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Seasonal Variation in Waste Generation in the Federal Capital City, Abuja

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Abstract

This paper examines seasonal variation in solid waste generation in Abuja, the Federal Capital City of Nigeria, with a view to improving policy development and management efficiency system in the area. An integrated methodological approach involving reconnaissance survey, detailed field observations, scheduled interviews, focused group discussions, questionnaire survey, and use of secondary information was used to obtain. Descriptive (mean, standard deviation and coefficient of variation percentage) and inferential statistics (multiple regression analysis and t-test) were used to analyse the data collected. The results indicate that there is relatively high rate of waste generation in the study area. Secondly, per capita waste generation in mean values is much higher during the raining seasons than the dry season. It was noticed that management would have much to contend with during the wet season. Thus it is recommended that the Abuja Environmental Protection Board (AEPB) should increase the frequency of waste collection from once daily to twice during the wet season. Likewise, all the good provisions made in the city's master plan for effective management of solid waste should be revisited and effectively implemented.

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Introduction

Since 1991 when the seat of the Federal Government of Nigeria was officially moved from Lagos to Abuja, the Federal Capital City of Abuja has been and still is witnessing tremendous influx of people. By the year 2000, it was believed that the city was home to about 3.5 million people (Abejide, 2007). This has exceeded the three hundred and fifty thousand (350,000) people being the projected population figure for the city by the year 2000. With the influx of people outstripping the provision of basic infrastructures, it is believed that the intractable problem of solid waste collection and disposal typical of the rapidly urbanizing cities of the developing world is already being experienced in Abuja city. Waste characterization and generation rates are backbone of any waste management systems. Selection of handling and treatment and disposal systems solely depend on waste characteristics and volume. Analysis of available data and collection of present data of waste characteristics and generation can help to forecast the future generation rates and characteristics of solid waste. Various factors responsible for change in these parameters can be identified (Smith, 1997).

It is important to give consideration to seasonal variations of waste quantities and composition, as this could have great influence on a number of issues such as the expansion of services and vehicle configuration and, in particular, cost.

As we approach the summer months, climatic temperatures and summer conditions can have a significant impact on waste composition on a virtually daily basis. This impact can be from a number of sources: increased fruits waste consumption; the effect on tourism in popular areas; increased use of disposable drinks and sachet water as a result of hot climate; changing household consumption; and high usage of polythene bags.

In this study wet season is referred to from May-October of the year 2010 while the dry involves December 2010 to March 2011 the second year. These changes in waste composition are not strictly limited to the waste collection element of service provision, and can easily extend to street cleansing and litter bin emptying services. Local authorities can experience peaks in litter bin collections, and increased frequencies of street cleansing requirements during the summer months, especially in relation to tourism.

This could also apply to waste treatment and disposal, as any changes to waste composition could influence the final disposal and treatment options, and subsequently affect productivity. evidently, there can be a number of changes to a local authority's waste composition as a direct result of seasonal fluctuations in waste production. The key challenge for local authorities is how to best use the resources available to maximize service delivery whilst still trying to maintain, or even reduce, costs.

Seasonal waste variations can easily lead to services being over or even under-specified at certain times of the year, and more strain is placed upon budgets. If a local authority is lucky enough to have a number of spare vehicle capacity, this could, and should, be regarded as a valuable resource in case of emergency. It is therefore necessary for local authority to design services that would take account of variations in waste generation in different seasons in order to improve service performance.

Data concerning generation rate, variation in generation rate, generation type, volumes of waste generated, and waste composition should be gathered so that waste collection needs can be determined. Information regarding the types, quantities of waste that would be generated and its seasonal variation in rate of waste generated in the FCT is an essential component in planning solid waste management systems. It is important not only to meet collection equipment and labour requirements but also to aid processing and disposal site management. Waste generation rates have been developed and are based on assumptions about growth and change provided by the master development plans for Abuja and the FCT. These rates should be reassessed as actual development in the city takes place. The residential waste generation rate, for example, was expected to increase at 2 per cent per year and then stabilize after 1990; a rapid rate of change was expected in Abuja initially, but continuing the rate indefinitely cannot be justified until an examination of the actual Abuja experience is possible. In general, it is impossible to predict accurately how either the rate of generation or the composition of waste will change over time, making monitoring of the waste actually generated an important component of the solid waste management system. This information is important not only in relation to planning a disposal site or processing alternative but also in selecting collection equipment.

