Seasonal Variations of Household Solid Waste Generation In Mubi, Nigeria.

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Abstract

Solid waste management problem has been a subject of great concern in developing nations because it has remained intractable mainly due to absence of quantitative data for its planning and management. This study examines seasonal variation in household solid waste generation in Mubi, Northern Nigeria because households are the main generators of solid waste since the country is not sufficiently industrial. Data was collected through observation and measurement of 603 systematically selected household from 30 wards that make up Mubi metropolis, and data generated was summarized using descriptive statistical measures. Results show that waste generated from households (wet and dry season) are mainly ashes, garbage, rubbish (paper and carton) plastic/polythene bags and metallic materials. The mean waste generation rate of a household is 2.7kg/day in wet season and 3.1kg in dry season. The calculated standard deviation for wet season is 1.6kg/household/day and dry season is 1.4kg/household/day, and the coefficient of variation is 59% and 45% in the same order.

The result of the student t-test shows that there is a slight variation in the volume and rate of wastes generated in wet season being less than that of dry season. This variation can be attributed to greater agricultural resource utilization resulting from crop harvest with on-set of the dry season with reciprocal waste generation, as well as the increase in the purchasing power of residents due from proceeds of crop sales at that time among others factors. The study recommends the use of the data base created by Adamawa State Environmental protection Agency (ADSEPA) and private waste management agencies, for effective planning for municipal solid waste management in the area. An increase in the provision of waste collection, storage and disposal facilities particularly in the wet season by waste management agencies should be imminent.

KEY WORDS: Seasonal, Variation, Household, Solid Waste, Generation.

Introduction

Household solid waste is any useless or unwanted solid material discharged as a result of domestic chores (Adefemi and Awokunmi, 2009). Household solid waste is troublesome to manage because it consist of diverse mixtures of materials (glass, metals, plastics, papers, food, nylon, vegetable, dead animals etc).

In Nigeria, like most developing countries, cities have been undergoing rapid growth rate primarily due to increasing rural-urban influx, natural population increase, industrial and economic activities, with a consequent increase in waste generation (Izeogu, 1989). The increase in the level of waste generation and subsequent management has attracted a lot of attention most recently yet the problem remains intractable. Wastes still proliferate most urban environment in Nigeria (Sada, 1980), as they are dumped indiscriminately because they are generated so fast, and the capacity and infrastructure to evacuate and properly dispose the wastes are grossly inadequate (Omuta, 1988).

In Mubi metropolis, households are the largest contributors of Municipal Solid Waste (MSW). This is because the area is not sufficiently industrialized and is not much of a centre of commerce but more or less a civil service and agrarian town. Thus, the sources of household solid waste are obviously domestic activities.

Mubi metropolis cut across Mubi North and Mubi South local government areas, and is located in the northern part of Adamawa State, North-Eastern Nigeria. It lies between latitude 10^0 14′ and 10^0 18′ north of the equator and longitude 13^0 14′ and 13^0 19′ east of the Greenwich meridian (Adebayo, 2004). The climate of the area is characterized by two main seasons, wet and dry season determined by two predominant winds, the South West Monsoon wind (wet) and the North East Monsoon wind (dry). The area has a total population of 280, 009 persons (FRN Official Gazette, 2007), mainly of the Fali and Gude agrarian ethnic groups, and a total land area of 4728.77Km^2.

The metropolis has since the 1990s expanded in land area and population, and has grown economically (Bernard, 2008). These changes, particularly the demographic expansion, and new consumption pattern, have brought phenomenal increase in volume and diversity of solid waste generated within the metropolis.

Considering the growth within Mubi Metropolis, the trend in waste generation has not been matched with appropriate waste management practices primarily due to the absence of quantitative data on the rate of generation needed for planning. The problem is the increasing gap between the volume of waste generated and the rate at which it is evacuated, albeit indiscriminately disposed. Major results of this gap are the heaps of refuse that characterize the metropolis since the township dwellers utilize the most expedient means of disposing their varied wastes.

