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Assessment of Households' Biodegradable Solid Waste in Parts of Kano Metropolis

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Abstract: *The solid waste management remains an outstanding problem to authorities and threat to health status and environmental quality. This is because the landfilling is the only alternative for getting rid of huge solid waste generated in Kano metropolis. This study tried to evaluate biodegradable components from the waste generated by households in parts of Kano metropolis. Stratified random sampling technique of data collection was used. The households were segregated into four socioeconomic levels (8 density units), where the solid waste was collected sorted and weighed from each of 78 households of the density units for a complete 30 days. The density units of this study were very high, high, moderate and low housing density units, all selected from Kano Municipal, Gwale and Kumbotso local government areas of Kano metropolis in Nigeria. Questionnaire was administered to determine the socioeconomic characteristics of households towards waste generation and management. Family size and income status of each household served as tool in assessing the solid waste generation in the study area. Three tonnes of solid waste are generated every month by 78 households in the study area and two-third of the waste is biodegradable. The biodegradable waste generated per household and per capita is higher than the other non-biodegradable waste. However, the solid waste generation is more influenced by economic status of a household than the population number. The biodegradable solid waste (BSW) could be converted to compost fertilizer or extended to pit into carbon market projects internationally.*

Keywords: *Solidwaste, biodegradable waste, solid waste management, landfilling, sorting, segregation, greenhouse gases, global warming, climate change, global warming potential*

I. Introduction

The life of human beings is totally attached to the planet earth. This is because of the nature and composition of the atmosphere and the position of the earth in the solar system, (Schlatter, 2009 and US Environmental Protection Agency, 1998). The life on the planet earth is facing great challenges due to excess of the atmospheric activities from its composition which render some life extinct and the living on it not comfortable. Man action is regarded as the great contribution to excessive atmospheric warming, which was so moderate and comfortable for life before humans' induced activities (IPCC, 2007). The excessive warming of the atmosphere caused a lot of changes in humans' life and the general ecosystem.

Municipal solid waste and household garbage in some Developing Countries are left to a stage where the further anaerobic decomposition of the waste result into emission of gases like carbon dioxide, methane and so on. Some of these gases are believed to be greenhouse gases. Six greenhouse gases are believed to cause more effect – carbon dioxide (CO_2), methane (CH_4), Four Fluorocarbon (CF_4), Chlorofluorocarbon ($CFCl_4$), Nitrous gas (N_2O), and four fluorocarbon (CF_4), (Arvind*et al*, 2007).

The problems faced by authorities in Kano concerning the volume of generated municipal solid waste by household is the processes of getting rid of the waste, which is reduced merely to landfilling, since it has been difficult by the authorities to make proper management of the waste, (Nabegu, 2010).

Looking at the waste generation especially the biodegradable form the immediate household hands before disposal will give more explanation about waste because the scavengers and animals at dump sites have not interfered with the waste. This study aimed to assess the biodegradable solid waste generated by different socioeconomic household levels in parts of Kano metropolis.

Solid waste is the non-liquid and nongaseous organic and inorganic products of human, industrial, commercial and agricultural activities that are regarded as useless or unwanted (Tchobangolus 1983 in Abur, 2014;andOgwuche and Yusufu, 2011).

The generation of solid was has been encouraged in many cities in developed countries according to UNICEF, (2001) due to rapid increase in population, improvement in wages, massive expansion of urban cities, better standard of living or change in life style and improvement in technology (Ajadi and Tunde, 2010). However, In most developing countries solid waste management from collection up to final disposal level, is done by local authorities. And these local authorities are faced with so many shortcomings, and therefore rendering limited services to solid waste management because of financial problems and human resources

capacity (Barton *et al*, 2008). The inadequacy of municipal solid waste management in most cities of developing countries result into problems such as human and animal health and make significant impacts on economic, environmental and biological losses (Wilson *et al*, 2006; Kapepula*et al*, 2007; Sharholy*et al* 2008 in Abdussalam*et al*, 2012).

The quantity and rate of solid waste generation in various states of Nigeria, according to Srindhar and Adeoye(2003) in Babayemi and Dauda 2009, depends on the population, level of industrialization, socioeconomic status of the citizens and the kind of commercial activities being predominant. Generally, they stated that, the solid waste generation per person per day in Nigeria is 0.58kg.

According to Nabegu (2014), In Kano metropolis the population growth per annum is 3% and that of urbanization is 40% which are clear evidence that resulted into high waste generation. The waste typical of developing countries has high proportion of organic or biodegradable matter and only 30% of the waste is actually managed due to many reasons and the managed waste are disposed in unsanitary landfill or open dumping to decompose and produce methane. Methane has a global warming potential 21 times that of CO_2.

United Nation Framework for Climatic Change Convention (IPCC, 2001), refers to climate change as a phenomenon that could be directly or in directly be related to anthropogenic activities where such activities affected the natural alignment of the atmospheric system. This therefore, refers to addition of variables that may affect the natural trend of climate change. Hence, human induced activities, like waste managementaffect the climatic change, is alien to the natural climatic change system. Since the wastesunkept properly generate greenhouse gases.

Greenhouse gases are gases that play a gigantic role in making the troposphere warm through absorption and re-emitting of the infrared radiation from the earth's surface. This action makes the environment conducive for living things. The greenhouse gases that are mainly generated by unkept waste include carbon dioxide (CO_2), nitrous oxide (N_2O), methane, perflourocarbons (CF_4), hydrofourocarbons (HFCs), and sulphur hexafluoride (SF_6) (IPCC, 1990).

Solid waste generation especially biodegradable components emit excess greenhouse gases into the atmosphere when fermented at dump sites. This emission contribute into global warming and climate change. The generation of solid was has been encouraged in many cities, according to UNICEF, (2001), due to rapid increase in population, improvement in wages, massive expansion of urban cities, better standard of living or change in life style and improvement in technology (Ajadi and Tunde 2010). More than 60% generated solid waste in Kano metropolis is biodegradable Nabegu, 2014). This study tried to assess the households' biodegradable solid waste generated in Kano metropolis, Nigeria.

II. Materials And Methods

Study Area

Kano Metropolis is situated between latitude 11^0 52' 30"N to 12^0 55' 0" N and longitude 8^0 25' 0" E to 8^0 38' 0" E and it is above 472 metres above sea-level.The samples of this study was mainly concentrated in three local government areas in the metropolis: Kano Municipal, Gwale and Kumbotso local government areas, they covered a land area of about 194 square kilometres and total estimate population of about 1,207,060 (National Population Commission, 2006). Kano Municipal Local government has the highest population followed by Gwale whileKumbotso local government has the largest land mass followed by Gwale. However, Kumbotso local government has low housing density generally.

