

Spatial Variation in Solid Waste Composition and Management in Ilorin Metropolis, Nigeria

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ABSTRACT Most State governments and urban agencies have identified solid waste as a major problem that has reached proportions requiring drastic measures. The increasing problem of solid waste in Nigeria has become one of the most intractable environmental problems today. Increase in volume of waste generated by urban residents, change in the quality of waste composition and the disposal method of waste collected are of major concern. Increasing population and pollution in urban areas and particularly big cities like Ilorin, coupled with ineffective management has led to serious environmental problems. This study examines spatial variation in solid waste composition and management. For the study, primary and secondary data collection methods were used to meet the objectives. The results revealed that disparities and similarities exist between management and composition of waste within the study area. Recommendations were made on how to improve on environmental problems and management of waste disposal.

INTRODUCTION

Solid waste generation has been encouraged by rapid increase in population, changes or improvement in wages, massive expansion of the urban areas and the changing lifestyle or better standard of living as well as improvement in technology (UNICEF 2001). Ilorin metropolis has over time experienced rapid urbanization, sprawling settlements and rapid population growth, which in turn have the effect of increasing the generation of solid waste.

Solid waste results from rapid increase in population, massive expansion of the urban areas and the changing lifestyle. Increase in population and income brings about an increase in production of goods and services and thus effluents are discharged into the environment. According to Ita (2003), waste can be defined as any material lacking direct value to the producer and so must be disposed of. Similarly, waste is any material that is thrown away as unwanted (UNICEF 2006).

Solid waste or refuse is regarded as anything human beings consign to the garbage or dispose of in any manner. It consists of organic matters such as papers, rags, discarded packages, food scraps gardens refuse and inorganic materials such as worn out appliances, junk automobiles, furniture, industrial waste and debris of construction projects. Solid waste can therefore

be defined as all non-gaseous, non-liquid wastes resulting from a wide range of community, industrial, commercial and agricultural activities (Adedibu 1983). Solid waste is any waste other than human excreta, urine and waste water. It can also be defined as the organic and inorganic waste materials produced by households, commercial and industrial establishment that have no economic value to the owner (UNICEF 2006).

Waste is a factor of what is provided and consumed and the problem arising from it has led to a concern about protecting the quality of the natural environment. This is being threatened by the size and density of human activities in urban areas.

The alarming rates at which human beings generate solid waste constitute a great problem to the governments as well as individuals in large urban areas especially in developing countries like Nigeria. This is because residues of products used are not always destroyed but discarded and these contribute greatly to land pollution (Adedibu 1987).

Waste management is the collection, transportation, processing, recycling or disposal of waste materials. Olorunfemi and Odiata (1998) reported that lack of solid waste data in Ilorin is the most conspicuous and probably most important problems militating against the successful management of solid waste effectively by the Nigerian Waste Management Authorities.

However, NDHS (2004) emphasised the poor sanitation coverage in different Nigerian settlement types (urban, semi-urban and rural areas) attributed to a number of factors including lack of awareness, poor planning, poor funding, poor implementation of sanitation programmes by different agencies and above all, the absence of a clear cut National or State policy on sanitation as well as inefficient management. According to Adedayo (2000), private sector participation should be encouraged in waste collection and disposal through the licensing of individual investors interested in private waste collection within their local government areas, thus opening the ways for government-private partnership in waste management and disposal.

Although, the Nigerian government has taken bold steps at various levels to solve the problem of refuse disposal, these efforts have not yet yielded much satisfaction as government involvement in the collection and disposal of wastes does not have the same effect as when the task is contracted or in partnership with private vendors or organisation. In the recent past, the government had taken on the primary responsibility for the management of wastes, and due to the complexity and competition, the workers have not been efficient. But with the involvement of the private led waste management effort in Kwara State, the urban agency (Kwara Waste Management Council) in partnership with O'lan Klean a private sector company (Green and Clean), the city has now fully appreciated the characteristics of solid wastes hence, the effectiveness of government attempts to clean up our metropolitan environment.

Objectives

This paper examines spatial variation in solid waste composition and management in Ilorin metropolis. The objectives of the paper include: the assessment of the relevance and effectiveness of solid waste management through public-private partnership. It also examines the distribution of solid waste bins over the study area.