The major practice is open dumping with no prior processing. Areas regarded as “no man’s land”, particularly open spaces, excavation sites, gutters, and drainages especially the Yedseram River that dissects the township serve as ‘available’ waste disposal outlets. Consequently, the wastes are either set ablaze on accumulation, with attendant air pollution, or allowed to block the water pathways, resulting to persistent annual floods in marginal or squatter settlements around the river Yedseram. To say the least, the wastes pose grave health hazards, blocking drains, roads and streams, exuding obnoxious odors, defile aesthetic values, creating eye sores, and causing fire out break when openly incinerated in high-density residential areas (Mshelia, 2001).Generally, waste if not properly managed contaminates the biosphere.

One of the major reasons why the problem of municipal solid waste management persists is the inability to quantify and estimate the amount of waste being generated in order to plan for its management by waste management agencies. Mubi metropolis, characterized by wet and dry seasons apparently may have variation in the quantity and rate of solid waste generation owing to the different scenarios, and may therefore require varying approach in the planning and management of waste generated at these varying periods. This concern with other reasons necessitated the study.

. The studies aim therefore is to evaluate the quantity and rate of wet and dry season waste generation in the metropolis by:

- Identifying/classifying by composition the types of solid waste generated by households in the area;
- Determining the quantity/volume of wastes generated by households seasonally;
- Comparing the average rate of solid waste generation between the two seasons (wet and dry season) in the area.

Hypotheses

Arising from the aim of the study is a hypothesis which states that:

There is no variation in the quantity or rate of household solid waste generation in wet and dry seasons in Mubi metropolis;

Materials And Methods

Equipment's/Tools used for Data Collection

The following are equipments/tools used to collect wet and dry season data for the study, regarding municipal solid waste generation;

i) Improvised data recording sheet
ii) Polythene waste receptacle.
iii) Hand gloves
iv) Still camera
v) Salter scale
vi) Tri Cycle
vii) Surgical Mask
viii) Metal Cart (push-push)

Procedures of Data Collection

(1) Reconnaissance Survey: The researcher reconnoiters the study area and areas of difficulties were identified among which are haphazard arrangement of land uses as the study areas development codes were not adhered to. For instance, residential areas (households) were found in areas purely meant for commercial activities. Equally, some residential houses were not numbered. Other areas of difficulties identified are accessibility problems of bad urban roads and cull de sac.

However, the problems were surmounted through various ways viz: careful choices of residents and those that were not been numbered were given numbers for research convenience.

The use of tri-cycle (*Keke NAPEP*) and metal cart (push push) was employed to facilitate the collection of waste samples from households to designated collection and weighing points within the neighborhood.

(2)Sampling: **T**he stratified systematic sampling techniques were employed in the selection of sample points (residences) to enable data to be collected on household daily waste generation.

Representative samples was chosen among residents on the basis of existing and recognized residential wards in the study area where 30 wards (15 in Mubi North and 15 in Mubi South LGA's) covering the study area was picked (see Figure 1).

Total number of dwelling units, and households (inhabitants) per ward were obtained through physical counting where 26,378 numbers of households, living in 6,020 dwelling units were obtained.

Thus, 40% (602 residences) of dwelling units selected for observation and measurement was picked on systematic basis i.e. every 4th dwelling unit was chosen as representative sample (see table 1) where a household is then selected from each dwelling unit based on availability for data collection.

Table 1: Sample Population of Household Selected for Data Collection.