The climate of Kano Metropolis is the tropical wet and dry Aw by Koppen's classification. According to Olofin (1987), the seasons in the Kano is determined by two air masses moist cool southerly air mass known as south-westerlies and a hot and dry northern mass called the north-esterlies.This seasonality influences both agricultural and commercial activities in most part of the area, (Liman*et al*, 2014).

Kano metropolis has all the characteristic of dryland regions of high temperature range between 30^0C and 32^0C, (Adzandeh*et al*, 2014). It has experienced several draught epidemics and fluctuating rainfall seasons with 694mm/year, (Jidauna*et al*, 2012).

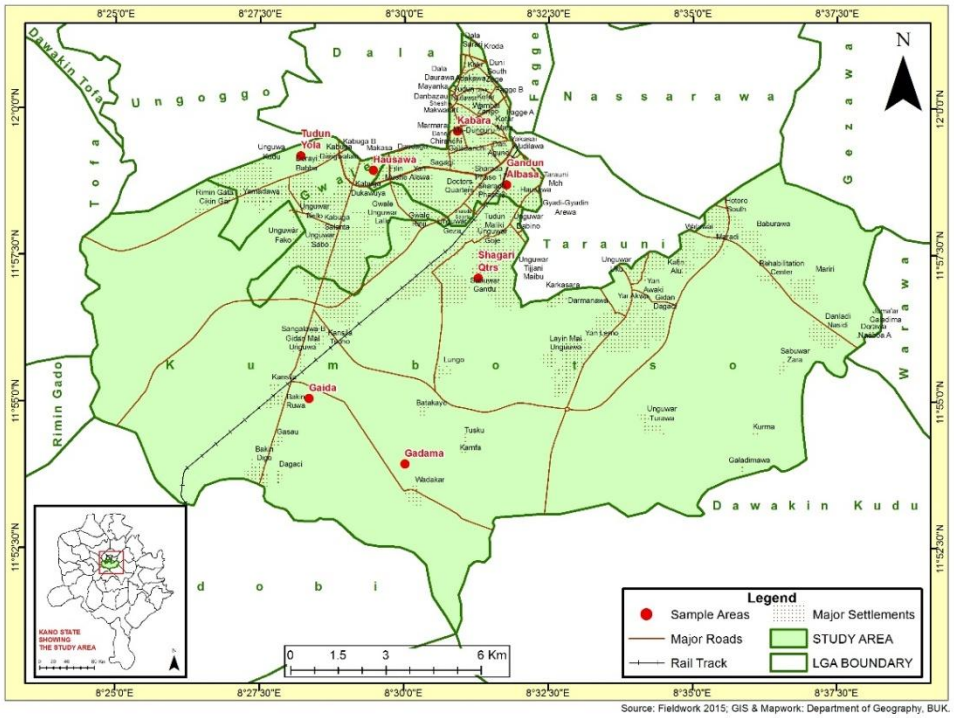

Figure 1: Land cover and land use of the study area

Most of the natural vegetation in Kano Metropolis are replaced with either exotic trees or building constructions. This is as a result of urban expansion and high population density. The cropped land areas in KumbotsoL.G.A. have scattered alien and exotic trees. The carbon capture potentiality from the three local government areas considering the vegetation cover is seems to be minimal.

Kano Metropolis has an estimated population of 3,628,861 people from the eight local government areas (Census, 2006), and it is among the fastest growing cities in Nigeria, (Nabegu, 2010). Population in Kano MuniciplalL.G.A. (17 sq.km) is about 437,840, Gwale L.G.A. (18 sq.km) has population of about 422,020 while KumbotsoL.G.A. (156 sq.km) has population of about 347,200 (Census projection for 2011). There is strong relationship between population and waste generation.

Land in Kano Metropolis are mainly used for agricultural and urban purposes, (Olofin, 1987). Urban development dominates the other activities in the two local government areas (Kano municipal and Gwale).There are many small scale commercial, hand craft and other land use services done by individuals or groups, along the major roads and within the residential areas, (Ibrahim, 2014).

The urban area of Kano is expanding rapidly due to several factors such as peace and tranquillity and outright acceptance of strangers who have different culture and beliefs, trading, commercial and industrial sectors, (Tanko and Idris, 2014).

This study was basically to generate information of the essential aspects of household solid waste generation.It is from biodegradable waste greenhouse gases such as carbon dioxide, methane and nitrous gas emitted. The emission of greenhouse gases from the waste usually happened through anaerobic fermentation of the waste at dumping sites. Questionnaire was admimistered to 80 households' heads or their representatives so as to come up with information about the socioeconomic aspects of the respondents pertaining waste generation and management.

The three local government areas were segregated into four housing density units.Stratified random sampling technique was used in categorizing the study area into four strata: Very high, high, medium and low density units. The categorization was achieved by using the land use map of housing density on Kano metropolis (figure 5), Google earth images and reconnaissance survey. Eighty households were selected, ten household from each of four density units . The target population for this study is the households and the individual heads in the area. Hence, the population of the research is the entire households within the three local government areas in Kano metropolis and the individuals occupying the households.

Installation of drums/containers at each of the eighty households was done prior to the data collection exercises of landfill-bound wastes. The sampling exercise covered forty five days (16th September to 31st October 2015). Each household was visited ten times at intervals of three days; at least, a household is visited twice every week.

The daily visits ranged from 7am to 12 noon. At each collection the sample was manually sorted and weighed in situ and the volume of waste in gram was calculated per head of each household and recorded.

Household's solid waste was collected, weighed, and then spread on white polythene platform to manually sort biodegradable materials from the waste, reweighed and recorded the readings. This was done to each collected solid waste from the selected households so as to evaluate waste generation per head and per household. The waste comprised the biodegradable waste and non-biodegradable components (such as metals, sand and gravels, ash, glass, electronics, plastics, ceramics, nylon, wool and polythene materials).

Statistical techniques were employed to make successful assessment of this study. General statistical applications in data analysis such as descriptive statistics for frequency, counts and expression in percentages etc., were arranged using Microsoft Excels.

