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Abstract- Municipal solid waste management has emerged as one of the greatest challenges facing environmental protection agencies in developing countries. This paper presents a characterization study of the municipal solid waste generated in the Federal Capital Territory, Abuja, Nigeria. The characteristics of the municipal solid waste were determined in terms of the components, average mass (kg) and percentage generated per district. It was found that 56.20%/52.0% of the solid waste generated in the area is made up of food/ petrucsible; rubber 10.20%/3.56%; paper 10.00%/ 12.46%; glass/ceramics 7.60%/1.42%; plastics 7.4%/2.85%; metals 2.60%/0.71% and other forms of waste 5.60%/25.62% (dust particle, Ash, stones) for wet and dry seasons respectively and the waste generation rates ranged from 0.59 to 0.79 kg/capita/day. The AEPB is faced with constraints like lack of institutional framework, inadequate budgetary provision, lack of institutional framework, inadequate bylaws and regulations and insufficient information on the quantity and composition of the solid waste. It is suggested that adequate financial provision, proper waste legislation, training and re-training of staffs and community full participation in waste management be encourage while formal composting and recycling facilities should be setup.

Keywords: *characterisation, municipal solid waste, abuja, composting, recycling.*

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Characterization of Municipal Solid Waste in the Federal Capital Abuja, Nigeria

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Abstract- Municipal solid waste management has emerged as one of the greatest challenges facing environmental protection agencies in developing countries. This paper presents a characterization study of the municipal solid waste generated in the Federal Capital Territory, Abuja, Nigeria. The characteristics of the municipal solid waste were determined in terms of the components, average mass (kg) and percentage generated per district. It was found that 56.20%/52.0% of the solid waste generated in the area is made up of food/ petrucsible; rubber 10.20%/3.56%; paper 10.00%/ 12.46%; glass/ceramics 7.60%/1.42%; plastics 7.4%/2.85%; metals 2.60%/0.71% and other forms of waste 5.60%/25.62% (dust particle, Ash, stones) for wet and dry seasons respectively and the waste generation rates ranged from 0.59 to 0.79 kg/capita/day. The AEPB is faced with constraints like lack of institutional framework, inadequate budgetary provision, lack of institutional framework, inadequate bylaws and regulations and insufficient information on the quantity and composition of the solid waste. It is suggested that adequate financial provision, proper waste legislation, training and re-training of staffs and community full participation in waste management be encourage while formal composting and recycling facilities should be setup.

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I. Introduction

Solid waste can be defined as garbage, refuse and other discarded materials including waste resulting from industrial, commercial and agriculture operations and from community activities or waste that are normally solid and that are discarded as useless or unwanted (Tchobangolus, 1983). The solid content is technically known as refuse while the liquid substances are called effluent (Ahmed, 2002). According to Environmental Protection Department Air Management Group, EPDA (2001), waste involves categories of household, municipal, commercial and industrial wastes, some hazardous and toxic.

Municipal solid waste includes wastes generated from residential, commercial, industrial, institutional, construction, demolition, process, and Residential Single and multifamily dwellings generate food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g., bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes. Commercial Stores, hotels, restaurants, markets generate paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, etc (Tchobanoglous et al., 1993).

Waste characterization is a fundamental component in any municipal waste management scheme (MWMS) of urban solid waste in a city but such data are not commonly compiled in cities across Africa (Guadalupe et al, 2009).

Waste characterization data consists of information on the types and amounts of materials (paper, food waste, glass, yard waste, etc.) in the waste stream. It depends on a number of factors such as food habits, cultural tradition, socioeconomic and climatic conditions. It varies not only from city to city but even within the same city itself (Gawaika, 2004).

The composition and characteristics of municipal solid waste is influenced by certain factors, which include the area (residential, commercial, etc), the economic level (differences between high and low-income areas), the season and weather (differences in the amount of population during the year, tourist places) and culture of people living or doing business in the area. High-income areas usually produce more inorganic materials such as plastics and paper, while low-income areas produce relatively more of organic waste. Uncontrolled or improperly sited open solid waste dumpsites constitute health hazards and damage the aesthetic beauty of many cities in Nigeria (Napoleon et al 2011). Characterization of municipal solid wastes is simply a descriptive means of identifying the various constituent of the waste stream in times of quantity and quality generation taking into account location as well as seasons in which these wastes are generated. It is a means of finding out how much paper, glass, food waste, etc. is discarded in the municipal waste stream.