There are multiple determinative factors that directly exercise an influence on the rate of waste generation. That the amount of waste generated in every environment varies from one individual to another, from one area to another and from one season to another, among others, points to the fact that the quantification of the amount of waste generated cannot be easily determined through a mono-causal argument. Many variables have been identified in the literature as being responsible for causing variations in the amount of waste being generated in a given area (Headley, 1998; Jayasundera, 1989; Cointreau, 1997; Mohit 2004; Senkoro, 2003). Among the variables mostly considered are income level, education level of household head and size of households, but this research by specifically examining the influences of income on waste generation within the Federal Capital City, phase one Abuja, Nigeria is critical to tackling the problem of solid waste management in the Federal Capital City.

Furthermore, good interactive data is an essential management tool in dealing with solid waste problems. Reliable data can assist waste producers and handlers to optimize management systems. It is, therefore, the concern and the need to prevent the Federal Capital City of Abuja from experiencing the problem of solid waste collection and disposal that inform this research. Thus, it is hoped that with the recommendations proffered, if implemented, this intractable problem of solid waste collection and disposal, as is the case with the rapidly urbanizing cities of the developing world, would not re-occur in the Federal Capital City of Abuja.

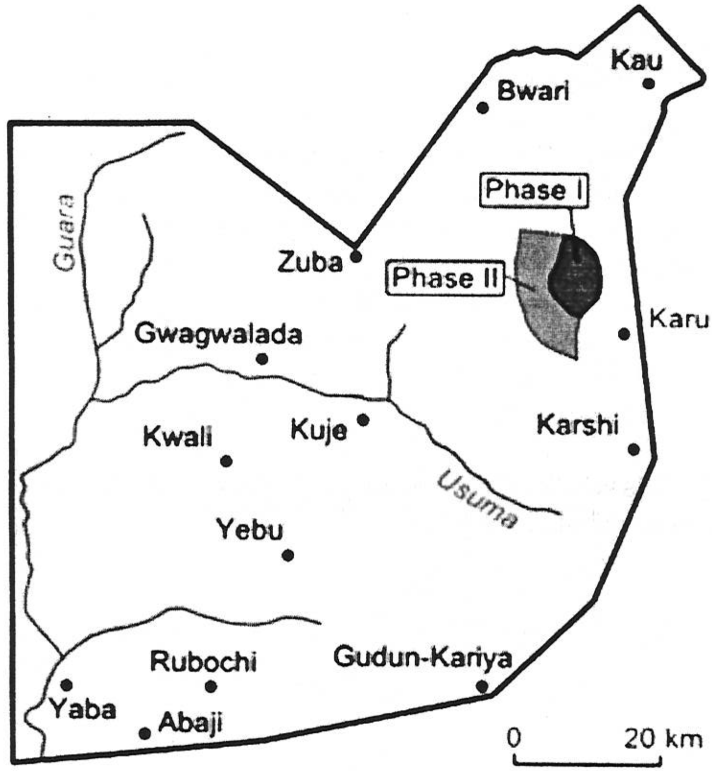
The Study Area

Abuja, the Nigeria Federal Capital Territory (FCT) is located between latitude $8^0$152 453 and $9^0$82 23 north of the equator and longitude $6^0$452 403 and $7^0$372 363 east of Greenwich Meridian in the centre of the country situated within the Savannah region with moderate climatic conditions and a landmass of approximately 8000 km^2. The Federal Capital City is with an area extent of 256.58km ^{2}, phased into phases I and II at the north eastern part of Abuja municipal with an overall land use pattern confined to crescent shaped site defined by developable land above elevation 200feet in the Gwagwa plain below the escarpment surrounding the outer arc of the site including the promontory of Aso hill, 365.76m above the sea level. Phase one of The Federal Capital City (FCC), Abuja has an area extent of about 6000ha (60 km^2) and it is divided into five districts which are Central area district, Maitama district, Wuse district, Garki district, and Asokoro district (See Table 1; Fig 1 & 2).