Wards	Total No. of Household	Total No. of Dwelling Units	25% of Dwelling units (Column 3) Selected for Questionnaire Administration	40% of Dwelling units (Column 4) Selected for Observation and Measurement (Waste Generation)
Wuro Gude	989	236	59	24
Sabongari	540	144	36	14
Shuware	1035	160	40	16
Barama	589	136	34	14
Lokuwa	792	180	45	18

Kolere	1346		272			68			27			
Sabon Layi	1311		264				66			26		
Wuro Jibir	1243		264			66			26			
Wuro Bulude	1527		296			74				30		
Yelwa	1304		260			65			26			
Wuro Alkali	1561		312			78			31			
Kochifa		757		152				38				15
Giipalma	659		188			47			19			
Federal Low Cost	506		148			37			15			
Dazala	596		200			50			20			
Giima	**720**		**140**			**35**			**14**			
Lamorde	**455**		**80**			**20**			**8**			
Gaya	**1089**		**260**			**65**			**26**			
Sebore	**462**		**124**			**31**			**12**			
Kwacham	**932**		**180**			**45**			**18**			
Va'atita	**605**		**168**			**42**			**17**			
Matakam	**735**		**228**			**57**			**23**			
Angwan Kara	**596**		**144**			**36**			**14**			
Nasarawo	**1278**		**256**			**64**			**26**			
Sabon Pegi	**548**		**100**			**25**			**10**			
Arhan Kunu	**744**		**208**			**52**				**21**		
Kabang	**1366**		**308**			**77**			**31**			
Wuro Patuji	**1275**		**248**			**62**			**25**			
Tudun Wada	**474**		**88**			**22**			**9**			
Mundang	**1192**		**276**			**69**			**28**			
Total	**26378**		**6020**			**1505**			**603**			