According to Gawaikar (2004), characterization of municipal solid waste helps in determining the quantity of waste generated in a particular location at a particular time of the year. This help in identifying the trend of generation as well as the influencing factors. It makes proper planning of solid waste management, determining the size and number of functional units and

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equipments required for managing the waste, the needed resources for the protection of environment and public health. Characterization is also important to determine its possible environmental impacts on nature as well as on society (Alamgir et al, 2005).

Treatment methods differ in dealing with different waste streams (Jarusombat, 2002). Options include recycling, land filling, biological treatment (i.e composting and gasification), and thermal treatment such as mass burn incineration (with or without energy recovery) and fuel burning (Refuse Derived Fuels-RDF) (Babcock and Wilcox, 2003, Yongziang et al.2003, Glusszynski 1995, Harvey 1987).

Municipal Solid Waste (MSW) data are sometimes measured both in volume (m3/capita/day) and in weight (kg/capita/day).

II. Materials and Methods

For the purpose of this study the the Gosa dumpsite located in the Federal Capital Territory was used for the waste collection and characterisation. Gosa dumpsite was chosen as it serves as the current solid waste management dumpsite in Abuja and also due to its problems, size, and challenges. The site has an approximate 90 hectare (222acres). The study was undertaken in the wet and dry seasons of 2010 and carried out in three steps.

Step 1: Documents, records and academic literature relating to municipal solid waste management.

Step 2: The Abuja environmental and protection board (AEPB) the environmental agency workers, private contractors, residents and scavengers involved in municipal solid waste management were interviewed to update information in the document and records collected.

Step 3: Gosa dumpsite was visited for the collection, sampling, separation and characterization.

Samples of freshly disposed municipal solid wastes from the waste stream at Gosa dumpsite were manually and randomly collected, identified, sorted out, characterized and weighed.

For the classification of waste, seven waste components were considered. These were food, paper, iron, glass, rubber, plastic and others. Others in this category represent solid waste that are not identifiable or do not fall into the first six categories. Sorting and weighing of collected waste were done at the dump site. The materials and resources used at the dumpsite for data generation were sorting platform, an electronic scale for weighing the waste, bins for all the sorting categories, gloves, a calculator and trained assistants.

The study also involved the use of questionnaires for the public as well as for the relevant government agency saddled with the responsibility (The Abuja environmental and protection board, AEPB). The questionnaire was designed and structured such as to allow the respondents to freely express their feelings as expressed or stated by variables and were administered to the general public in the study area in the months of March and August, 2010.

Descriptive statistics was used in obtaining frequency, counts and expressing such in percentages.

III. Estimation of Municipal Solid Waste Generated in the Federal Capital, Abuja

A total of 727 trips was estimated to be made weekly by the privately owned waste trucks evacuating waste from different locations in the Federal Capital to Gosa dump site. Each waste truck is estimated to have a carriage capacity between 8 – 10 tonnes.

In view of the above, the total estimate of tonnes of solid waste evacuated for year 2010 in the Federal capital, Abuja lie between 302,372 to 378,040 tonnes (302472000kg to 378090000kg) and the average solid waste generation rate is also estimated to lie between 0.59 – 0.74 kg/person/day.

Table 1: Annual Estimation of Municipal Solid Waste in the Federal Capital, Abuja for Year 2010.

Name of District	Waste per Annum (kg)	Percentage (%)
Phase I (Abuja Districts)	144,040,000	38.10
Phase II & III	76,440,000	20.22
Satellite Towns/Suburban Districts	157,560,000	41.68
Total	**378,040,000**	**100%**

Table 2 : Breakdown of Municipal Solid Waste Generation Rate in Abuja District Year 2010.

Name of District	Mass (Kg)	Percentage (%)
Asokoro	14, 560, 000	10.11
Central Area	8, 320, 000	5.78
Garki	50, 960, 000	35.38
Maitama	19, 240, 000	13.36
Wuse	50, 960, 000	35.38
Total	**144, 040, 000**	**Total=100**

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Table 3 : Physical Characterisation Household Wastes at Gosa Dumpsite During the Wet Season of 2010.