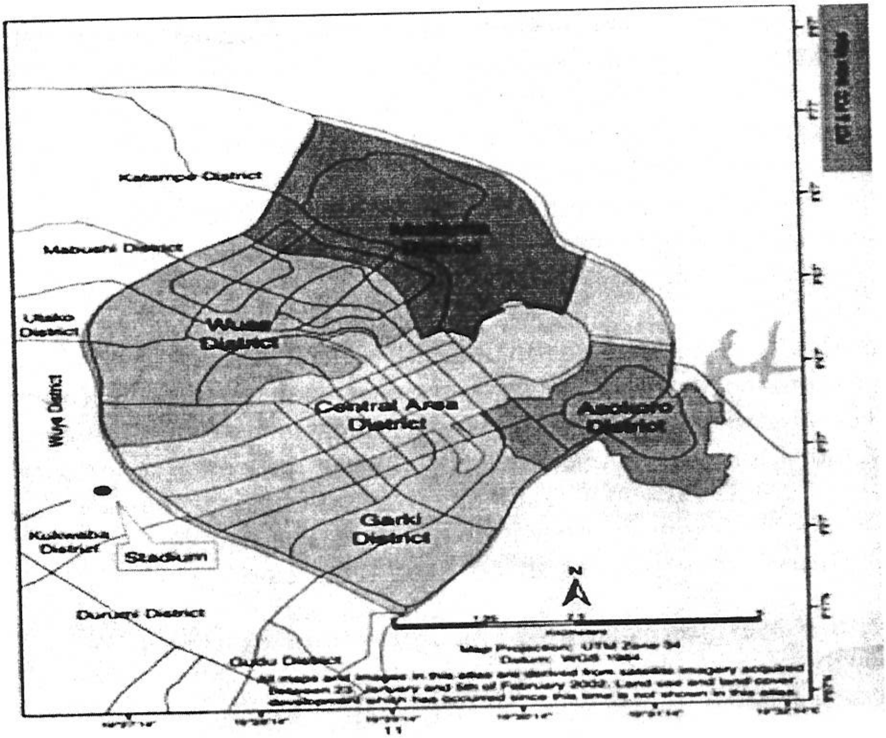
Table 1: Districts of the Federal Capital City Abuja Phase I and Areas in Hectares

District	Area(HECT)	Geographic location
Central Area	1658	lat 9°5'11" and 9°3'8" N; long 19°26'52" and 19°31'48"E
Garki	865	lat 9°3'8" and 9°5'11"N; long 19°26'52" an d 19°26'52"E
Wuse	1530	9°3'8" and 9°6'1"N, long 19°26'30" and 19°29'17"N -
Asokoro	897	lat 9°2'12"and 9°4'12"N ,.long 19°29'56" and 19°30'41" E
Maitama	1050	between 9°4'10" and 9°7'7" N, long 19°28'13" and 19°30'31"E

Source: The Review of Abuja Master Plan, 2001.



Source: Abuja Geographic Information System (AGIS)
Fig.1.0 Map of F.C.T



Source: NASRDA 2002.
Figure 2: The Study Area

Methodology

Reconnaissance Survey was carried out in the study area in order to stratify the location into units for easy administration of questionnaire. The data sources for the research included primary and secondary sources. Secondary sources included studying the specifications on waste collection and disposal contained in Abuja Master Plan and, concept plan for the solid waste collection and disposal system for the Federal Capital City, Abuja.

The bulk of the primary data was derived from measurement of solid waste during the dry and wet seasons of 2003. Other sources of primary data included questionnaire administration, measurement of unofficial dumpsites by volume, and field observation. Information regarding rate of waste generation, per capita per day; types of collection points, dump sites, depots, pits, plastic container, among others; frequency of collection; types of transportation equipment; processing methodologies, residual disposal methods, among others, were derived. Similarly, the recommendations contained in the concept plan for the solid waste collection, and disposal system for the Federal Capital City, Abuja, were studied.

Three different questionnaires were administered which elicited information concerning the generation of solid wastes, were designed. The first set was administered to individual households so as to determine the amount and rate of generation of solid wastes at this level and the factors influencing the amount and rate of generation to households based on plots of land within each district. The study area comprised of district and in each district, there are sub-divisions and number of plots sampled in each area/zone/phase (see Table 2). Systematic sampling was used to sample plots of land in each area/zone/phase within a district. The sample interval for each area/zone/phase is as shown on Table 2.

