SOLID WASTE GENERATION AND MANAGEMENT IN TUDUN WADA, ZARIA, KADUNA STATE, NIGERIA

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ABSTRACT

Solid Waste management problem is one of the most common environmental challenges facing most cities particularly in the less developed countries. This study therefore, examines solid waste generation and management in Tudun Wada, Zaria, Nigeria. Questionnaire survey and direct field measurement were employed for data acquisition. Three hundred and eighty two (382) respondents were systematically sampled, and waste was collected from each of the sampled households for a period of one week. Questionnaire was also administered to the respondents in order to elicit data on the common methods of waste management in the area. The volume of the waste was measured with the aid of calibrated bucket. The results revealed that the average volume and weight of waste generated per household per day was 13.98dm. It was also discovered that food and fruit remnants constituted the highest proportion (23.55%) of the entire waste components. Biodegradable category of the waste accounted for 76.23% while the non-biodegradable was 23.77%. The results further showed that open space burning was the most common (37%) method of managing waste in the area followed by dumping at illegal open dumpsites (34%). The study recommends conversion of biodegradable component of the waste into compost manure for farming purpose; also recycling and reuse of the non-biodegradable component of the waste should be encouraged.

Keywords: Solid waste, Solid waste generation, Solid waste management.

INTRODUCTION

Solid waste is any discarded (abandoned or considered waste-like) material. This includes household refuse, agricultural remnants, food leftovers, plastic bags, tin cans, ash and packaging, such as cartons and used *jonya* sacks. They become waste once they have been discarded because they are no longer needed in their present form. Refuse, garbage, litter and street sweepings are all terms used to describe solid waste in various situations. The type of solid waste generated varies depending on the particular location and the socio-economic and cultural conditions of the area (Hester & Harrison, 2002).

Among all the wastes (solid, liquid and gas), solid waste is the most popular and most difficult to manage locally (Ogunbiyi, in Akpu & Yusuf, 2011). This is because solid waste does not flow, evaporate, diffuse, dissolve or be absorbed into the surrounding unlike liquid waste which flows away from its point of generation and dries or evaporates if on land, or dissolves or is absorbed by surrounding water to dilute if in rivers or seas. In a similar

manner, gaseous waste flows away from its point of generation and diffuses into the atmosphere.

The volume and composition of solid waste generated varies from place to place. According to Akpen (2005), the amount of solid waste generated by a place, is a function of population, technological advancement and the type of economic activities in such an area. Similarly, Ibrahim (2006) identified population as the main determinant of the volume of waste generated per household. Ajadi and Tunde (2010) observed that socio-economic activity was a major determinant of the type of solid waste generated in different parts of Ilorin metropolis and that food remnant and paper were the most common components of solid waste generated in the area.

The increase in the composition of non-biodegradable component of solid waste in most cities of developing nations has been attributed to the importation of fairly used goods. The countries have become dumping grounds for these goods which expire within a short period of time, and eventually become waste posing environmental challenges (Annan, 2001). Similarly, Aondoakaa (2007), in his study on household demands for improved solid waste management in Gboko, Benue State, discovered that the use of 'tokumbo' electronics was responsible for the rapid growth in the volume of solid waste accumulation in the area. Also, Freduah (2008), in his research on the problems of waste management in Nima, Ghana, identified canned food industries as the major contributor of non-biodegradable solid waste, which has resulted to waste management problem in the area.

Waste is not just an environmental issue as many people still believe, it is a threat to human health since a dirty environment is one in which infectious diseases such as malaria, cholera and many others spread further and faster (Annan, 2001). Hester and Harrison (2002) viewed open pile up of refuse as a factor that favour the breeding of household pests such as mosquitoes and cockroaches which cause diseases of different types. The quality of ground water in an area is subject to the nature of waste generated in such an place, as injurious materials from waste often leach into the water table and thereby, resulting to adverse health implications on the users.

Sustainability of waste management is key to providing an effective service that satisfies the quest for a sustainable environment. One pillar of sustainable solid waste management is categorization of the waste generated in an area; it enables the choice of most appropriate method of managing each category of waste. It also gives room for cost analysis of solid waste options, as well as useful analytical tools for effective waste management. Categorization of solid waste is the systematic grouping of waste into classes based on similar characteristics (Seo, 2004). The first step toward achieving effective waste management is categorization (Nwanko, 2004).

