-degradable could be easily sorted out for re-use or recycling. As such very little quantity may require outright disposal by the institutions. The soils where these refuse were dumped have the potentials for health risk because the concentrations of some of the heavy metals analyzed exceeded permissible limits of both WHO and FEPA. Efforts should be made towards solid waste reduction, biodegradation, re-use and recycling.

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