III. Result And Discussion

Segregation of Households in The Study Area Into Socioeconomic Units

The categorization of the households in Kano metropolis was achieved by using housing density map of Kano Metropolis (figure 5)where the households were classified into four density units: very high, high, moderate and low. Neighbourhood analysis was used to arrive at the classification. Google Earth maps of the density units were captured to verify the selection of the units (See plates 1-4). The images from Google Earth were captured on November 6, 2015 and except for Shagari Quarters whose eye altitude is1.28km (4221ft), same eye altitude level of 1.20km (3952ft) was used throughout to capture the images of the houses. The third criterion was reconnaissance survey which aided in making cross-sectional identification of the study area. Hence, two dimensional visualization was obtained. The households in the study area of Kano metropolis were basically classified into four density units:

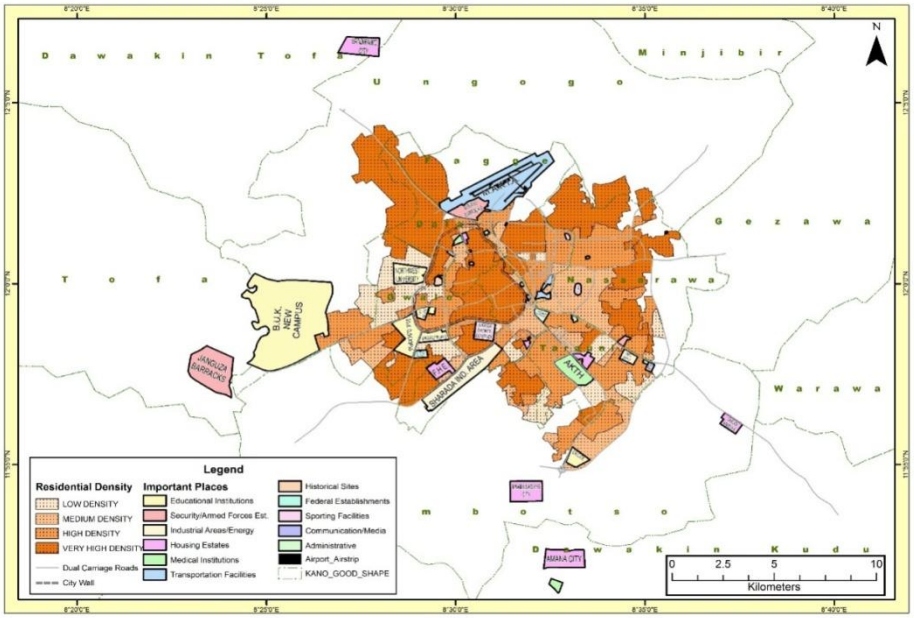

Figure2. Categorised Housing Density in Kano metropolis

Very High Density Units: The two density units belong to old city area in the city wall Kabara-Mandawari and Hausawa were selected. Most of the houses of the area are storey building. Compound family houses are very common in the area. The houses which initially built in mud bricks are now being replaced with cement blocks. These areas are classified as very high housing density units (plate 1). The major occupation of the people is trading followed by civil service, self-employment and handcrafting. The solid waste generation in this unit was 1.99kg/household/day and 0.23kg/capita/day (table 1). It was 1.33kg/household/day and 0.15kg/capita/day of biodegradable solid waste.

High Density Units: These residential areas are government layouts, and have more modernized town plan. These areas are Gandun-albasa and Shagari Quarters layouts. Gandu has more storey building than Shagari quarters (plate 2). The major occupation of the populace is civil service, followed by trading and self-employment. The solid waste generation in this unit was 2.41kg/household/day and 0.35kg/capita/day (table 1). It was 1.64kg/household/day and 0.24kg/capita/day of biodegradable solid waste.

Moderate Density Units: The density unit at Gaida was classified moderate. The housing plots are not designed by government they are of varying sizes and shapes. The whole area have very few storey buildings. Some of the buildings are still under construction with some few open land areas (plate 3). Most of the people are self-employed, some are civil servants while some are traders at varying scales, too. The solid waste generation in this unit was 1.22kg/household/day and 0.26kg/capita/day (table 1). It was 0.74kg/household/day and 0.06kg/capita/day of biodegradable solid waste.

Low Density Units: These houses here are more of nucleated houses pattern with no storey buildings. The places are more of rural pattern because most of the family heads are farmers and their economic activities are at local scales. The settlements are mainly surrounded by crop lands. Some of the household heads are civil servants and at the same time have other earning sources. Plate 4 shows Gadama and GadamaCikin-Gari, the area has more open spaces then built up areas, the buildings and population density are very low. The solid waste generation in this unit was 1.01kg/household/day and 0.1kg/capita/day. It was 0.57kg/household/day and 0.11kg/capita/day of biodegradable solid waste (table 1).

Table1 Characteristic of Biodegradable and Non-Bioderadable Solid Waste Genration in the Four Density Units.

Density unit	Solidwaste/HH (kg)		Biodegradable/HH (kg)		Solidwaste/capita (kg)		Biodegradable/Capita (kg)	
	Daily	In 30days	Daily	In 30days	Daily	In 30days	Daily	In 30days
V. High	59.7	1.99	39.9	1.33	4.5	0.15	6.9	0.23
High	72.3	2.41	49.2	1.64	7.2	0.24	10.5	0.35
Moderate	36.5	1.22	22.2	0.74	1.8	0.06	7.8	0.26
Low	30.3	1.01	17.1	0.57	3.3	0.11	3.0	0.1