The problem of solid waste management has become a matter of national and even global concern. Presently, the poor state of solid waste management in urban areas all over the developing countries is not only an environmental problem but also a major social handicap (Ugah, 2008). No environmental problem has greater significance than the disposal of man's liquid and solid waste. During the first century of the industrial revolution, the volume of waste generated globally was relatively small and could be managed through the concept of dilute and disperse (VME., 1999). However, with the high rate of

industrialization and urbanization, dilute and disperse method became inadequate and inefficient. This marked the beginning of solid waste management problem (Knox & MacCarthy, 2005). Inadequate management of solid waste can be responsible to various environmental problems such as blockage of drains, obstruction of free flow of traffic, ground water pollution and the destruction of the aesthetic value of the city (Jegede, 2008; Ibrahim, 2008; Aondokaa & Ishaya, 1997; Botkin & Keller, 1998).

There has been a phenomenal increase in the volume and range of solid waste generated daily in Nigeria within the past few years and this is largely due to the increasing rate of population, urbanization, industrialization and general economic growth (Aondoakaa, 2007). Uwadiegwu and Chukwu (2013) asserted that big cities like Enugu, Lagos and Kano, in Nigeria produced on the average, 46kg of solid waste per person, per day. In many Nigerian cities, the volume of solid waste has overwhelmed urban administrator's capacity to manage; thus, it is not uncommon to find urban streets and roads practically blocked by solid waste (Abaje, 2007). United Nations System in Nigeria (2001) revealed that only about 30-50% of generated wastes are collected in most Nigerian cities and the practice of waste recycling is minimal. In other words, the rate of collection and evacuation of solid wastes is yet to keep pace with the high rate of their generation in Nigerian cities and this therefore, constitutes an environmental nuisance in the country (Uwadiegwu & Chukwu, 2013). It was observed that the ineffective approaches adopted in the management of solid waste in Nigerian cities have created the wrong impression that urban waste management issues are one of the most intractable environmental problems facing the country. For instance, Ajadi and Tunde (2010) discovered that refuse depots in Ilorin metropolis were inadequate, unevenly distributed and not easily accessible. It was discovered that more than 65% of the residents in the area had to cover a distance of between 300 and 700m to access a refuse depot. This could result in indiscriminate waste disposal.

 Solid waste management involves the interplay among generation, storage, collection and final disposal. One single governmental agency alone cannot effectively cope with the volume of solid waste generated in Nigerian settlements; the management of solid waste should therefore, involve all and sundry (Uwadiegwu & Chukwu, 2013).

Like any other city in Nigeria, solid waste management is a major environmental problem in Zaria area due to the increasing rate of urbanization. With increase in population and urbanization, the volume of waste increases and the composition of waste changes as well creating management problems. In their rural- urban analysis of the composition of waste dumpsites and their use for sustainable agriculture in Nigeria, Akpu and Yusuf (2011) observed that food and fruit remnants were the most common component of waste in urban Zaria while in the rural part, it was ash and dirt. The existence of heaps of refuse along major roads, back yards and drainage system are common features observed in the area due to improper solid waste management. It has been discovered that indiscriminate open dumping of waste is the most dominant method of waste disposal among residents of Zaria (Ukwede, 1999). Hence, the need to analyze the generation and management of waste in Tudun Wada, Zaria, Nigeria. The aim of this study therefore, is to examine the nature of waste generated and methods of its management in Tudun Wada, Zaria. In order to achieve

the said aim of this paper, the objectives are to: (i) determine the volume and weight of waste generated by households (ii) identify the type and category of waste generated (iii) examine the methods of waste management in the area.

THE STUDY AREA

The study area (Tudun Wada) is located at about 83km to the north of Kaduna, with latitudinal position of between 11°12'20" and 11°13'00" North of the Equator, and longitudes 7°34'85" and 7°35'23" East of the Greenwich meridian (See Fig. 1). Tudun Wada is an extension of urban Zaria, politically, it is part of Zaria Local Government Area.

It is characterized by Tropical continental climate with distinct wet and dry season (Mortimore, 1970). The climate of the area is dry sub-humid with annual rainfall of about 1200-1500mm. The mean monthly temperature is about 27°C but higher between the months of March and May, representing the hot dry period (Oguntoyinbo, 1998). Zaria is drained by Galma River with four other tributaries namely, River Kubani, Shika, Saye, and Basawa (Mortimore, 1970). The area lies on the Hausa High plains of northern Nigeria, characterized by inselbergs, pediments landscape overlying on the basement complex (Oguntoyinbo, 1998).