Presently there are several tens of dumpsters spread all over the city in an haphazard manner to facilitate the generation and collection of solid wastes, yet, there has not been efficient management of solid waste, even with the involvement of private sector in the disposal process. The

rationale for this study is as a result of mountainous heaps of solid waste that still deface some parts of Ilorin. Waste disposal is still a problem confronting the metropolis and even the neighbourhood of Government Reservation Area (GRA) which has become a very serious environmental challenge to the society.

The Study Area

Ilorin the Kwara State Capital comprised of three Local Government Areas namely: Ilorin West, Ilorin East and Ilorin South. The city has been selected because of the increased heterogeneous population over the years and urbanisation, which made it a good ground for the study of this nature. The city performs the function of a state capital and headquarters for the three local government areas. Ilorin which is an urban centre has been selected for this study due to the exacerbated waste problem evident as a result of its increasing population and urbanization.

Ilorin is located on latitude 8°30'N and longitude 4°35'E with an area of about 100km² (Kwara State of Nigeria 1997). The city in its geological settings consists of Pre-Cambrian basement complex with an elevation of between 273m to 333m (i.e., 900 ft to 1,200 ft) above sea level. There is an isolated hill (Sobi hills) of about 394m above sea level towards the north of the western part and 200m to 346m in the east. The city is covered mainly by ferruginous soil on crystalline acidic rock. The pattern of the drainage system of Ilorin is dendritic due to its characteristics. The most important river is Asa River which flows in south-northern direction. Asa River occupies a fairly wide valley and goes along way to divide Ilorin into two parts namely, the eastern and the western part. The eastern part covers those areas where the GRA is located while the core indigenes areas of Ilorin fall under the western part. The other rivers that drain into Asa river are river Agba, river Alalubosa, river Okun, river Osere and river Aluko. The vegetation is characterised by scattered tall trees such as Baobab, Locust beans, Shearbuter, Acacia etc.

According to Ifabiyi (1999), the climate of the city is tropical continental with high temperature throughout the year. It is characterised by wet and dry seasons. Ilorin falls within derived savannah vegetal cover with the existence of dry lowland rain forest vegetal cover. The wet season

is between March and October while the dry season is between the months of November and February. The mean annual rainfall is 1200 mm.

The 2006 population figures showed that the city has a population of 766,000 (NPC 2006). Within the metropolis, the major occupation includes distributive trading, civil service of varying cadres and persuasions and a host of informal sector services. Like many traditional cities in Nigeria, Ilorin retains the characteristics of traditional town alongside a modern urban centre. The traditional part of Ilorin is located west of Asa river with a concentric pattern. The centre includes the Emir's palace, Central mosque and Emir's market. This is followed by the zone of transition, which contain deteriorating houses. The third zone is the independent working man zone, comprising residence of second generative immigration into the city. The fourth zone is zone of better residences i.e. middle class, small businessmen, professional people, and salesmen etc. The last zone is the commuter zone of small cities, towns and hamlets which serves as dormitory suburbs for the weather city dwellers e.g. Tanke, Ganmo etc. The modern residential part

of Ilorin developed along the east and south of Asa river attracted Industrial, Residential, Administrative, Commercial, Transportation, Institutions, Communication, Health, Religious Recreation, Financial, Primary land use and general services etc.

Ilorin has about 21 roro-bins (dumpsters) placed by Kwara State Environmental Protection Agency (KWEPA) and about 108 roro-bins spatially distributed by O'lan Clean/ (KWMC) within Ilorin Metropolis (Fig.1).

METHODOLOGY

Two sources of data collection were employed to meet the objectives of this study. The first was the collection of data via existing documents and records on environmental sanitation edicts, maps, newspapers, etc. The second source of data collection was through field survey. This was done by the administration of questionnaires and by conducting oral interviews with the management of O'lan Clean/Kwara Waste Management Council.