Table 2: Distribution of Land plots per districts

DIVISION	ZONE/AREA/ PHASE	TAG	NO.OF PLOTS	% OF SAMPLED PLOTS	NO OF PLOTS SAMPLED	SAMPLE INTERVAL
MAITAMA DISTRICT		A5	937	05%	47	20
		A6	2, 847	01.5%	42	68
ASOKORO	PHASE I	A4	1, 703	05%	44	20
"	EXETNSION 2				43	20
CENTRAL AREA	PHASE 1				30	20
"	PHASE II	A0	1, 193	05%	30	20
WUSE II	WUSE II	A7	1, 309	04%	49	27
	WUSE II	A8	1, 239	04%	49	25
WUSE	ZONE I				49	7
	ZONE 2				49	7
	ZONE 3				49	7
	ZONE 4	A2	2, 316	15%	49	7
	ZONE 5				49	7
	ZONE 6				49	7
	ZONE 7				49	7
GARKI	AREA 1				39	4
	AREA 2				39	4
	AREA 3				39	4
	AREA 7	A1	1, 101	24%	39	4
	AREA 8				39	4
	AREA 10				39	4
	AREA 11				39	4
GARKI II	GARKI II	A3	1, 369	05%	68	20

Source: *FCDA Development Control Unit (2000)*

The systematic sampling technique was used for the selection of respondents. The town was stratified into seven units, namely, Maitama District, Asokoro, Central Area, Wuse II, Wuse, Garki I and Garki II.

The sample interval for each area was determined using this formula:

$$\frac{\text{Nos. of Plots}}{\text{Nos. of Respondents}}$$

Table 3 represents the total number of plots allocated in the study area. The letters A1,A2,A3,A4,A5,A6,A7,A8 and A10 signify the different parts of the planned area. This was to ensure an even coverage of the study area during questionnaire administration see Table 3 A total of 295 respondents were sampled.

Table 3: Field Sampled for the Study Area

DIVISION	ZONE/AREA/ PHASE	TAG	NO.OF PLOTS	NO OF PLOTS SAMPLED	Number of Respondent
MAITAMA DISTRICT		A5	937	47	20
		A6	2, 847	42	68
ASOKORO	PHASE1	A4	1, 703	44	20
"	EXETNSION 2			43	19
CENTRAL AREA	PHASE 1			30	20
"	PHASE II	A10	1, 193	30	20
WUSE II	WUSE II	A7	1, 309	49	28
	WUSE II	A8	1, 239	49	25
WUSE	ZONE I			49	7
	ZONE 2			49	7
	ZONE 3			49	6
	ZONE 4	A2	2, 316	49	6
	ZONE 5			49	7
	ZONE 6			49	7
	ZONE 7			49	7
GARKI	AREA 1			39	4
	AREA 2			39	4
	AREA 3			39	4
	AREA 7	A1	1, 101	39	4
	AREA 8			39	4
	AREA 10			39	4
	AREA 11			39	4
GARKI II	GARKI II	A3	1, 369	68	20 TOTAL= 295.

Source: Fieldwork, 2005

Result and Discussions

Students't-test statistical technique was employed to compare the average per capita for wet and dry seasons waste generation figures of each sampling zone/area. The results obtained, presented in Table 4.2, indicate clearly that the differences in per capita waste generation between dry and wet seasons are in general statistically significant within every sampling zone/area. It was only in Garki Area One that the difference was not significant during both the first and second visits, as well as when the averages of the two visits were compared.

During the first visit to households within the sampled area, variation in the amount of waste generated between wet and dry seasons was significant at both confidence levels in Wuse zone three, Wuse zone four, Wuse zone six, Wuse zone seven, Garki area two section one, Garki area eleven, Asokoro phase one, Maitama A5, Wuse II A7 and Wuse II A8 sampled areas. Variations was significant at 99.90% confidence limit only in Asokoro phase 1 and that variation was not significant at both confidence levels in Wuse zone one, Wuse zone five, Garki area one, Garki area two section two, Garki area three, Garki area seven, Garki area eight, Garki area ten, Maitama A6 and Garki II.