Source: Fieldwork, 2015. HH = household

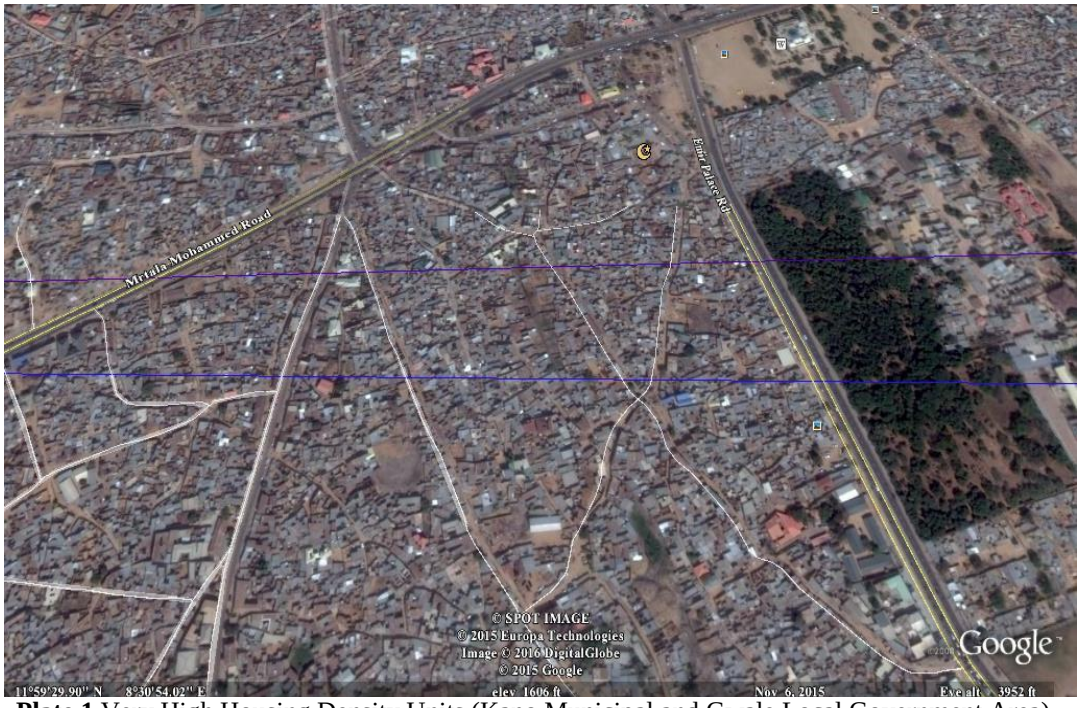

Plate 1 Very High Housing Density Units (Kano Municipal and Gwale Local Government Area).

Plate 2. High Housing Density Unit (Shagari quarters, KumbotsoL.G.A.)

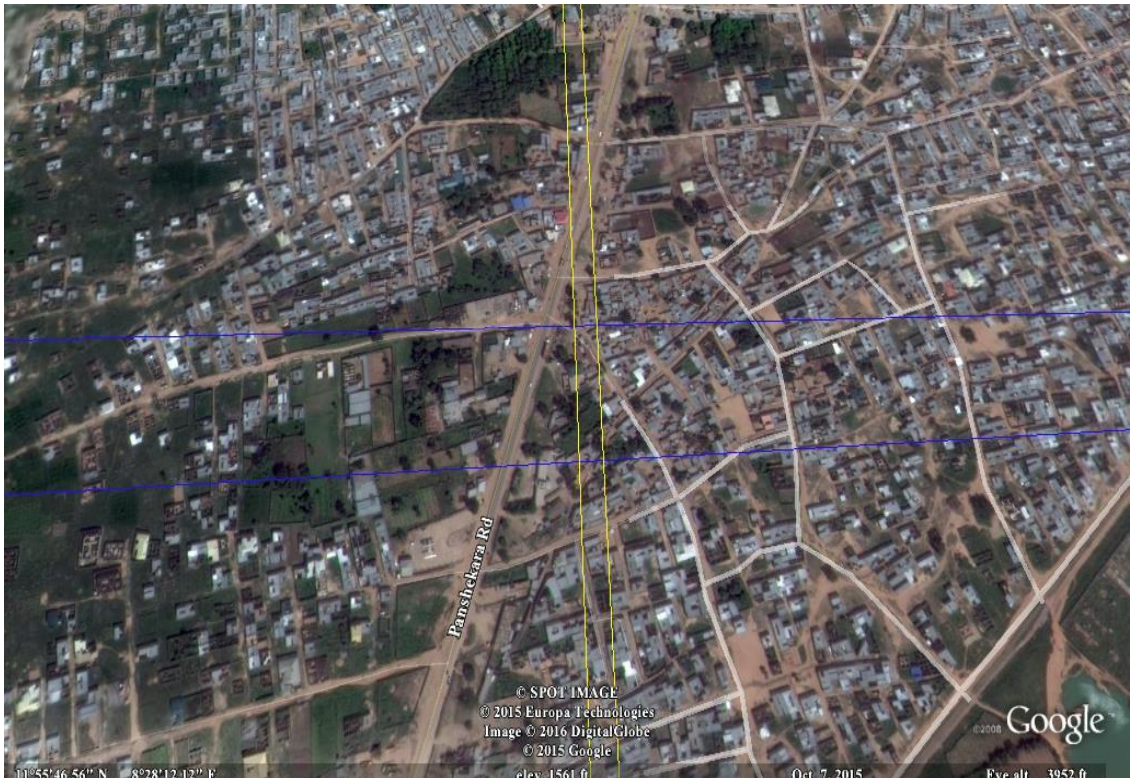

Plate 3. Moderate Housing Density Unit, (Gaida, Kumbotso L.G.A.).

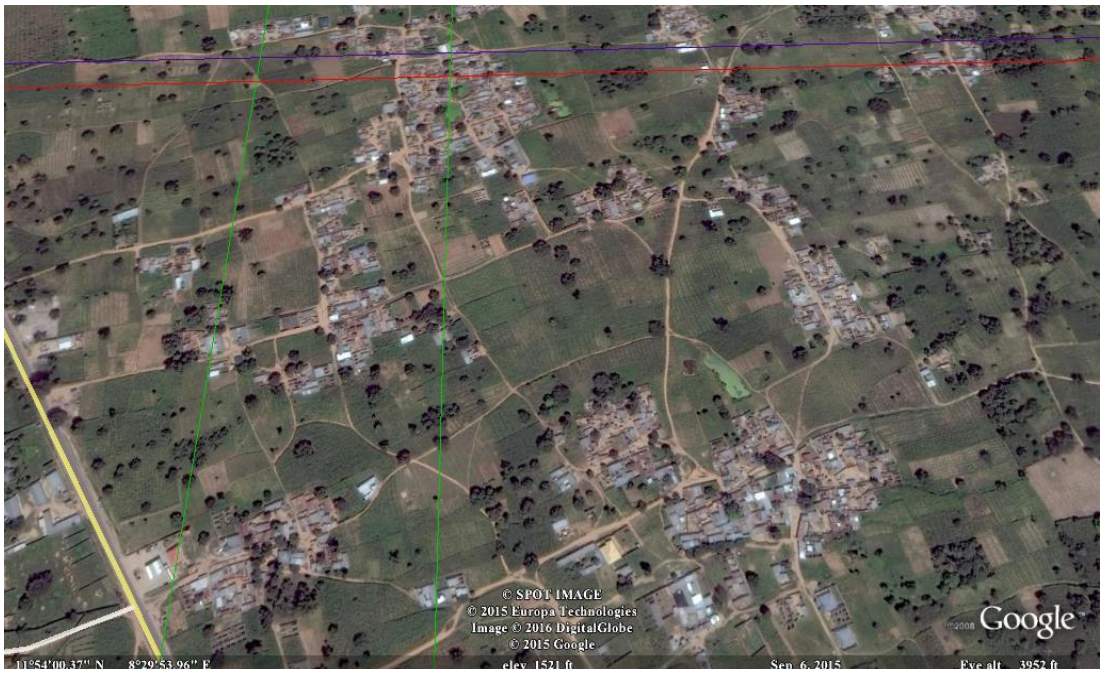

Plate 4. Low Housing Density Unit, (Gadama, KumbotsoL.G.A.)