Wastes type	Mass (kg)	Percentage (%)
Fabrics	-	-
Food/petruscible	19.1	56.2
Glass/ceramics	2.6	7.6
Metals	0.9	2.6
Paper	3.4	10.0
Plastics	2.5	7.4
Rubber	3.6	10.2
Others	1.9	5.6
Total	**34.0**	**100.0**

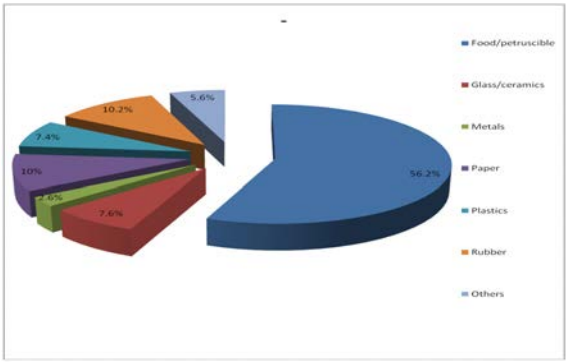

Fig. 1: Percentage of the Physical Characterisation of Household Wastes at Gosa Dumpsite during the Wet Season of 2010.

Table 4 : Physical Characterisation of Household Wastes at Gosa Dumpsite during the Dry Season of 2010.

Wastes type	Mass (kg)	Percentage (%)
Fabrics	0.4	1.42
Food/Petruscible	14.6	52.00
Glass/ceramics	0.4	1.42
Metals	0.2	0.71
Papers	3.5	12.46
Plastics	0.8	2.85
Rubber	1.0	3.56
Others	7.2	25.62
Total	**28.1**	**100.0**

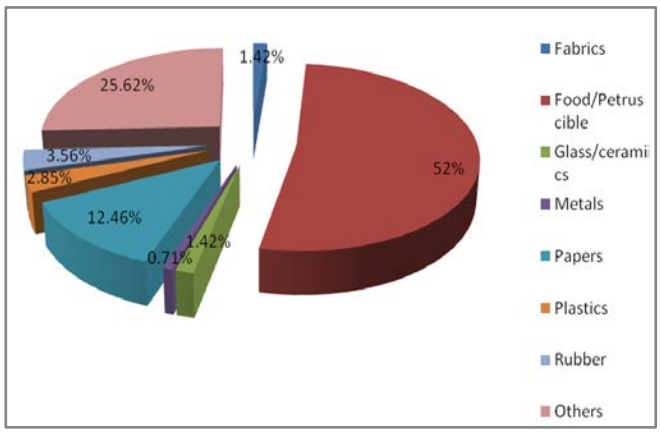

Fig. 2 : Percentage of the Physical Characterisation of Samples of Household Wastes at Gosa Dumpsite during the Wet Season of 2010.

IV. Discussion of Results

a) Waste Collection and its Transportation in Abuja

It is both the function of the state and local government environmental protection agencies to collect and properly dispose municipal solid waste. Due to the increasing rate of waste generation, private contractors are also involved in the waste collection for a fee. Hence, private solid waste collection operators exist in parallel with the official agency charge with the collection of waste just like in other cities in Nigeria. The private contractors are designated to specific areas of the town. These private companies were found to have higher efficiencies than the government agency but better still are not properly monitored or regulated by the government agency including dishonesty on the part of some of the contractors and late payment of contractors by the government worsen the situation. Stationary containers system is adopted for waste collection; the waste containers remain at the points of waste generation and collected few days for disposal by the Abuja Environmental Protection Board, AEPB and the private contractors designated to specific locations. The residents of are requires to deliver the waste to the storage container which are generally kept at open spaces along street ends or junctions. The positioning of fixed containers were mostly in the suburban unlike in the major town movable bins mostly of plastic nature were place house-to-house for the collection of the waste. This method of waste collection is less convenient for the sanitation staffs. Some of the containers are movable while some are fixed on the ground.

Some of the available vehicles used for the solid waste collection and disposal were the compactor trucks, side loaders, rear loaders, mini trucks, tippers, skip trucks and open back trucks are the commonly used collection trucks and were in-short supply and mostly out of service due to frequent breakdown as a result of overuse.

