Municipal Solid Waste Characteristics in Ado-Ekiti, Nigeria

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ABSTRACT---- ***Rapid development of urban cities and towns in Nigeria calls for proper planning of urban waste management to provide a tolerable environment for the growing population of Nigerian cities. This paper discusses the characters of solid waste generated in Ado-Ekiti, the capital city of Ekiti State, Nigeria. The area was divided into ten zones based on the number of wards in the city. Households were randomly selected based on the map of the area and demarcation of zones. Questionnaires were designed and administered on the people in the area. Waste was collected from sampled households. The waste was sorted and analyzed. Household sizes sampled ranged from 1 to 11 with an average of about 5 persons per household. Over 50% of the sample population were children with an average of two children per family and a maximum of six. Over 80 percent of the respondents have some form of education ranging from primary to tertiary education. The study revealed that majority (35.5%) households in the study area employ plastic dust bin materials for waste storage. Waste generation in the area is influenced by cultural background, standard of living and economic activities among others. The study showed that the bulk of the wastes sorted in Ado-Ekiti were of domestic origin. About 1.028 kg/household/day waste was generated. Leaves/vegetable matters; ashes, dust and stones; and food remnants have high percentage weight of 20.4%, 16.6% and 12.3% respectively. Other components are paper (10.2%), plastic (8.2%), and tin cans (6.1%). The least of all the waste generated comes from bones which was 1.2% of the sample. Further analysis showed that the weights of non biodegradable wastes collected from the sampled areas were less than the weights of biodegradable wastes. The study suggests that the municipal solid waste stream in a typical Nigerian city at point of disposal is high in putrescible organic content. The study suggests that as urban environmental problems worsen in developing countries, non-conventional approaches to urban pressure points like waste management will have to be adopted.***

Keywords--- waste management, environmental, putrescible, organic content, biodegradable, recyclable

1. INTRODUCTION

Municipal Solid Waste (MSW) is defined to include refuse from households, non-hazardous solid waste from industrial, commercial and institutional establishments (including hospitals), market waste, yard waste, and street sweepings. Municipal Solid Waste Management (MSWM) refers to the collection, transfer, treatment, recycling, resources recovery and disposal of solid waste in urban areas. The goals of Municipal Solid Waste Management are to promote the quality of the urban environment, generate employment and income, and protect environmental health and support the efficiency and productivity of the economy.

In many developing countries, Municipal Solid Waste Management (MMSW) systems are becoming more complex with movement from landfill-base systems to resource-recovery-based solutions (Burnley *et al*., 2007). Cities in developing countries are confronting a twin dilemma in rapid growth of urban population resulting in increased demand of waste management services and poorly developed traditional public sector to the growing demand for such services (Ahmed and Ali, 2006). The issue of poor solid waste management (SWM) has become a challenge for governments of developing countries of Africa (Calo` and Parise, 2009; Halla and Majani, 2003; Mwangi, 2000; Ogu, 2000; Zia and Devadas, 2008). Hence, this has huge consequences in terms of collection, disposal and the elimination of waste (Thonart *et al*., 2005; Moghadam *et al*., 2009). In almost all developing countries, city solid waste constitutes a hazard, be it from the ecological point of view or the public health point of view. Almost everywhere, there is a distinct lack of policy on efficient waste collection and a total absence of its treatment (Ojeda-Benitez, *et al*., 1999).

Many experts from various cities in developing countries have expressed serious concerns about improper waste treatment and disposal in these countries (Berkun *et al.*, 2005; Pokhrel and Viraraghavan, 2005; Barton *et al*., 2008; Chung and Lo, 2008; Imam *et al*., 2008; Sharholy *et al*., 2008). In most developing countries, solid waste management is undertaken by the local authorities. These services include waste collection (either from households or city collection points) to final disposal. However, the low financial base and human resource capacity of these local authorities mean that in most cases they are only able to provide a limited service (Barton *et al*., 2008). Inadequate management of solid waste in most cities of developing countries leads to problems that impair human and animal health and ultimately result in economic, environmental and biological losses (Wilson *et al*., 2006; Kapepula *et al*., 2007; Sharholy *et al*., 2008).

Solid Waste Management is an obligatory function of State and Local Government Administrations in Nigeria. However, this service is poorly performed, resulting in problems of health, sanitation and environmental degradation. With over 2.38% annual growth in urban population and the rapid pace of urbanization, the situation is becoming more and more worrisome with the passage of time. Lack of financial resources, institutional weakness, improper choice of technology, and lack of support from public, towards Municipal Solid Waste Management (MSWM) has made this service far from satisfactory in Nigeria.