IV. Socio-Economic Characteristics Of Respondents

From the analysis made on the data obtained (table 1), it showed that the average age distribution of the household heads is 48 years. Most of the aged house heads (18.3%) are from high density units like Kabara and Hausawa followed by Gandu, a high density unit.

Table 1: Age Distribution among the Density Units

VARIABLE (X)	**FREQUENCY**				
AGE	Very high	High	Moderate	Low	Total
20-30	-	1	2	5	8
31-40	4	1	13	5	23
41-50	2	4	2	-	8
51-60	5	6	1	7	19
Above 60	7	5	-	1	13
Total	18	17	18	18	71

Source: Fieldwork 2015. Mean =48years; n= 71.

The family size distribution is taking magnanimous similarity with age distribution among the households (Table 2). Hence, a household at high density units like Kano Municipal counsel and Gwale could produce more waste than Gadama whose housing patterns are low density unit.

Table 2. Family Size Distribution among the Density Units

VARIABLE (X)	Frequency in the Density Units				
5) FAMILY SIZE	Very high	High	Moderate	Low	Total
1-5	3	4	11	6	24
6-10	4	7	9	11	31
11-15	10	3	-	3	16
16-20	2	2	-	-	4
21-25	1	-	-	-	1
26-30	-	1	-	-	1
Total	20	17	20	20	77

Source: Fieldwork 2015

About 59.2% (45 persons) of the respondents underwent contemporary studies up to tertiary level. 21.1% (16 respondents) underwent Islamic Studies only at varying degrees. 11.8% (9 respondents) and 8.5% (6 respondents) have either studied up to secondary or primary level respectively (table 3).

Table 3: Education Status among the Density Units

VARIABLE (X)	FREQUENCY				
EDUCATION STATUS	Very high	High	Moderate	Low	Total
Islamic Education	6	3	5	2	16
Primary	-	-	1	5	6
Secondary	1	1	2	5	9
Tertiary	13	13	11	8	45
Total	20	17	19	20	76

Source: Fieldwork 2015

The leading occupation by the respondents is civil service (table 4); although the respondents have stated the major sources of income, however, some of the respondents have more than one kind of business. However, markets in the study area seem to be more buoyant when workers receive monthly salaries. The mean monthly income of the respondents is ₦36,830 (table 5). More than 45% of the respondents have their monthly income above the mean monthly income (₦36,830).

Table 4: Occupation Distribution among the Density Units

VARIABLE (X)	Frequency in the Density Units				
3) OCCUPATION	Very high	High	Moderate	Low	Total
Farming	8	5	-	18	31
Trading	5	5	9	-	19
Crafting	7	-	1	5	13
Civil service	10	5	9	8	32
Company	-	1	-	-	1
Retired	1	1	-	-	2
None	31	18	19	31	99

Source: Fieldwork 2015

Table 5. Monthly Income Status among the Density Units

VARIABLE (X)	Frequency in the Density Units				
4) MONTHLY INCOME	Very high	High	Moderate	Low	Total
below ₦15,000	3	-	2	-	5
₦15001 - ₦20,000	4	-	2	9	15
₦20,001- ₦25,000	-	-	1	6	7
₦25,001- ₦30,000	-	1	4	1	6
₦30,001- ₦35,000	1	2	1	2	6
₦35,001- ₦40,000	-	2	2	-	4
₦40,001- ₦45,000	-	2	2	-	4
₦45,001- ₦50,000	2	3	3	1	9
Above ₦50,000	9	6	1	-	16
Total	19	19	18	19	72

Source: Fieldwork 2015

Table 6. Distribution of Employed Adults among the Density Units

VARIABLE (X)	Frequency in the Density Units				
6) EMPLOYED ADULTS	Very high	High	Moderate	Low	Total
None	2	6	11	9	28
1 – 3	5	8	9	9	31
4 – 6	9	3	-	2	14
7 – 9	3	1	-	-	4
10 – 12	-	-	-	-	0
13 – 15	1	-	-	-	1
Total	20	18	20	20	78

Source: Fieldwork 2015. Mean =3;

V. Characteristics Of Solid Waste In The Four Density Units Of Kano Metropolis

a. Solid Waste Generated by the Households in the Density Units of Kano Metropolis

From table 7 that the very high density units of Kabara and Hausawa, generatedabout 1145.6kg (32.5%) of the total waste generated by 78 households. While the high density units of Gandu and Shagari Quarters generated about 1139.7kg (32.3%). However, 694.7kg (19.5%) and 550.7kg (15.6%)of the waste were generated by moderate and low density units of Gaida and Gadama respectively.

Table 7: Showing total solid waste weight with respect to density units over 30 days

DENSITY UNITS	30 DAYS RECORDS			
	SW(kg)	%	BSW(kg)	%
Very High	1145.6	32.45	760.5	33.40
High	1139.7	32.28	790.8	34.73
Moderate	694.6	19.67	420.9	18.49
Low	550.7	15.60	304.6	13.38
TOTAL	3530.6	100	2276.8	100
% (SW & BSW)	100		64.5	

Source: Fieldwork 2015. SW = solid waste; BSW= biodegradable solid waste(n=78).

Table 8 Showing total solid waste weight per day with respect to density units

DENSITY UNITS	PER DAY RECORDS			
	SW(kg)	%	BSW(kg)	%
Very High	39.83	31.19	26.57	32.27
High	43.46	34.03	29.58	35.92
Moderate	24.3	19.03	14.77	17.94
Low	20.11	15.75	11.42	13.87
TOTAL	127.7	100	82.34	100
% (SW & BSW)	100%		64.48%	

Source: Fieldwork 2015. SW = solid waste; BSW= biodegradable solid waste(n=78).

The proportion of solid waste generation among the density units, except between very high density unit and high density units, was not different with the quantities of biodegradable solid waste generation. For instance (table 7), the very high density units have higher generation of solid waste (1145.6kg/month) than high density unit (1139.7kg/month), but generated less biodegradable solid waste (760.5kg/month) than the high density unit (790.8kg/month). On daily basis (table 8), the proportion of biodegradable solid waste tallied the quantity of solid waste generated.

The family population (table 9) did not tally in proportion with quantity of waste generated in the household density categories. Gaida has a moderate housing density but generate 6.95kg of solid waste per month per capita, while a very high housing density area and more population generated 5.0kg/capita/month solid waste.