1. Wards in Mubi North
2. **Wards in Mubi South**

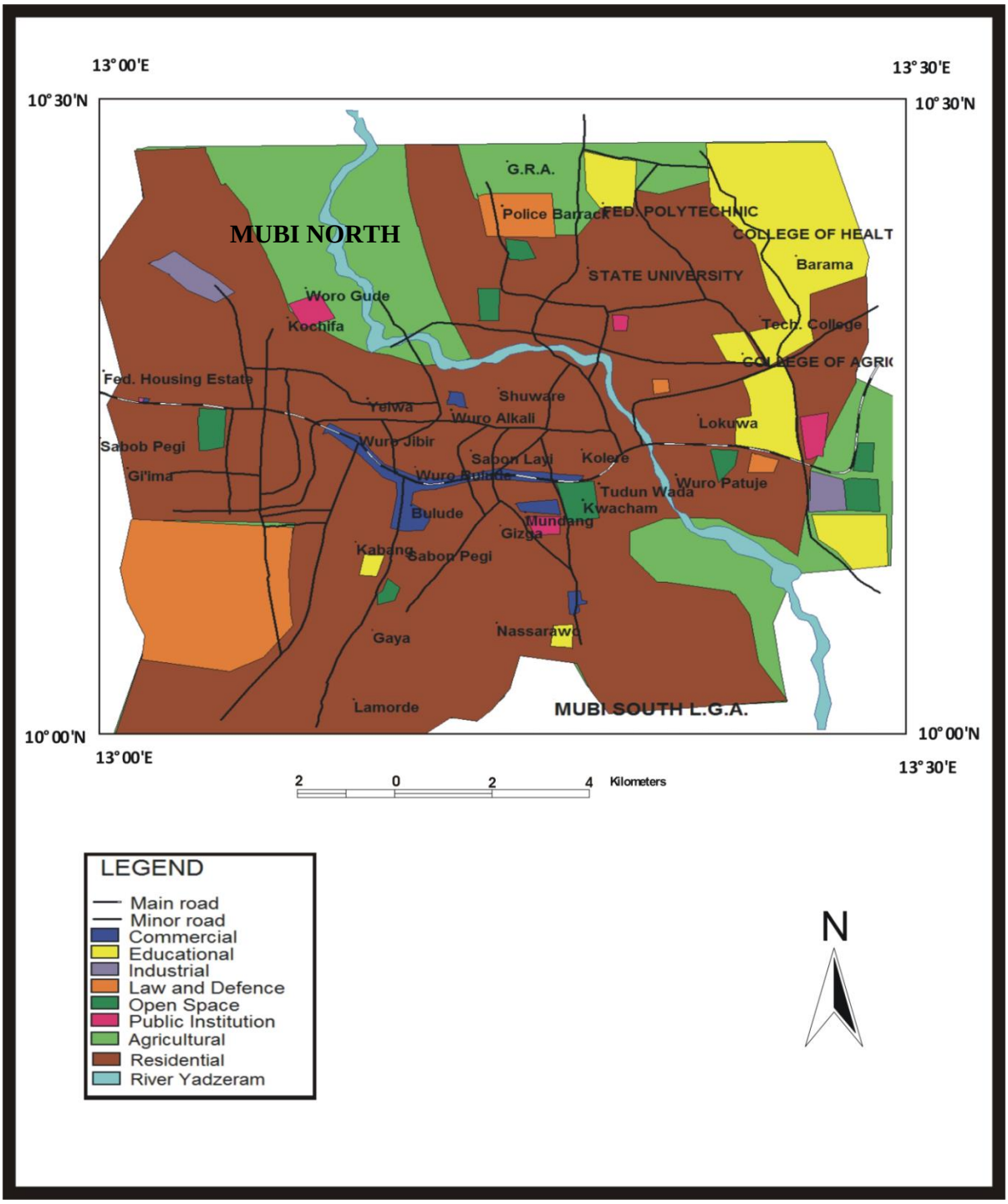

FIGURE.1 LAND USES OF MUBI METROPOLIS

(3) Data Collection: The method employed to generate such data was the use of nine (9) sets of classified black polythene waste receptacles accorded to nine (9) carefully chosen category/class of waste base on their nature or composition as classified in tables 2 and 3. Thus, the sampled residents (see table 1) on daily basis segregate and collect each category/class of waste they generate into the nine (9) sets of polythene bags issued. The wastes are collected daily by two (2) research assistants in all the wards and each class is observed and weighed using the salter scale. This is done to determine the proportion or weight of each class of waste generated in every ward.

The procedure is repeated daily for one week (January 15th to 22nd 2011 for dry season and August 15th to 22nd for rainy season, 2011 respectively). This is to reflect daily and seasonal variations. Equally, the choice of these

particular times in the season is because January is the peak of dry season and August is the peak of wet season in the study area. Thus the average wet and dry season field data for the metropolis is computed in tables 2 and 3.

It is worthy of note that some classes of waste collected from households for this exercise were returned after observation and weighing because some of the materials generated as waste (metal and plastic) are sold by residents to commercial waste collectors or recycled to usable products such as ashes to potash (*dalang*), a local soup condiment.

(3) Statistical Analysis: All data generated were analyzed statistically by calculating, average waste generation (mean), standard deviation (S) coefficient of variation (V) and student t Test using MINITAB Soft ware package and result are discussed below:

Results And Discussion

Tables 2 and 3 below summarizes results of data generated on the average wet and dry season household municipal solid waste generation rate for Mubi metropolis.

Table 2: Waste Generation during the Wet Season in Mubi (Kg/day)