In Nigeria, big cities are faced with many problems due to improper management of household solid waste. Indeed, even with the best of intentions, authorities are unable to establish and implement an efficient management plan mainly because of the lack of understanding of solid waste generation and its characteristics. Authorities tend to implement management plans and use equipment which is not adapted to the realities of Nigeria cities. Monitoring of solid waste generation and its assessment is a continuous process. Extensive research works are therefore needed in this field to find ways to abase the problems arising from improper solid waste management. A good understanding of municipal solid waste (MSW) stream (generation and assessment) could allow local authorities to better plan waste management.

The present study was conducted for producing data on the quantity and assessing the composition of municipal solid waste which could help in developing adequate management strategies in Ado-Ekiti. Ado-Ekiti is the capital of Ekiti State in the Federal Republic of Nigeria. Solid waste generation has increased proportionately in this city with the growth of urban population. The existing solid waste management system in the city is not well organized and hence not serving the proper solution of the problem. Solid waste collection rate by Ekiti Central Local Authority is not satisfactory. Non-collected waste is generally thrown in drainage canals, footpath, in open fields and buildings under construction. Beside this, government system and policies, administrative and managerial procedures are considered as some of the major waste management problems in Ado Ekiti city. The main objectives of this study therefore, were to make a systematic analysis of municipal solid waste leading to quantification of the amount of municipal solid waste (MSW) generated from the studied areas and to determine its composition so as to highlight some specific features capable of promoting research on recovery of Ado-Ekiti city solid waste.

2. MATERIAL AND METHODS

The study area is Ado-Ekiti which serves the dual roles as the headquarters of Ado Local Government and the capital of Ekiti State, Nigeria. It is situated 254 kilometers East of Ibadan, capital city of Oyo State, Nigeria, 218 kilometers, South of Ilorin, capital of Kwara State, 351 kilometers, North East of Lagos, the commercial capital of Nigeria. Ado-Ekiti lies between Latitude 7^{o} 40` North of the equator and Longitude $5^{o}$ 15` East of Greenwich meridian (about 400 m *a.s.l*) in South Western Nigeria.

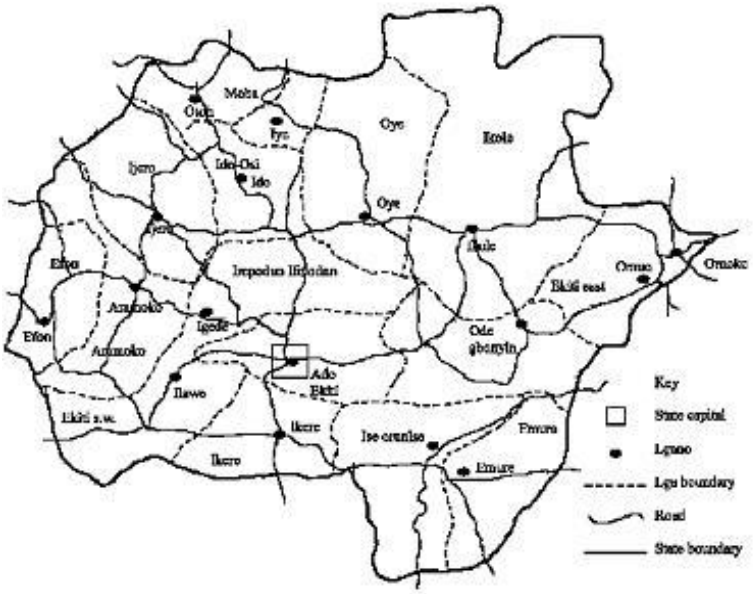

Fig 1: Map of Ekiti State, Nigeria showing the geographical location of the study area.