The average solid waste and biodegradable solid waste generation in Kano metropolis was revealed to be 882.7kg and 569.2kg per density unit per month respectively. It was 45.3kg solid waste and 29.2kg biodegradable solid waste generation per household per month.

b. Family Size distribution and proportion of Solid Waste Generation from the Selected Households of Kano Metropolis

It was revealed (table 9) that the households at very high density units have higher population (231 people), comprising 35.8% of the total household members (646) of the entire 78 households. Followed by the high density unit (174 people), the low density unit (141 people) and lastly the moderate density unit (100 people).

The highest waste generation of 6.95kg/capita/month was at Moderate housing density unit despite having low population size. This indicates that the population size has less influence in quantity of waste generation that the socioeconomic status of the households.

In a nutshell, 5.5kg/capita/month (0.2kg/capita/day) of solid waste and 3.53kg/capita/month (0.13kg/capita/day) of biodegradable solid waste are produced in three local government areas of Kano Metropolis (table 10). It was stated that urbanization in Kano metropolis is 40% and population growth per annum is 3%, therefore, this could be a good reason for higher waste generation (Nabegu, 2014).

Table 9: Family size distribution and solid waste generation at the density units

DENSITY UNITS	FAMILY SIZE		SOLID WASTE HEAD^{-1} DAY^{-1}	
	Population	%	SW (kg)	BSW(kg)
Very High	231	35.76	0.17	0.12
High	174	26.94	0.25	0.17
Moderate	100	15.48	0.24	0.15
Low	141	21.83	0.14	0.08
TOTAL	646	100.01		
		AVERAGE	0.2	0.13

Source: Fieldwork, 2015.

Table 10: Family size distribution in proportion to solid waste generation per head per 30 days in Kano metropolis

DENSITY UNITS	FAMILY SIZE		SOLID WASTE HEAD^{-1} MONTH^{-1}	
	Population	%	SW (kg)	BSW(kg)
Very High	231	35.76	5.0	3.29
High	174	26.94	6.55	4.55
Moderate	100	15.48	6.95	4.21
Low	141	21.83	3.91	2.16
TOTAL	646	100.01		
		AVERAGE	5.5	3.53

Source: Fieldwork, 2015.

c. Monthly Income Distribution of the Respondents and Proportion of Solid Waste Generation.

Waste generation among the households in the study areas is affected by factors such as family size and income status. Income status determines what a household will purchase in terms of food staff and its processing. In order to assess the waste generation based on income status, the households were reclassified based on monthly income status.

Three classes were obtained: high, medium and low income statuses (table 11). The high income status was defined to earn between ₦46,000 and above per month. The moderate income household earn between₦26,000 to ₦45,000 per month. Low income household earn from less than ₦15,000 to ₦25,000 every month. After the classification table 11, was generated and revealed that the distribution of household has not been equal. 29, 21 and 28 are the numbers of household obtained in high, medium and low income classes respectively. To make the assessment of waste generation more justifiable, 21 households were taken from each class, total of 63 households and this is how table 4.8 emerged.

Table 11. Distribution of Households Based on Income Status (n= 78)

Household Status	High Income		Medium Income		Low Income	
	Count	%	Count	%	Count	%
Very High	21	41.38	1	4.76	7	25.00
High	11	37.93	7	33.33	0	0.00
Moderate	5	17.24	11	52.38	4	14.29
Low	1	3.45	2	9.52	17	60.71
Total	29	100	21	99.99	28	100

Source: Fieldwork, 2015.

Table 12 is the adjusted set of 63 out of 78 households. It was revealed that the monthly income status influenced daily solid waste generation of the households. Where 48.23kg/day of the solid waste was generated by high income households; medium income households generated 32.97kg/day of solid waste, whereas low income households generated 25.37kg/day. This shows that the higher the income of a household the more waste they generate, both degradable and non-degradable waste.

Table 12.Household distribution based on income status in relation to waste generation per density unit per month in Kano metropolis (n=63)

Household Status	High Income		Medium Income		Low Income	
Waste generated	Solid Waste (kg)	Biodegradable Solid Waste (kg)	Solid Waste (kg)	Biodegradable Solid Waste (kg)	Solid Waste (kg)	Biodegradable Solid Waste (kg)
Total	48.23	33.03	32.97	21.1	25.37	14.86
Average	2.3	1.57	1.57	1.01	1.21	0.71
Percentage	45.26	30.94	30.94	30.58	23.81	21.54
% BSW	100	68.48	100	64.0	100	58.57

Source: Fieldwork, 2015.

The trend of biodegradable solid waste generation is similar with the total solid waste generation. The biodegradable solid waste generation (table 12) based on income status of high, medium and low income classes was 33.0kg, 21.01kg and 14.8kg per density unit per month respectively. This shows that the biodegradable solid waste quantity in the study area shows a declining trend in proportion with quantity of solid waste generation.

d. Characteristics of Solid Waste Generation Over 30 Days of Salary Month

The solid waste collection exercise was done in intervals of three days per household. Over 30 days ten visits were made to each household as the average values of solid waste in kilograms per household per density units are presented in table 13.

Table 13. Correlation: Characteristics of Solid Waste Generation over 30 Days of Salary Month

Density Unit	Date of the Month									
	3rd	6th	9th	12th	15th	18th	21st	24th	27th	30th
	Solid Waste Generation									
Very High	6.24	5.49	5.06	6.64	6.76	4.88	6.2	6.67	6.32	6.3
High	7.16	6.32	7.71	7.83	6.74	6.56	8.42	8.38	6.24	7.57
Moderate	4.56	2.34	3.16	3.25	4.29	4.47	3.43	4.13	3.96	4.54
Low	3.02	2.12	2.24	3.64	3.28	2.88	2.63	4.1	2.51	2.93

Source: Field work, 2015.

The quantity of solid waste generation in Kano metropolis seem to be rising and falling regardless of the days of monthly salary payment (figure. 3 and 4). This could be related to some other factors, for instance some household heads have more than one sources of earning; however, loans are collected from wholesalers and retailers by the household heads to be paid when salaries are also paid.