Furthermore, during the second visit to households within the sampled area, variation in the amount of waste generated between wet and dry seasons was significant at both confidence levels in Wuse zone two, Wuse zone four, Wuse zone three, Wuse zone six, Wuse zone seven, Asokoro phases one and two, Maitama A5, Wuse II A7 and Wuse A8 sampled areas. It can also be observed that Wuse zone one, Garki area one, Garki area two section one, Garki area two section two, Garki area eight, Garki ten, Garki II and Maitama A6 sampled areas did not show significant variation in the amount of solid waste generated between the two sections during the second visit to households.

The observed differences in per capita waste generation between dry and wet seasons have been statistically depicted within every sampling zone/area (Figs 3 & 4). Furthermore, since it has been established that more solid waste is generated in wet than in the dry season (Buenrostro & Gerardo, 2001), it is natural that the per capita waste generation between dry and wet seasons should be statistically significant within every sampling zone/area. Furthermore the per capita waste generation, in mean values, for wet and dry seasons also vary. During the wet seasons, the per capita waste generation varies in mean values between 1.12 kg to 1.96 kg. Similarly, during the dry season, the per capita waste generation varies in mean values between 0.81 kg and 1.41 kg. This shows that the per capita waste generation in mean values is much higher during the raining seasons than the dry season (see Table 4 to 7). Zerbork and Candidate (2003), Buenrostro and Gerardo (2001) and Rand and Marxen (2000), among others, stated that most of the waste composition in the third world consists of food leftovers and that most food items are seasonal. Thus, this explains the higher per capita waste generation in mean values during the raining season. The fact that most food items are seasonal in the third world connotes, as opined by Dente et al (1998), Maclaran (2002) and Senkoro (2003) that most food items would be available in large quantities only in the wet season. Thus, larger quantities of wastes would be generated in the wet season than in the dry season. The result obtained in the study area conforms to this established observation.

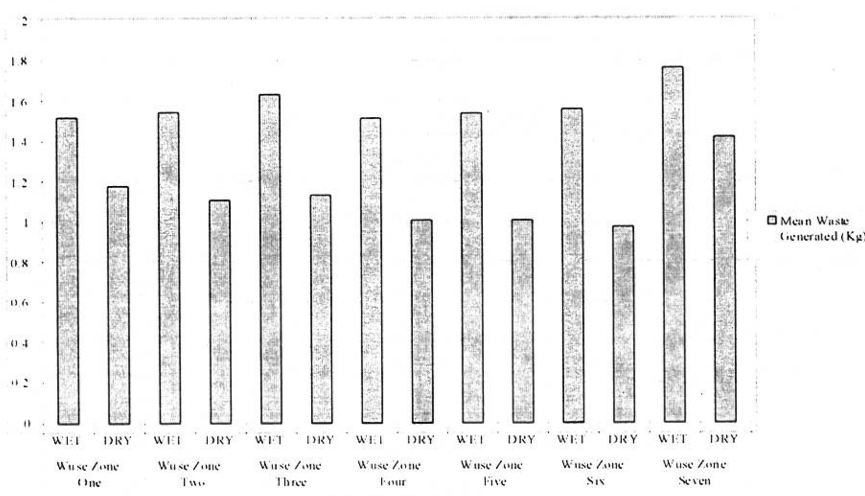


Figure 3: Seasonal Variations in Mean per Capita Waste Generated (Kg) in Various Zones in the Study Areas