S/N	Ward	Garbage	Rubbish (paper, card-board.	Wood & leaves	Leather & textile fabrics	Ashes	Others (Dust, sand stone etc)	Ceramics, Glass & Glass bottles	Polythene, rubber & plastic materials	Metallic objects	Total Quantity of Waste Generated	Number of Households	Average Quantity of Waste
1	Wuro Gude	16.0	1.8	5.5	0.4	10.0	5.4	4.0	1.0	6.4	50.5	24	2.10
2	Federal Lowcost	13.2	1.6	4.0	1.0	4.1	3.0	2.6	1.3	2.0	32.8	15	2.19
3	Sabon Gari	10.3	1.2	3.5	1.1	7.0	5.8	1.0	1.8	2.0	33.7	14	2.41
4	Dazala	10.7	1.3	2.4	0.6	12.7	8.7	2.4	1.6	2.2	42.6	20	2.13
5	Gipalma	9.8	2.5	2.2	1.1	12.4	5.1	2.0	1.2	2.3	38.6	19	2.03
6	Shuware	20.0	3.2	1.0	2.0	8.5	8.0	5.6	3.1	4.0	55.4	16	3.46
7	Lokuwa	54.0	3.0	7.0	2.1	15.0	4.4	7.5	3.5	6.5	103.0	18	5.72
8	Barama	10.7	2.2	2.0	1.9	10.3	6.0	6.0	2.7	4.1	45.9	14	3.28
9	Sabon Layi	6.3	0.9	3.0	1.0	11.1	6.1	1.4	1.0	4.0	34.8	26	1.34
10	Wuro Alkali	12.0	2.0	2.4	0.5	10.4	4.0	0.9	2.0	2.0	36.2	31	1.17
11	Wuro Jibir	10.2	1.0	4.0	0.3	12.3	7.0	3.0	8.6	6.4	52.8	26	2.03
12	Wuro Bolude	20.0	2.1	4.3	1.0	10.0	4.3	4.2	1.5	7.0	54.4	30	1.81
13	Kolere	22.0	1.9	6.3	0.4	5.0	8.0	5.3	1.2	15.3	65.4	27	2.42
14	Kochifa	21.5	0.8	7.7	1.0	9.0	3.0	2.8	1.4	11.0	58.2	15	3.88
15	Yelwa	12.7	1.0	0.9	0.2	8.7	6.5	2.0	1.1	4.4	37.5	26	1.44
16	Mundang	8.5	1.1	2.9	0.6	11.7	4.6	0.4	0.4	3.0	33.2	28	1.19

17	Tudun Wada	10.4	1.0	2.6	0.3	14.2	2.2	2.5	1.0	3.0	37.2	9	4.13
18	Matakam	5.4	2.1	4.9	1.0	10.2	5.0	4.1	3.5	5.2	41.4	23	1.80
19	Lamorde	19.2	0.8	1.4	0.2	16.0	7.0	4.3	0.8	4.1	53.8	8	6.73
20	Kwacham	15.0	1.5	3.1	1.1	10.7	9.5	4.1	1.1	3.0	49.1	18	2.73
21	Gima	20.0	0.9	3.0	60.1	10.3	4.0	4.5	1.0	5.0	108.8	14	7.77
22	Kabang	15.5	2.0	1.2	0.3	12.6	8.7	1.0	2.1	4.0	47.4	31	1.53
23	Wuro Patuji	16.7	0.6	1.2	0.2	10.5	6.9	5.6	0.8	3.3	45.8	25	1.83
24	Nasarawo	20.2	1.0	5.3	1.0	13.5	4.6	2.4	1.6	5.5	55.1	26	2.12
25	Gaya	15.0	0.7	2.3	0.2	12.1	5.2	2.9	1.7	6.0	46.1	26	1.77
26	Sebore	6.3	0.6	3.7	0.4	10.5	7.2	3.0	2.1	3.6	37.4	12	3.12
27	Sabon Pegi	10.0	0.8	2.0	0.1	14.2	6.0	3.3	2.2	4.9	43.5	10	4.35
28	Angwan Kara	7.1	1.6	3.0	0.2	12.0	5.4	1.8	2.1	1.2	34.4	14	2.46
29	Va'atita	5.0	0.8	4.4	0.5	4.2	4.7	2.8	4.8	5.4	32.6	17	1.92
30	Arahan Kunu	8.8	1.0	1.0	0.3	8.0	7.0	0.5	0.6	0.8	28.0	21	1.33
	Total	**432.5**	**43.0**	**100.2**	**21.1**	**317.2**	**173.3**	**93.9**	**58.8**	**137.6**	**1435.6**	**603**	**2.38**

Table 3: Waste Generation during the Dry Season in Mubi (Kg/day)