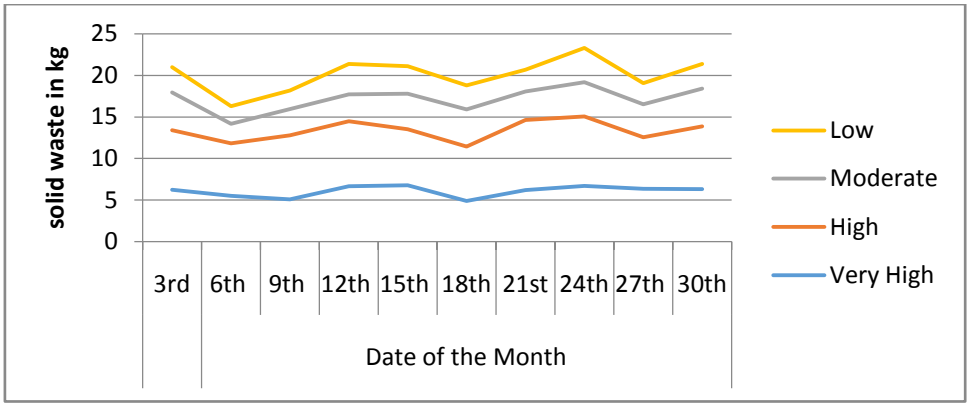

Figure 3.Correlation: Characteristics of solid waste generation over 30 days of salary month

It can be seen that there is sharp falling of solid waste generation at the beginning of a salary month (fig. 10), this could also be related to the high quality and processed or easy processing food items are purchase by householders while towards the month ending unprocessed food item are more which generate high quantity of solid waste.

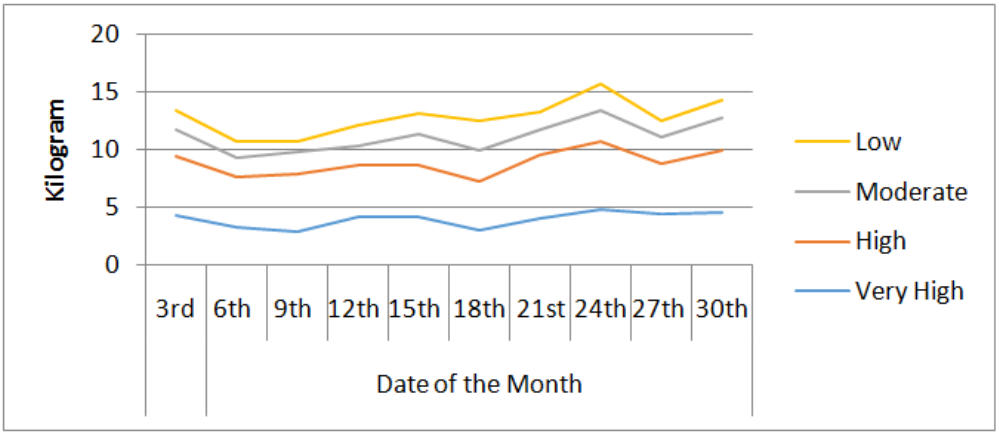

Figure 4. Correlation: Characteristics of Biodegradable solid waste generation over 30 days of salary month

VI. Conclusion and Recommendations

Conclusion

From the assessment conducted on biodegradable solid waste in Kano metropolis it could be concluded that most of the respondents are literate and salary earners.The socioeconomic status of majority of the households in the study area is average, mostly due to many sources of earning a household head may have.

Each household generate more biodegradable solid waste compared to other components of the solid waste per day. Income level has more significance in determining the quantity of both biodegradable and solid waste generation than size of the family.

More than three tonnes of solid waste are generated by 78 households every month in the study area. However, from the solid waste generated every month, more than two tonnes of it is biodegradable.

The trend of solid waste generation over 30 days has little differences. Which could be related to many sources of earning most of households' heads have. Hence, waste generation is increases with time due to increase of population and socioeconomic activities.

The biodegradable waste in this study (65% of the total waste) was not similar with whatBichi and Anatobi (2013) found (57.5%) at the households in Sabon-Gari area. Nabegu, (2014) found it to be 65% biodegradable which is similar to this work. Hence, one can conclusively said that biodegradable always take the higher proportion from the generated solid waste composition.

High income households generated 48.23kg/day of solid waste and 33.03kg/day (6848%) biodegradable solid waste. Low income households generated 25.37kg/household/day solid waste and 14.86kg/household/day (58.57%) biodegradable solid waste.

The quantity of waste generation does not fluctuate significantly over the 30days of the salary month. In other words, the waste generation in the first ten days, the second ten days, and the last ten days of the month have little variation despite the fact the that most of the house heads are salary earners who are paid at the end of month and despite the fact that markets seem to be more lively wen salaries are paid.

Recommendation

Having assessed the characteristics of solid waste generation and socioeconomic status of the households in Kano metropolis, the following recommendations are postulated:

a. The biodegradable solid waste which makes more than 60% of the household solid waste, can be used in producing compost fertilizer. For the fulfilment of this, research institutes could be invited in order to make the compost production to standard. This will certainly enhance farming activities, reduce methane gas emission from landfilling, and compost fertilizer is positive to environmental prosperity than chemical fertilizers. However, converting biodegradable solid waste to compost fertilizer will generate more income to the state and will provide job opportunities to many citizens in Kano state. However, fuel biogas production from the solid waste generation will reduce more than 60% of the work spent in waste evacuation in Kano metropolis. The remaining waste to be carried away will be lighter and cause almost no unpleasant odour along the roads.
b. The biodegradable solid management has to be subjected to carbon credit projects such Clean Development Mechanism and REDD+. The carbon content is higher in the biodegradable solid waste; when it is recycled or reused into compost or biogas, the state government can claim compensation for sequestration of carbon and its equivalents. The solid waste can be collected in separate bins, according to the need, at each household. Due to level of literacy and little bit of incentives will make the people dispose waste separately as may be required.
c. Some components of the solid waste assessed are recyclables. Such as plastics and metals. Plastics and rubber make high volume of households' solid waste and created problems to environment. When recycling machines are installed enough to serve the waste generation will reduce the waste to raw materials for our industries, will make more revenue to the state and also more job opportunity to people.
d. Having assessed the quantity of waste generated by household per day, and per capita, assessment of greenhouse gases emission from the biodegradable solid waste generated in Kano metropolis will be of great potential to Clean Development Mechanism (CDM). The contribution of each household and/or individual in greenhouse gases emission could be detected when appropriate sample are collected and subjected to laboratory analysis.
e. It will be of high value to make projection of GHG emission in to the future (for instance, greenhouse gas emission from landfilling in the year 2025, 2050 etc.) based on the rate of population growth and urbanization in Kano metropolis.
f. Biodegradable solid waste assessment need to be extended to cover the other parts like Dala, Fagge, and UngogoLGA.s of Kano metropolis. This will help in making more precise conclusion on values and characteristics of solid waste generation by households and the socioeconomic status of households in Kano metropolis.

References

[1]. AbdusSalam M., Hossain L. M., Roy Das Satyajit, Wahab R. and Hosain M. K. (2012), "Generation and Assessing the Composition of Household Solid Waste in CommercialCapital City of Bangladesh", International Journal of Environmental Science, Management and Engineering Research. Vol. 1 (4). http://www.ijesmer.com.