Systematic random sampling technique was

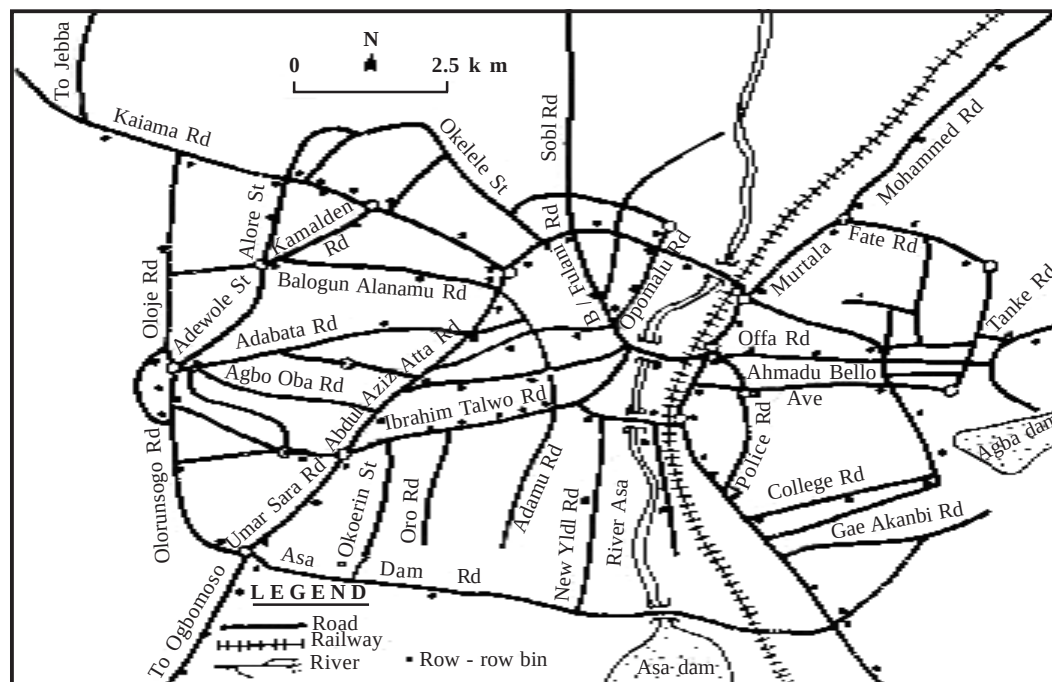


Fig. 1. Map of Ilorin Metropolis showing locations of Dumpsters (Roro bins)

Source: Ministry of Lands and Surveys, Ilorin.

employed due to the micro scale of the study. It was estimated that there are four hundred households that have direct access to the location of a dumpster. However, ten per cent of this gives forty respondents. Hence, forty copies of structured questionnaires were distributed and administered in each of the three residential areas since these are the areas where higher percentages of waste are being generated. On the whole, a hundred and twenty questionnaires were randomly administered and distributed in the study area. The study employed the analysis of variance and nearest neighbour statistical techniques. Analysis of variance was used to confirm the relationship and the existence of spatial variation in solid waste. The same method was also used to determine the composition and disposal system among the three different residential areas. Nearest Neighbour Analysis was adopted to examine the spatial distribution of the dumpsters within the city. The simple percentage was used to summarise and organise questionnaire and interview responses. For the purpose of this study, Ilorin is divided into three broad sub-areas on the basis of residential characteristics and socio-economic differences between them (Ajadi 1996; Jimoh 1997; Aderamo 2000).

The sub- divisions are:

- 1) The Old Residential Areas: These are the indigenous built up parts of the city, which occupy the Central Core Area. Such areas include Pakata, Oja-Oba, Oloje, Baboko etc.
- 2) The New Residential Areas: These are the post-colonial residential areas, which are built up around the core area of the city such as Tanke, Basin, Gaa-Akanbi, Asa Dam, etc.
- 3) The Government Reservation Area (GRA): This is the high status neighbourhood area of Ilorin metropolis. It occupies the south-eastern sector of the city.

RESULT AND DISCUSSIONS

Component of the Refuse

Certain differences and similarities exist in solid waste generation and composition pattern in Ilorin metropolis, as specific variation are exhibited in availability of dumpsters according to residential areas in Ilorin.

Table 1 reveals that in the old residential area, represented by Magaji-Ngeri, food wastes and

other wastes such as rags, rubbers, bones, hatches, aluminium, polythene bags, leathers wastes constitutes the largest components of solid waste generated by the people. They constitute 28.2% and 21.0% respectively. Paper waste and nylon constitute 27.3%, leaves and human faeces constitute 11.50% while bottle and tins waste amounted to only 11.5% of the total waste generated.

Following this is the new residential area represented by Oko-Erin ward. Paper wastes are the largest waste component constituting 27.8% of total solid waste. This is followed by food wastes with 25%. The proportion of leaves and nylon waste in the composition in this residential area are very high and constitutes 26.1% of the total wastes in the area. The category classified as others, constitutes 15.6% while tins and bottle waste formed just a minute proportion. Waste from leaves and human faeces are 24.1% and 6.5% respectively.