S/N	Ward	Garbage	Rubbish (paper, card-board,	Wood & leaves	Leather & textile fabrics	Ashes	Others (Dust, sand stone etc)	Ceramics, Glass & Glass bottles	Polythene, rubber & plastic materials	Metallic objects	Total Quantity of Waste Generated	Number of Households	Average Quantity of Waste
1	Wuro Gude	10.1	1.2	10	0.2	13.3	18.2	4.6	0.6	9.4	67.6	24	2.82
2	Federal Lowcost	7.3	2	11	1.9	17.1	5.1	3	2.5	3.5	53.4	15	3.56
3	Sabon Gari	5.4	3	4.5	1.6	10.8	6.8	2.3	1.2	1.8	37.4	14	2.67
4	Dazala	6	2.1	3	2	15.2	10	4.4	1.4	3.2	47.3	20	2.37
5	Gipalma	5.1	3	6	1.5	20	15.5	2.5	1.8	3.3	58.7	19	3.09
6	Shuware	7.6	2	3	2.4	12	10.7	6	3	10.1	56.8	16	3.55
7	Lokuwa	24	3.3	10.2	1.9	25.3	10.4	6.3	1.7	14.6	97.7	18	5.43
8	Barama	7	2.2	3.3	1.1	18	14.4	5.4	3	6	60.4	14	4.31
9	Sabon Layi	4	0.6	2.7	0.3	20	10.2	3	0.8	3.1	44.7	26	1.72
10	Wuro Alkali	10.4	3.3	2.4	1	18	8.4	4	2.9	3.8	54.2	31	1.75
11	Wuro Jibir	6	1.1	5.5	0.5	15.3	19.7	6	6.2	11	71.3	26	2.74
12	Wuro Bolude	9.1	3	5	1.7	17.9	10.3	9.2	2.3	8.8	67.3	30	2.24

13	Kolere	15.2	2	9.5	0.5	15	15.5	10.1	1	9	77.8	27	2.88
14	Kochifa	10.4	1.4	11	1.8	15.7	17.5	4	1.5	12.1	75.4	15	5.03
15	Yelwa	7.2	1.7	1.5	0.5	11.7	20.4	3.4	1.4	3.8	51.6	26	1.98
16	Mundang	4.5	1.2	4	1	12	9	1	1	4.6	38.3	28	1.37
17	Tudun Wada	5	1.2	3	0.7	16	10	2.5	0.9	3.6	42.9	9	4.77
18	Matakam	4	4	6	2.8	19.4	11.8	8.8	4	10	70.8	23	3.08
19	Lamorde	11.3	1.2	3	1	20.2	15.5	3.1	0.9	5.1	61.3	8	7.66
20	Kwacha m	10.2	3	5	1	16.3	18	7.2	1.3	4.2	66.2	18	3.68
21	Gima	16.3	1	4.3	1.1	15	9.9	6	1.2	5.5	60.3	14	4.31
22	Kabang	10	3.1	2	0.5	18.2	11	1.2	1	8.1	55.1	31	1.78
23	Wuro Patuji	9	1.5	2.1	0.9	17	10	7	0.7	4.3	52.5	25	2.10
24	Nasarawo	4	1.8	4	1.7	13	5.3	4.2	0.5	6	40.5	26	1.56
25	Gaya	7.5	1	3.3	0.3	14	8.2	3.1	2.2	3.2	42.8	26	1.65
26	Sebore	4.6	1.4	4	0.3	18	10.1	4.3	1.1	4.6	48.4	12	4.03
27	Sabon Pegi	5.9	1.2	3.4	0.6	13	8.1	3	1.8	5.1	42.1	10	4.21
28	Angwan Kara	4	2	2.5	0.4	18.1	6.2	2.1	1	2.4	38.7	14	2.76
29	Va'atita	3.2	1	3.8	1	6.1	4.5	3.1	5.5	6.8	35	17	2.06
30	Arahan Kunu	5	1.3	2.6	0.2	20.2	9.6	1	0.7	1.4	42	21	2.00
	Total	**239.3**	**59.9**	**141.6**	**32.4**	**481.1**	**340.3**	**131.4**	**55.1**	**178.4**	**1658.5**	**603**	**2.75**

Categories and Rate of Household Solid Waste Generation

Data was generated by the researcher with respect to categories and rate of solid waste generation by household in Mubi Metropolis. What is analyzed is classified into average wet and dry season field data for solid waste generation.