Research finding revealed challenges faced by the agency saddled with the responsibility of waste management in Abuja, which include inadequate

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budgetary provision, poor trained staff, lack of institutional framework, insufficient information on the quantity and composition of the solid waste and inadequate bylaws and regulations.

b) Waste Generation, Characterisation and Recycling

The result in table 3 reveals that population density influences greatly on waste generation rate as this is seen by the estimated fractions of household waste evacuated from the Satellite towns/Suburban districts as most workers in the territory resides in the satellite towns hence the major reason for such volume of waste generated. The closeness of industrial area to the dumpsite could also attribute to it. Phase I is home exclusively to the elite society and it is next to the Satellite towns in percentage of tonnes of municipal solid waste generated annually. Phase II and Phase III are estimated to have the lowest annual percentage of tonnes of waste generation. Table 5 puts Garki and Wuse as the highest generators of municipal solid waste ahead of Maitama followed by Asokoro and lastly Central Area under Phase I (Abuja District). This trend is undoubtedly influenced by income and the socio-economic activity and population density.

The analysis of solid waste composition in the study for both wet and dry seasons shown in tables 3 and 4 indicates that 56.2% and 52.0% of the solid waste is made up of food/petruscible materials for the wet and dry seasons respectively. The other composition are; plastics (7.4% and 2.85%; glass/ceramics (7.6% and 1.42%); metals (2.6% and 0.71%); paper (10.0% and 12.46%) and rubber (10.2% and 3.56%).

This indicates that composting/biodegradation can be used for the disposal of this 56.2% and 52.0% of the waste and the fertiliser can be derived as the end-product. This is in-line with previous research work by Hoornweg et al, (1999) where they found out that waste stream are over 50% organic materials in developing countries. In separate works in Bandung and Indonsia have shown that residential waste composed of 78% and 81% composable materials (Cointreau, 1982). High-income earners consume more of packaged products that give rise to a higher percentage of non-biodegradables (inorganic materials) like metals, plastics, glass/ceramics (Ogwueleka, 2009). This was found to be true as higher percentage of the inorganic materials were influence by the income rate.

The average per capita waste being generated in the study area is estimated to lie between 0.59 – 0.74 kg/capita/day depending on the location. Dauda and Osita (2003) obtained 0.25kg/capita/day for Maiduguri, Igbinomwanhia and Olanikpekun (2007) research study review 0.56kg/capita/day for Mushin, Lagos and Solomon (2009) quoted 0.49kg/capita/day for average Nigeria communities with household and commercial centres. The range of 0.59kg/capita/day to 0.74kg/capital/day depends on the socioeconomic status of the people and thus the location.

Presently at the Gosa dumpsite, there are no formal recycling and composting. Scavengers were in their number scavenging useful materials for recycling to earn a living. These scavengers were mostly young men who drop out of school due to one reason or the other whereas in some few cases are men who earn their living through it. The work is hazardous to their health as they operate without protective wares. Recycling which is a solid waste management technique is more desirable and environmental friendly. The practice of recycling and composting would save cost in waste management (Agunwamba, 1998).

V. Conclusion

The first step in waste management is to gain an understanding of the waste types being generated in order to design appropriate collection and disposal strategies and this can be achieve through characterisation of waste. The largest proportion of waste in Abuja metropolis can be composted rather than disposed of. The solid waste being generated is made of seven major components (fabrics, food/petruscible, glass/ceramics, metals, paper, plastics, rubber and others). The study shown that 56.2% and 52.0% of the total solid waste generated in the FCT was made of biodegradable matter. The per capita waste generated in the FCT lie between 0.59 – 0.74 kg/capita/day. The result clearly suggest the need to establish a formal composting (for 56.2% and 52.0% of the waste) and recycling facilities (for 37.8% and 21% of the waste) within the FCT using the result of this characterisation study as a guide.

Efforts should be made by stakeholders to evolve policies for disposal, waste reduction and recycling project. There is need for adequate budgetary provision for Abuja Environmental Protection Board, AEPB for proper training and replacement of the existing vehicles with modern equipment to reduce operating costs. The agency should also encourage community participation and involvement in waste management. Also formal composting and recycling facilities should be setup at Gosa dumpsite.

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