In the Government Reservation Area (GRA), food wastes constitute 30.9% of total waste. This is followed by paper waste with 23.0%. The category classified as others constituting 16.0% while waste leaves; nylon and tins/bottles constitutes 15% and 14.01% respectively (Table 1).

The analysis of the solid waste data reveals that there is a high percentage of food and paper generated as a result of accumulated waste resulting from the process of preparation as well as after consumption, in which case, we have excess food left out, which cannot be preserved, particularly staple food items. Paper waste, polythene bags, iron, rubber among others are generated by all irrespective of age, calibre or status because of their numerous uses such as writing, packages, buildings among others.

The high waste food generated by the GRA can be likened to the socio-economic characteristics and household factors in the area. As about 75% of the residents in the GRA are high income earners. This is very high when compared with the old and new residential area with 27.1% and 52.0% of the people falling into high income group (see Table 2).

Both the G.R.A. and Old Residential Area exhibit similar pattern in household size, as the percentage of waste food is very wide in the two areas. In the G.R.A, we have the largest proportion of tins/ bottles waste (Table 1). This is in support of Awomuti (2008), that rate of waste generated

Table 1: Residential areas and solid wastes component

<i>Residential</i>	<i>Food waste %</i>	<i>Paper waste nylon plastics %</i>	<i>Waste bottles, tins %</i>	<i>Waste leaves, human faces %</i>	<i>Other wastes %</i>	<i>Total %</i>
Old residential area (ORA) (Magaji Gerin)	28.20	27.3	12.0	11.5	21.0	100.0
New/modern residential area (NRA) (Oke-erin)	24.0	27.8	26.1	6.5	15.6	100.0
Government reservation area (GRA)	30.9	23.0	16.0	14.1	16.0	100.0

Source: Authors' survey 2009.

in Residential and Commercial (market) land uses is higher than the other land use areas. Furthermore, the socio-economic characteristics of the residents of this area can also be used to explain this. The high status of the residents make it quite possible for them to be able to consume more items such as beverages, milk, wine, plastic cans of drinks like yoghurt, viju milk, canned foods etc. than the people who reside in the other residential areas (Table 2). Similarly, variations are observed in other components as shown in table 1. Some factors in the environment also account for variations in solid waste generations and composition. Seasonal variations in climate and vegetation affect food items and fruits such as corn, chaff mangoes, oranges among others which are seasonal in nature and consequently, more of them would be generated in wet seasons.

Spatial Pattern of Solid Waste Disposal System in Ilorin Metropolis

There is no variation in solid waste disposal

Table 2: Residential areas and income group

<i>Residential area</i>	<i>Low income group %</i>	<i>High income group %</i>	<i>Total</i>
Old Residential area (ORA)	73.8	26.2	100.0
New/modern residential area (NRA)	48.3	51.7	100.0
Government residential area (GRA)	28	72	100.0

Source: Authors' survey 2009.

in the three areas of Ilorin metropolis. The Kwara State Waste Management Council in partnership with O'lan Clean Company, a private concern in partnership with the state government on waste disposal and management in the area of personnel and equipment, is responsible for the maintenance and emptying of the Ro-Ro bins (dumpsters) placed at strategic places in Ilorin metropolis. One hundred and eighty refuse depots (KWMC) were distributed randomly with a size of 2.4m by 2.4m and have a capacity of 2.4cubic which must be disposed daily. The distribution of these dumpsters was done along the major streets in the state capital with the intention to make the accessibility close to residential areas but the evidence showed that majority of our respondents do not have close access to these dumpsters. Table 3 expressed the level of satisfaction of the people to the location of these Ro-Ro Bins.

It can be observed from table 3, that there is a great similarity in all the areas concerning the distribution and availability of dumpsters\Ro-Ro bin to their residences. The spatial patterns exhibited in the composition and disposal of solid waste in the three different residential areas is further confirmed by the analysis of variance technique (Table 4). This statistical tool was used to confirm the relationship and the existence of spatial variation in solid waste, composition and disposal system. The ANOVA results (Table 4) indicate variation in waste data composition and generation and similarly in the availability of refuse depot. It was found to be significant at 0.5

Table 3: Distribution of refuse depots on major streets and accessibility to residents

<i>Residential Area</i>	<i>Availability of refuse bin (%)</i>	<i>Satisfied (%)</i>	<i>Not satisfied (%)</i>
Old residential area (ORA)	89	70	30
New/modern residential area (NRA)	95	75.7	25
Government residential area (GRA)	92	65	35

Source: Authors' survey 2009

probability level for waste generation; the result was 0.87 at 0.42 F- value. This trend thus confirmed our earliest assumption of variation in the different residential area. The result also indicated inadequacy of the dumpsters in the metropolis, as they would need to walk some distances before they could get access to the Ro-Ro bins. The inadequacy was due to increase in the volume of waste generated by the residents of Ilorin and change in the composition of waste generated due to improvement in the standard of living in the modern residential area and the GRA.