(a) Category/class

Data analyzed ascertained that in both wet and dry seasons, the categories of ash and other forms of solid waste such as dust, sand, stone, are most generated followed by garbage, and metallic objects (Tables 2 and 3).

Other waste categories generated in varying degrees are wood and leave, ceramics, polythene, rubber and plastic material, rubbish paper cardboard and cartons, and the least waste generated are leather and textile fabrics (Tables 2 and 3). The varying forms of waste categories or class are as a result of residents consumption pattern which in turn roll out waste associated with leftovers of what was consumed or utilized domestically.

(b) Rate of Household Solid Waste Generation

Tables 2 and 3 summarize data on the rate of solid waste generation for wet and dry season in Mubi Metropolis. From the tables, the calculated mean waste generation for wet season is 2.7kg/household/day while that of dry season is 3.1kg/household/day. A simple summation to know the mean waste generation rate for households in Mubi Metropolis will be:-

2.7kg/household/day + 3.1kg/household/day = 2.9kg/household/day.

2

(c) Estimates of Waste Generation for Mubi Metropolis

If an average of 2.9kg of solid waste was generated daily by a household in Mubi metropolis, the mean monthly solid waste generation for a household will be: 2.9kg multiplied by thirty days = 87kg, and the mean annual solid waste generation for a household will be 2.9kg multiplied by three hundred and sixty five days = 1058.5kg (1.05 tons).

Going by the 26378 total numbers of households in the metropolis, the mean annual generation of solid waste in the study area is: 1058.5 multiplied by 26378 = 49023513kg (49023.513 tons).

Statistical Analysis of Solid Waste Generation in Mubi Metropolis, Mubi North L.G.A and Mubi South L.G.A.

The calculated waste generation rate of the various wards in the study area as classified in Tables 2 and 3 was subjected to statistical test of validity in the form of the average Mean; measures of Standard Deviation (SD); Coefficient of Variation (CV); and the Student's t Test

It was determined that households of Mubi metropolis in wet season generate an average of 2.7kg/household/day, while households in dry season generate an average of 3.1kg/household/day. A slight variation is depicted between the average wastes generated in the dry season than in the wet season. The reason for the slight variation corresponds to rate of consumption of products particularly farm products which are higher in the dry season because crops intensively cultivated during the wet season are harvested for consumption at that period. Even the urban poor cultivate his backyard and harvest some crops for consumption by the harvest period (beginning of dry season). Besides, food stuff is more affordable at the beginning of the harvest season (dry season), more so farmers purchasing power is enhanced by the sales of their produce, hence they could afford to buy most of what they desires. Consequently, the higher rate of resource utilization, particularly at the onset of the dry season results to a higher level of waste generation.

The standard deviation for wet season consisting of thirty (30) wards is 1.6kg/household/day while the standard deviation for dry season consisting the same number of wards is 1.4kg/household/day. This shows in comparison, a larger scatter in the set of measurement for wet season than dry season.

The coefficient of variation for solid waste generation rate varies from 10% to 60% (Tchobanglous and Eliassen, 1977). The coefficient of variation of wet season is 59% while that of dry season is 45% and both values fall within the ranges given by Tchobanglous and Eliassen which indicate that less variation is seen in data collected from households in the study area and as such the studies and analysis deducted from them are suitable.

The student t Test was used to test the hypothesis which states that there are no differences between solid waste generation rate in wet season and dry seasons of Mubi Metropolis. The result of the t Test shows the P-value is (0, 02711), and is less than the level of significance (0. 05). hence, the there is significant differences between solid waste generation rate in wet season and dry season in the study area.

Conclusion

Mubi Metropolis is bedeviled by intractable waste management problems or what have become, a myth, defying solutions primarily due to the absence of data for planning. This study hitherto provides a database for planning and policy implementations with regards to municipal solid waste management for wet and dry seasons that characterize the area.

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