[2]. Adzandeh EmmanuelAyila, Fabiyi O. OluseyiBelloYakasaiAnas, (2014),"Statistical Analysis of Urban Growth in Kano Metropolis, Nigeria",International Journal of Environment – Monitoring and Analysis. Vol. 2, No. 12014, pp. 50-56. doi: 10.11648/j-ijema. 20140201.16.

[3]. Ajadi B. S. and Tunde A. M. (2010), "Spatial variation in solid waste composition and management in Ilorin Metropolis, Nigeria", Kamla-Raj J Hum Ecol, 32(2); 101-108 (2010).

[4]. Arvind K. Jha, C. Sharma, Nahar Singh, R. Ramesh, R. Purvaja and Prabhat K. Gupta, (2007), "Greenhouse Gas Emissions from Municipal Solid Waste Management in Indian Mega-Cities: A case study of Chennai Landfill sites".

[5]. Babayemi, J. O.; Dauda, K. T. (2009). "Evaluation of solid waste generation, categories and disposal options in developing countries: A case study of Nigeria. J. App. Sci. Environ. Manage".September, 2009 Vol.13 (3) 83-88.

[6]. Barton, J. R., Issias I. and Stentiford, E. I. (2008), "Carbon Making the Right Choice for Waste Management in Developing Countries." Waste Management, 28:690-8.

[7]. Bichi, M. H., Amatobi, D. A. (2013), "Characterization of Household Solid Waste Generated in Sabon-Gari area of Kano in Northern Nigeria". American Journal of Research Communication, 2013, Vol. 1(4): 165-171. www.usajournals.com ISSN: 2325-4076.

[8]. Geo Visuals and GIS Laboratory, Geography department BUK, (2015). Land use and land cover of Kano metropolis.

[9]. Google Earth. Accessed on 15th August, 2014.

[10]. Ibrahim A. M. (2014),"Evolutionary Trend, Spatial Distribution and Issues associated with Markets in Kano Metropolis".Merit research journals (ISSN: 2350-2266 Vol. 2(9) pp.205-216, December, 2014 www.meritresearchjournals.org. Assessed 14th October, 2015.

[11]. Intergovernmental panel on climate change (IPCC) (2007). Impact, Adaptation and vulnerability. Contribution of Working Group 1 of the intergovernmental panel on climate change to the Third Assessment Report of IPCC. London: Cambridge University Press.

[12]. IPCC (1990), Intergovernmental Panel on Climate Change, United Nations Report, Nov. 1990, WMO, Geneva, Swaziland.

[13]. Jidauna, G. G., Dabi D. D. and Dia R. Z. (2012), The Effect of Climate Change on Agricultural Activities in Selected Settlements in the Sudano-Sahelian Region of Nigeria. Archives of Applied Science Research, 2012, 4(1): 703-713 www.scholarsearchlibrary.com. Accessed on 21st February, 2015.

[14]. Kano State 1998 and 1999 projected population by local government areas.(Printed on 01/04/2015 via http://www.kanoonline.com/population.hotml). Accessed on 1st April, 2015.

[15]. Kapepula, K. M., Colson, G. ,Sabri, K and Thonart, P. (2007), A Multiple Criteria Analysis for Household Solid Waste Management in Urban Community of Dakar. Waste Management, 27:1690-705.

[16]. LimanM. ,Idris H. A. and Mohammed U. K., in A. I. Tanko and S.B. Momale (Eds.) (2014),Kano:Environment, Society and DevelopmentLondon and Abuja. Adonis & Abbey Publishers

[17]. Nabegu A. B. (2010), "An Analysis of Municipal Solid Waste in Kano Metropolis, Nigeria. J. Hun Ecol, Kamla-Raj 31(2): 111-119 (2010).

[18]. Nabegu A. B. (2014), "The potential of municipal solid waste as a Clean Development Mechanism (CDM) project in Kano metropolis, Nigeria.Greener Journal of Social Sciences ISSN:2276-7800 Vol.4(2), pp.130-138, April 2014.

[19]. National Population Commistion (2006), 2011 Census projection,Nigeria, 2006. Logbaby.com Nigeria Delivery-Knowing is Golden. Encyclopedia/History. Accessed on 03/06/2015.

[20]. Oguche J. and Yusufu F. A. (2011),"Assessment of the Factors Influencing the Generation and Disposal of Urban Household Solid Waste in Africa",The Nigerian Perspective. Journal of Environmental Sciences and Resource Management Volume 3, December 2011.

[21]. Olofin E. A. (1987), Some Aspects of the Physical Geography of the Kano Region and Related Human Responses. Departmental lecture note series No. 1. Geography department, Bayero University, Kano. Debris Standard printers, 73A, Zaria road, Gyadi-Gyadi, Kano.

[22]. Schlatter T. W. (2009), Atmospheric Composition and Vertical Stracuture Retired Meteorologist Earth System Research Laboratory National Oceanic and Atmosphiric Administration Boulder, CO, USA

[23]. Sharholy, M., Ahmad, K. and Mahmood, G. (2008), "Trivedi RC. Municipal solid waste management in Indian cities", Waste Management, 28(2):459-67.

[24]. Sridhar, MKC; Adeoye, GO (2003), Organo-nineral fertilizer from urban wastes; development in Nigeria. The Nigerian Field, 68: 91-111.

[25]. Tanko A. I. and Idris H. A., (2014), "Trade, Commerce and Industries". In A. I. Tanko and S. B. Momale(Eds)Kano: Environment, Society and Development. London & Abuja, Adonis and Abbey Publishers- p111.

[26]. Tchobanoglus G. and Peavy R. (1983), Environmental Engineering. McGraw Hill,Michigan.

[27]. U. S. Environmental Protection Agency (1998), Greenhouse Gas Emissions From Management of Selected Materials in Municipal Solid Waste. EPA530-R-98-013, September 1998 http://www.epa.gov Accessed on 03/11/2014

[28]. UNICEF (2001), Waste Disposal System. Sanitation and Policies and Objectives. World Health Report, 2012.

[29]. Victor O. I, Nwajuaku A. I., and Ejikeme R. I. (2011), "The Effects of Environmental Air Pollution in Nigeria"International Journal of Mechanical, Automobile and Production Engineering.VSRD-MAP, Vol. 1 (1), 2011, 36-42

[30]. Wilson, D. C., Velis C. and Cheeseman, C. (2006), "Role of Informal Sector Recycling in Waste Management in Developing Countries",Habitat International30:797-808.