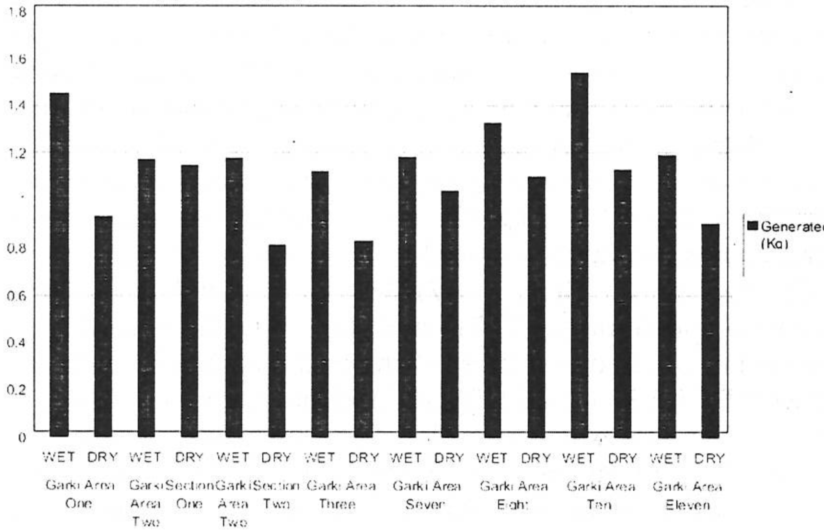


Figure 4: Seasonal Variations in Mean per Capita Waste Generated (Kg) within the Sturdy Areas of Abuja.

Table 4: Descriptive statistics of waste generated over two seasons in Abuja FCC

LOCATION	SEASON	MEAN WEIGHT (Kg)	SD	CV%
Wuse Zone One	Wet	1.5164	0.2604	17.17
	Dry	1.1789	0.2029	17.21
Wuse Zone Two	Wet	1.5449	0.2007	12.99
	Dry	1.1087	0.1377	12.24
Wuse Zone Three	Wet	1.634	0.4008	24.53
	Dry	1.1326	0.1937	17.1
Wuse Zone Four	Wet	1.512	0.2527	16.71
	Dry	1.008	0.1685	16.71
Wuse Zone Five	Wet	1.54	0.3089	20.06
	Dry	1.0062	0.3769	37.46
Wuse Zone Six	Wet	1.5583	0.3002	19.26
	Dry	0.9723	0.6109	62.83

Wuse Zone Seven	Wet	1.7619	0.8494	48.21
	Dry	1.4199	0.4981	35.08
Garki Area One	Wet	1.4514	2.2351	153.78
	Dry	0.9315	0.2292	24.61
Garki Area Two Section One	Wet	1.174	0.1035	8.82
	Dry	1.1491	0.2071	18.02
Garki Area Two Section Two	Wet	1.179	0.1932	16.39
	Dry	0.813	0.1131	13.91
Garki Area Three	Wet	1.1227	0.1491	13.28
	Dry	0.8309	8.136	979.18
Garki Area Seven	Wet	1.1833	0.671	56.7
	Dry	1.0402	0.496	47.68
Garki Area Eight	Wet	1.3293	0.5703	42.9
	Dry	1.1014	0.4535	41.17
Garki Area Ten	Wet	1.5387	0.5978	38.85
	Dry	1.1309	0.4481	39.62
Garki Area Eleven	Wet	1.1885	0.5056	42.54
	Dry	0.903	0.1596	17.67
Asokoro Phase One	Wet	1.8049	0.702	38.89
	Dry	1.1787	0.1128	9.57
Asokoro Phase Two	Wet	1.8882	0.6944	36.78
	Dry	1.1327	0.1087	9.6
Maitama A5	Wet	1.7084	0.4242	24.83
	Dry	1.0072	0.6357	63.11
Maitama A6	Wet	1.6355	0.4651	28.44
	Dry	1.0764	0.2087	19.39
Wuse II A7	Wet	1.7188	0.3387	19.71
	Dry	1.0187	0.5886	57.77
Wuse II A8	Wet	1.9613	0.5571	28.41
	Dry	1.0103	0.1166	11.54
Garki II	Wet	1.4836	0.3421	23.06
	Dry	1.225	0.1171	9.56

Source: Fieldwork 2005

S D = Deviation from the Mean; CV% = Percentage of Standard Deviation

Table 5: Inter Season Variation In Per Capita Waste Generation For The Various Sampling Zones

Sampling Location	Number of Visits	T-value	Degree Of Freedom	Significance Of Difference
Wuse zone one	First visit	1.538	96	Ns
	Second visit	2.03	96	Ns
	Average	7.156	96	Xx
Wuse zone two	First visit	2.608	96	X
	Second visit	2.788	96	Xx
	Average	12.541	96	Xx
Wuse zone three	First visit	2.937	96	Xx
	Second visit	2.894	96	Xx
	Average	7.884	96	Xx
Wuse zone four	First visit	2.928	96	Xx
	Second visit	2.642	96	Xx
	Average	11.614	96	Xx
Wuse zone five	First visit	2.242	96	Ns
	Second visit	4.019	96	Xx
	Average	12.006	96	Xx
Wuse zone six	First visit	3.732	96	Xx
	Second visit	3.817	96	Xx
	Average	13.389	96	Xx
Wuse zone seven	First visit	3.067	96	Xx
	Second visit	4.665	96	Xx
	Average	2.431	96	X
Wuse II	First visit	1.327	76	Ns
	Second visit	1.205	76	Ns
Wuse ii a8	Average	11.579	96	Xx