The climatic characteristic of Ado-Ekiti is a by product of the climate of Nigeria. Ado-Ekiti, being a tropical climatic area, is affected by two air masses in the course of the year - the tropical continental (TC) which is hot, dry and dusty and the tropical maritime (TM) which is cooler and moisture laden. The tropical continental is responsible for the dry season why the tropical maritime is responsible for the raining season. The onset of raining season begins about April and ends in late October or early November. The mean minimum temperature in Akure is about 20^{o}C while the mean maximum is 36^{o}C. Relative humidity in Ado-Ekiti is generally high ranging between 80% and 100% in the

mornings and during precipitations, while in the afternoon values range between 60% and 80%. However, during the hamattarn haze spells of November to January, relative humidity values of 40% to 50% are possible especially after mid-day. When the temperature start to subside at this time, the relative humidity will start to increase to attain higher value of between 60% and 80%. The city enjoys abundant rainfall of over 1500 mm yearly where the precipitation is virtually restricted to the wet season (April-October). The study area has a landmass of about 13 km^2 which is about 40% of Ekiti State landmass and a population of about 336,628 as at year 2005.

A stratified random sampling was adopted. The area was divided into ten zones based on the number of wards in the city. Households were randomly selected based on the map of the area and demarcation of zones. Questionnaires were designed and administered on the people in the area. Size of households as well as residential density of each zone determines the number of questionnaires administered. Households however cut across residential as well as houses used for commercial/business activities.

Table 1: Division of Ado-Ekiti into Zones

Zone A	**Zone B**	**Zone C**	**Zone D**	**Zone E**
Oke Ado	Oja-Oba	Ijigbo	Idolofin	Oke-Ila
Irona	Oke-Ila	Ojumose	Danimo	Demo
Ureje	Atikankan	Oke-Ese	Stadium	Housing Estate
Waterworks	Governors Office Area	Mathews Street	Oke-Iyinmi	Aralepo
Zone F	**Zone G**	**Zone H**	**Zone I**	**Zone J**
Idolofin	Owode	Remo	Oke-Bola	Opopogboro
Federal Poly	Ilawe Road	Inisa	Ilaro	Adebayo
Odo-Ado		Ogbon-Oba	Olokuta	General Hosp

About 200 questionnaires were administered on 13th May, 2008 to heads of households and organizations out of which 152 were received from respondents. In order to identify the type of consumer, homogeneity of solid waste generated, rate and amount of waste generated in the study area, households with population ranging from 3-12 were selected. The households were first sampled for the kind of materials used for daily waste storage and were then given containers for weekly waste collection. The wastes collected were later separated into biodegradable and non-biodegradable sources. These were weighed using a weighing balance of 0.05 kg sensitivity.

As a w ay of collecting necessary information, following procedures were adopted:

(a) Reconnaissance visit to all zones
(b) Oral interview were conducted on the people as well as the staff of Ekiti State Waste Management Authority
(c) Administration of questionnaires to a cross section of people in the study area
(d) Collection of waste from sampled households, waste sorting and analysis
(e) Weighing of each waste component and determination of total weight.

3. RESULTS AND DISCUSSION

3.1 Basic characteristics of sampled households

Table 2. shows the basic characteristics of sampled households.

Table 2: Basic Characteristics of Sampled Households

Variable	Household characteristics of Respondents (N = 152)			
Age of Respondents (yrs)	Minimum	Mean	Maximum	Standard Deviation
Size of Household (people)	21	38	69	9.2
Total No. of children	1	4.8	11	1.8
Total No. of Old People	0	2	6	1.2
Dependency ratio	0	1.7	4.5	-

The sample consists of 152 households with respondents' ages between 21 and 69 years. The average age is 38 years with a fairly even distribution as indicated by a standard deviation of 9.2. Household sizes sampled ranged from 1 to 11 with an average of about 5 persons per household. An unusual one person per household occurred within the sample but only once as this is very rear in this part of the country. Over 50% of the sample population were children with an average of two children per family and a maximum of six.

Twenty three percent of the sample population comprised of old people which is relatively fairly distributed across the sample. The relatively large number of children and old people among the inhabitants of the sample household leads to an average dependency ratio of about 1.7 with a maximum of about 4.5. This gives the indication of the relatively high

economic pressure on the working population of the people of Ado-Ekiti in terms of responsibility for the livelihood of unemployed relatives or non-working age.
Fig. 2 shows the level of education as reflected from the responses of the questionnaires administered.