Tudun Wada is one of the largest and densely populated districts in urban Zaria, inhabited by the indigenous Hausas and other multi ethnic groups such as Yoruba, Igbo, among others. The population was 36,601 (NPC, 1992), by 2013, the population has reached 65,045 (projected population using 1991 census as base). The population almost doubled between 1991 and 2013. This implies great increase in the volume and character of waste generated which would eventually pose management issues. Farming is the dominant economic activity in the area, followed by trading. Small scale industries and craft works which are labour intensive are also found in the area. Most of the commercial activities take place in the traditional Tudun Wada market. As a result of these activities, it is expected that waste of various kinds (biodegradable and non-biodegradable) would be generated.

This research employed both primary and secondary sources of data acquisition. The primary data were acquired through questionnaire survey and direct waste measurement in the field. A total of 382 respondents were sampled as a representative of the entire population (Krejcie & Morgan, 1970). The respondents were systematically sampled due to the well laid-out streets in the area. The first house on each street was selected then the 5th, 10th, 15th etc. Daily wastes generated by the households were collected, and sorted into different components. The volume of the wastes collected from each sampled household was measured using a bucket calibrated in litres which was then converted to diameter cube (dm^3). The questionnaire was also administered to the sampled respondents. This was to ensure proper representation and coverage of the entire population. The questionnaire sought data on the methods of waste management in the area. Simple frequency tables were employed to analyze and present the results.
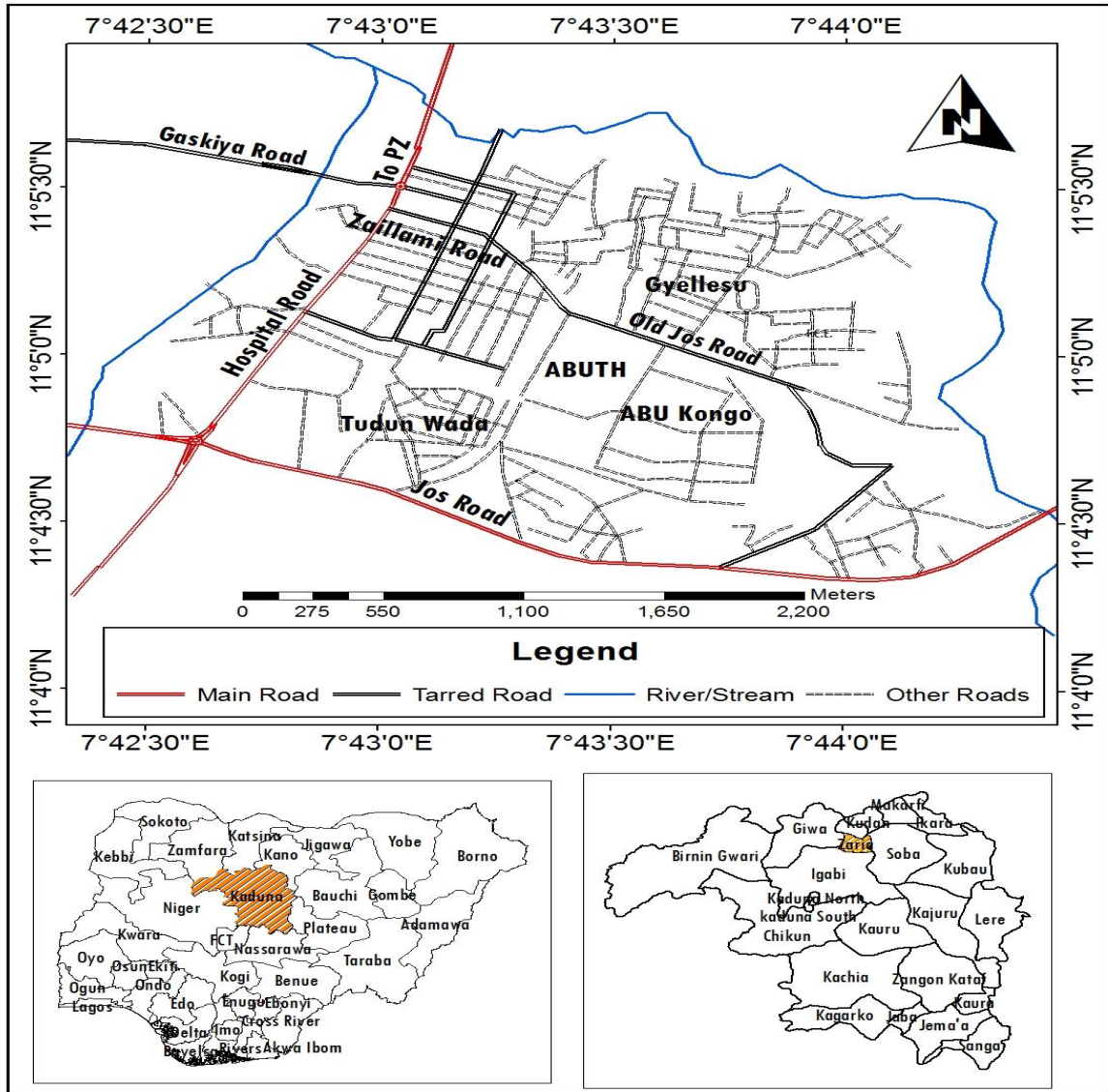
Fig.1 Zaria Metropolis showing Tudun Wada.
Source: Adopted from Jegede, Osazua & Abdullahi (2011)