Table 6 : Garki Zone

Sampling Location	Number of Visits	T-value	Degree Of Freedom	Significance Of Difference
Garki area one	Average	1.451	76	Ns
Garki area two section one	First visit	2.373	76	Xx
	Second visit	-298	76	Ns
	Average	0.674	76	Ns
Garki area two, section two	First visit	1.224	76	Ns
	Second visit	1.023	76	Ns
	Average	10.206	76	Xx
Garki area three	First visit	-0.879	76	Ns
	Second visit	2.427	76	X
	Average	10.727	76	Xx
Garki area seven	First visit	2.123	76	Ns
	Second visit	2.274	76	Ns
	Average	10.707	76	Xx
Garki area eight	First visit	1.633	76	Ns
	Second visit	1.153	76	Ns
	Average	19.371	76	Xx
Garki area ten	First visit	1.882	76	Ns
	Second visit	1	76	Ns
	Average	34.085	76	Xx
Garki area eleven	First visit	4.941	76	Xx
	Second visit	0.381	76	Ns
	Average	10.649	76	Xx
Garki ii	First visit	1.646	134	Ns
	Second visit	1.759	134	Ns
	Average	5.899	134	Xx

Table 7: Asokoro and Maitama zone

Sampling Location	Number of Visits	T-value	DF	Sig. of Difference
Asokoro phase one	First visit	2.491	86	X
	Second visit	3.711	86	Xx
	Average	5.843	86	Xx
Asokoro phase two	First visit	3.607	84	Xx
	Second visit	2.796	84	Xx
	Average	7.049	84	Xx
Maitama a5	First visit	2.754	91	Xx
	Second visit	3.867	91	Xx
	Average	11.206	91	Xx
Maitama a6	First visit	1.941	82	Ns
	Second visit	1.632	82	Ns
	Average	7.108	82	Xx

Source: *Fieldwork 2005*

X = Significant at 0.010 Probability level (99.90%) Confidence level.
XX = Significant at 0.005 Probability level (99.95%) Confidence level.
NS = Not Significant at either of the Confidence Levels
0.010 (DF96) = 2.364
0.005 (DF96) = 2.626
S/D = Significance of Difference

Conclusions

The composition of solid waste generation in F.C.T is as a result of cultural aspects as well as social behavior, and it is strongly influenced by economic factors. In Abuja there is currently a lack of well developed separate collection systems for recyclable materials. It is urgent to obtain more information about the waste composition in order to establish adequate collection systems. Random sorting actions do not provide sufficient information because of strong seasonal fluctuations in waste composition and generation. The seasonal changes in composition may strongly influence the volume of waste generation.

This disparities between residential areas as regard waste generation have been observed to be basically an environmental crisis as a result of poor management system. This has consequently given rise to the need for further studies on ways by which it could be effectively managed. It was also discovered that most residents do not have easy access to dumpsters in their residential areas, however there is still room for improvement in terms of adequate supply of funds, distribution of more dumpsters, employment of more road managers, equipment and options technology etc. The involvement of private company in partnership with the government agency, the Waste Management Council, the disposal of waste has not been very effective in solving waste disposal problems as well as proper maintenance of refuse depots.

Recommendations

The government should either set up or encourage the private sector to establish more waste recycling plants in the FCT as a bulk of the waste generated in the study area are recyclables (plastics, bottles, cellophane, paper, etc). Although the scavengers are already in the business of gathering and melting such recyclables but they are inhibited by the cost of transporting them out of the study area to locations such as Kano and Kaduna states, where there are so many recycling plants for different types of recyclables.

There is also the need to sensitize the public on the issue of multiple waste bins, which will enhance waste sorting and make it easier for the scavengers, who usually gather and sort such recyclables after being dirtied by the biodegradable wastes which they are often combined with in the single waste bins.

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