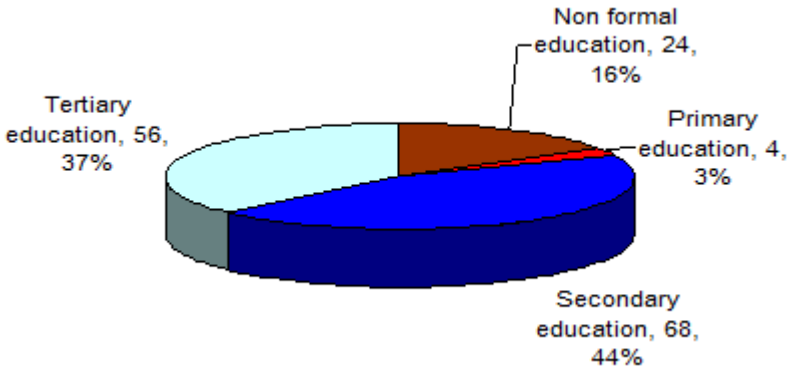

Fig.2: Level of education of Respondents
Source: Author Field Survey, 2008

The figure showed that a sizable proportion of the responses had gone through one form of education or the other. That is, over 80 percent of the respondents have some form of education ranging from primary to tertiary education. Nearly 40 percent of the respondents acquired education above secondary school. These figures reflect the relative high literacy rate in urban centers' in Nigeria especially in Ado-Ekiti, the capital of Ekiti State, generally regarded as leading State in Nigeria in terms of education and therefore given the acronym "the fountain of knowledge".

3.2 Type and Percentage of Waste Storage Materials

The study revealed that majority (35.5%) households in the study area employ plastic dust bin materials for waste storage. Next to this is metal dust bin with a percentage household usage of 18.4. Card boxes ranked 5th among the type of materials used for waste collection in the study area.

Table 3: Type and Percentage of Waste Storage Materials

Container	Respondent	% of Household	Rank
Plastic	54	35.5	1
Basket	22	14.5	3
Polythene bag	18	11.8	4
Cardboard (Box)	16	10.5	5
Metal Dust bin	28	18.4	2
Others	14	7.3	6
Total	**152**	**100**	

It was observed however that some households prefer dumping their wastes directly on the floor in a corner of the house but sweep off or pack such wastes early in the morning to dumping grounds few meters away from their residences. The reason for high usage of plastic materials as a major collection material in the study area may not be unconnected with its affordability. Study however revealed that roll of bins and baskets are used in commercial areas such as the market places. Such containers are placed at a distance of not more than 250 m to waste generation spots.

3.3 Source of wastes generated in the study area

Table 4 shows the source of wastes generated in the study area. Waste generation is influenced by cultural background, standard of living and economic activities among others. Industrialization is low in Ado-Ekiti and this accounts for the low percentage of source of waste generation. People engage mainly on petty trading and farming. The bulk of the wastes sorted in Ado-Ekiti therefore were of domestic origin.

Table 4: Source of wastes generated in the study area

Source	No of Respondents	% of Respondents
Domestic Activities	132	86.8
Commercial Activities	12	7.9
Industrial Activities	8	5.3
Total	152	100

3.4 Per capita generation of wastes in selected household in Ado-Ekiti

Shown in Table 5 is the result of the per capita generation of wastes in the selected household in Ado-Ekiti.

Table 5: per capita generation of wastes in selected household in Ado-Ekiti.

Household Group (HG)	Range of Household No.	Mean of Household No.	Weight per household (kg/household/day)	Weight per capita (kg/C/day)
HG 1	1-2	1.5	0.374	0.249
HG2	3-4	3.5	0.627	0.179
HG3	5-6	5.5	0.759	0.138
HG4	7-8	7.5	1.163	0.155
HG5	9-10	9.5	1.843	0.194
HG6	11-12	11.5	1.403	0.122
Total			**6.169**	**1.038**
Mean			**1.028**	**0.173**

The result showed that about 7.2 kg/household/week or 1.028 kg/household/day was generated. It was observed that group HG5 had the highest waste generated per day with a value of about 1.84 kg/household/day. This may be as a result of high number of adults in this category of household. It was also noted that HG6 with the highest number of household had the least wastes generated per day. This may not be unconnected with the difference in the level of income and economic power among the households in the study area. This invariably determines the purchasing power of the people and a possibility of downward trend in the per capita waste generation even as population increases.

3.5 Waste Composition

The characteristics of waste generated from the sampled area of Ado-Ekiti are shown in Table 6.