RESULTS AND DISCUSSION

This section presents the results gotten from the analysis of the questionnaire survey and measurement of the volume and weight of the waste collected from the sampled households.

Socio-Demographic Characteristic of the Respondents

The socio-demographic characteristics of the respondents are shown in Tables 1 and 2. The sex and age distribution are presented in Table 1 while Table 2 shows the occupation of the respondents.

Table 1: Demographic Characteristics of Respondents

Sex	Frequency	%
Male	115	30
Female	267	70
Total	382	100
Age		
15-19	50	13
20-24	84	22
25-29	84	22
30-34	80	21
35-39	50	13
40 and above	34	09
Total	**382**	**100**

Source: Field Survey, 2013

Table 1 shows that majority of the respondents (70%) were females. The high proportion of female respondents could be attributed to the fact that women especially married ones spend more time at home than their men counterparts and more so, they are more directly involved in the management of waste in the homes. It can also be observed in table 1 that the bulk of the respondents (78%) were within the youthful age group of 15-34. This portrays the high youthful population structure that characterizes the population of developing countries.

Table 2 shows that farming was the most common (34%) in the area. this is closely followed by trading which constitutes 33% of the entire respondents. This implies that the youthful nature of the population and the occupation of the populace may have contributed to a greater extent to the nature and volume of waste generated in this area.

Table 2: Occupational Distribution of the Respondents

Occupation	Frequency	Percentage (%)
Civil Service	107	28
Trading	126	33
Farming	130	34
Others (Artisan, etc)	19	05
Total	**382**	**100**

Source: Field Survey, 2013

Component of the Solid Waste

The composition of the solid waste generated by the sampled respondents as derived by sorting of the collected waste is presented in table 3.

Table 3: Composition of Waste

Composition	Volume (dm^3)	Percentage (%)
Plastic	160.21	3.02
Textile	427.23	8.05
Paper and card board	907.86	17.11
Food and fruit remnants	1249.64	23.55
Metal scrap	9.08	0.17
Ash and dirt	726.29	13.69
Leaves and woods	733.77	13.83
Polythene and nylon	904.12	17.04
Bottle and glasses	13.35	0.25
Tin and cans	174.63	3.29
Total	**5306.18**	**100**

Source: Field Survey, 2013

The component of the solid waste collected as revealed in Table 3 shows that fruit and food remnant was the most popular which constituted about 23.55% of the entire waste collected in the area. This was expected because it was a residential area. The second largest component of waste was paper and cardboard (17.11%) flowed by Polythene and nylon (17.04%). The high proportion of paper and cardboard may be due to the presence of educational institutions in the area. The large fraction of Polythene and nylon could be attributed to the consumption of sachet water and other food stuff packaged with these materials as well as the use of polythene bags to package goods bought from markets.   The high percentage of ash and dirt (13.69%) may be attributed to the common use of firewood for cooking in the area. Plastic, bottle and glasses, and tin and cans constituted a minute proportion of the waste generated in this area. This is similar to the result obtained by Ajadi and Tunde (2010) in Ilorin metropolis which shows that food remnant and paper were the most common components of solid waste generated in the area. This result also agrees with the findings of Akpu and Yusuf (2011) which shows that food and fruit remnants were the most common component of waste in Urban Zaria.