Table 6: Solid Waste characteristics

Waste Composition	% of Total Waste Composition
Leaves/vegetable matters	20.4
Food remnants	12.3
Paper	10.2
Textiles	3.4
Plastic	8.2
Metals	2.7
Glasses	2.5
Bones	1.2
Wood	3.2
Ashes, dust and Stones	16.2
Organic matter (animal waste)	2.6
Tin cans	6.1
Ferrous metals	1.9
Non ferrous metals	1.4
Cotton wool and empty sachets	2.3
Miscellaneous	5.4

The study revealed that leaves/vegetable matters; ashes, dust and stones; and food remnants have high percentage weight of 20.4%, 16.6% and 12.3% respectively. Other components are paper (10.2%), plastic (8.2%), Tin cans (6.1%). The least of all the waste generated comes from bones which was 1.2% of the sample.

Further classification of the wastes generated into biodegradable and non-biodegradable components (Table 7) showed that the weights of non biodegradable wastes collected from the sampled area were less than the weights of biodegradable wastes.

Table 7: Biodegradable and non-biodegradable components of Waste generated

Household Group (HG)	Range of Household No.	Mean of Household No.	Biodegradable Components		Non-Biodegradable Components	
			Daily*	PCPD**	Daily	PCPD
HG 1	1-2	1.5	0.238	0.159	0.136	0.091
HG2	3-4	3.5	0.261	0.075	0.366	0.105
HG3	5-6	5.5	0.347	0.063	0.412	0.075
HG4	7-8	7.5	0.684	0.091	0.479	0.064
HG5	9-10	9.5	1.305	0.137	0.538	0.057
HG6	11-12	11.5	0.981	0.085	0.422	0.037
Total			3.816	0.610	2.353	0.427
Mean			0.636	0.102	0.392	0.071

*Daily components in kg/household/day. **PCPD-per capita per day in Kg/C/day

Most of the non biodegradable wastes come from metal packaging materials and degraded vehicle parts in addition to some non-edible items; hence majority of the households cannot afford this luxury consumption probably due to low income level. The difference in weight may also be due to the fact that the biodegradable waste contains more moisture than the non-biodegradable, hence more weight.

The study shows that the waste generated contains high putrescible organic content with less of plastic, glass, metals and paper. However, though the per-capita generation rates of these materials are relatively low, they may be present in sufficient quantities in the municipal solid waste streams of neighbouring densely populated cities in the State to warrant labor-intensive recovery ventures. The high organic content suggests possible value as composting material. However, the viability of these schemes is likely to depend highly on end markets for their products. The low calorific values make the waste stream unsuitable for energy recovery via incineration.

In general, at the household level in low-income peri-urban areas, resource recovery begins with the reuse of plastic bags, bottles, paper, cardboard, and cans for domestic purposes, thereby extending their useful life. The rate of reuse in this instance is high, and these materials enter the waste stream only when they are no longer fit for domestic use. In high income areas, recovery is carried out by domestic servants and/or wardens. Rather than reusing the materials directly, they sell bottles, plastics, cardboard, and paper to middlemen or commercial centers that pay for these materials. The extent to which these transactions occur depends on the availability of marketable end uses for the materials. While such industries may be found in some primary cities, they are largely absent in secondary cities and in rural areas. Even in those cases where they are found, they do not consistently stimulate recycling in their host cities. Glass bottles are usually returned to their point of sale for direct reuse by the beverage industry. The glass content of the municipal solid waste stream is insufficient to support a glass recycling industry. Instead, the bottles not used for beverages are diverted from the waste stream and used as containers in homes. Other glass items are discarded with the rest of the municipal solid waste stream.

4. CONCLUSION

The study suggests that the municipal solid waste stream in a typical Nigerian city at point of disposal is high in putrescible organic content. However, it is low in percentage of commercially recyclable components and too low in heating value for energy recovery by incineration. Certain wastes may eventually become resources valuable to others once they are removed from the waste stream.

Waste recycling is often undertaken as a survival strategy when the urban poor are unable to obtain formal employment, and when non-waste resources are scarce or unaffordable. By reducing the total amount of solid waste headed for the landfill or left lying to decompose in the streets), recycling and composting are land saving and pollution reducing strategies. Waste re-use also plays a valuable resource conserving role: by recycling materials, further exploitation of scarce natural resources is minimized, thus containing the spreading ecological footprint of the city. Despite these environmentally and socially beneficial aspects of waste recycling, however, it is not without its negative impacts, which include exploitation by waste buyers and poor health and living conditions for the urban poor who deal in waste picking. Environmental pollution is a major health risks to humans, which is to be tackled on a priority basis. It is also essential to prepare comprehensive national health profile database on health effects due to pollution with respect to urban cities.

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