Categories of Generated Solid Waste

In this research, the wastes were categorized into biodegradable and non-biodegradable. Table 4 presents the percentages of each category as derived from Table 3. The biodegradable material include: textile material, paper and cardboard, food and fruit remnants, ash and dirt, leaves and woods. This category of waste constituted the bulk of the generated waste which amounted to about 76.38% of the total waste collected by the respondents.

Table 4: Categories of Solid Waste

Categories of Waste					
Biodegradable			**Non-biodegradable**		
Component of Waste	Vol. (dm^3)	%	Component of Waste	Vol.(dm^3)	%
Paper and cardboard	907.86	17.11	Plastic	160.21	3.02
Textile material	427.23	8.05	Metal scrap	9.08	0.17
Food and fruit remnants	1249.64	23.55	Polythene and nylon	904.12	17.04
Ash and dirt	726.29	13.69	Bottles and glasses	13.35	0.25
Leaves and woods	733.77	13.83	Tin and cans	174.63	3.29
Total	**4044.79**	**76.23**	**Total**	**1261.39**	**23.77**

Source: Field Survey, 2013

The non-biodegradable component which includes metal scrap, plastic materials, bottles and glasses, polythene and nylon, as well as tin cans constituted about 23.77% while the biodegradable component was 76.23% of the entire waste. This result is similar to the one obtained by Akpu & Yusuf (2011) which shows that biodegradable waste was significantly higher than non-biodegradable waste in Urban Zaria. This percentage of non-biodegradable waste is enough to pose solid waste management problem in this area and if not properly handled, could result in various environmental problems.

Volume and Weight of Generated Waste

The average volume and weight of waste generated per day per house hold was 13.98dm³ and 10.3kg respectively. The results also revealed that an average volume and weight generated per capita daily was 2.12dm³ and 1.5kg respectively. This figure is enough to cause solid waste management problem in the area. Considering the rate of population growth in this area (almost doubled between 1991 and 2013) and the per capita volume of waste generated, ones can imagine how solid waste mange problem will look like in the next ten years.

Waste Management

This section examined the most common methods of waste management used by the inhabitants in the area as presented in table 5.

Table 5: Methods of Waste Management

Methods	**Frequency**	**Percentage (%)**
Dumping at illegal dumpsites	130	34
Open space burning	140	37
Indiscriminate throwing at open spaces	107	28
Others (burying, incinerating, and land filling)	4	01
Total	**382**	**100**

Source: Field Survey, 2013

As presented in Table 5, open space burning was the most common method of waste management in this area. This was closely followed by dumping at illegal dumpsites (37%). Only 1% of the respondents use either incinerators, landfills, or buries their waste.

Environmental and Health Implications of the Waste Management Methods

It is established from the results presented in table 5, that 99 percent of the inhabitants in the area use inappropriate waste management methods. The concomitant effects of these waste management methods may pose great environmental challenges. For instance, Abaje (2007), in his work on "flood in Kafanchan", asserted that dumping of solid waste in gutters and streets was among the major causes of flooding in the area. It is obvious that a high percentage of the respondents (28%) throw their waste indiscriminately in open spaces around. This could culminate in blocking the drainage channels and hence, contributing to urban flooding during the rainy seasons. Open space burning which was the most common method of waste management emits smoke which pollutes air making it unhealthy for the inhabitants. According to Seo (2004), smoke from burnt waste affects the eyes of the people that are exposed to it. The wastes dumped at the open or unprotected illegal dumpsites often destroy the aesthetic value of area, and pollute the air by emitting some unpleasant odor especially during the rainy season. The heavy metal and other injurious elements from the open dumpsites often leach into the ground and may pollute the ground water sources and thereby, constituting health problems.

CONCLUSION

This study examined the nature, and management methods of generated solid waste in Tudun Wada Zaria, Nigeria. The average volume and weight of waste generated per household per day were 13.98dm³. The composition of the waste generated in the area includes metal scrap, plastic material, textile material, paper and card board, food and fruit remnants, ash and dirt, leaves and woods, polythene and nylon, bottles and glasses, and tin cans. The bulk of the waste collected in the area was of the biodegradable component constituting about 76.38% of the total waste collected.

Based on the findings of this research, the following are recommended:

i. Biodegradable waste should be converted to compost manure for agricultural production. This will go a long way in reducing the volume of waste accumulation in the study area.
ii. Individual and corporate investors should invest on technologies that convert waste to organic fertilizers.
iii. There is a need for legislation that will prohibit indiscriminate dumping of solid waste.
iv. Recycling method of waste management should be adopted to manage the non biodegradable component of the waste.

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