However, for availability of refuse depot the result tends to confirm the availability of these dumpsters within some distance to their residence or households with F-value of 0.68 and the Fr (degree of fraction) value given as 0.73.

Table 4: ANOVA for comparison of waste data in different residential areas

<i>Sources</i>	<i>Sum of squares</i>	<i>Degree of freedom</i>	<i>Mean square</i>	<i>F-value</i>	<i>Fr f</i>
A.					
Between	0.63	2.0	0.32	0.85	0.41
Within	41.75	118	0.35		
Total	42.48	120			
B.					
Between	0.114	2.0	0.05	0.02	0.96
Within	293.864	118	2.51		
Total		120			

Source: Authors' survey 2009

The implication of this is that, the distribution of refuse depots is about 500 metres to dispose their waste.

Haphazardly done, while this may favour some residents, others may need to walk longer distances to dispose their wastes.

A-Waste Generation/Composition

B -Availability of Waste Depots

The spatial pattern exhibited in the composition and management of solid waste in the identified residential areas was further confirmed by the result of the analysis of variance technique. This tool showed the existence of spatial variation in solid waste composition and management in Ilorin. Therefore, variation exists in waste data composition and availability of refuse depots and was found to be significant at 0.5 levels, this also confirms the variation in composition of waste data in the identified residential areas.

Solid Waste Management in Ilorin Metropolis

O'lan Clean is the environmental management consortium that manages the waste disposal in Kwara State in partnership with the Kwara State Waste Management Council (KWMC); this agreement came into effect on the 18th of August, 2004 with about 1,200 employees. Apart from eradicating all communicable diseases that can emanate from the dirty environment, the company was also charged with the responsibility of beautifying the state, and in the nearest future to turn waste to wealth and to formalise recycling process in the state.

The company has both light and hard wares for its smooth activities in the city. The inventory at disposal of the company contains dyno-trucks, lift diving, Ro-ro bins, trailer truck, bulldozer, graders, tray loader, computer machine, generating plant among other plants while the following items are for light use of the company for effective disposal activities digger, hard gloves, cutlass, rakes, shovels, wheelbarrow, rain boot, crowbar, v-shaped pushing stick, garden fork, watery can, etc. The company has made reasonable environmental impact in the area of pollution control, communicable diseases and control of weeds, reptiles and rodents as observed by the authors on the field.

The company is faced with problems such as inadequate equipment, poor orientation of the people as many are not well- cultured on how to maintain the environmental buildings among others. The company removes the refuse depots to the sites at Oloje, Kulende, Ganmo on daily basis as revealed in the course of this research survey and disposed off on routine basis. The

personnel resume work 5.00 am and closes at 9.00 pm, so has to allow the market area to be well-kept.

Solid Waste Generation and Availability of Dumpsters

The proportion of available dumpsters for waste generation is high in the three residential areas (Table 3) from the study survey, it was observed that the locations of dumpsters are accessible to their households, as only 30%, 25% and 35% respectively for the old residential area (Magaji Ngeri), New residential area (Oko-erin) and the government reservation areas respectively have it 100m to 200 metres away from their homes. While a large proportion of more than 65% in the ORA, NRA, and GRA have waste dumpsters at not easily accessible distance to their homes as far as between 300-700m. The distribution is uneven and inadequate in the metropolis to cater for their needs.

Thus, there is uneven distribution in the citing or location of refuse depots in Ilorin. The GRA has more depots than other residential areas; the old residential area has the next highest numbers while the new residential area has the least.

The nearest neighbour analysis result reveals that the distribution of refuse depots is random. The Rn factor of 1.02 was computed for the three areas and the relative disposition of different locations indicates absolute randomness of refuse depots therefore, showing dispersal measures in the three areas. There are, however, more depots in the peripheral regions than the core areas due to the availability of space in the areas most of them are located along major ways in Ilorin Metropolis. However, areas like Ita Amodu, Pipeline road, Gaa Akanbi, Olorunshogo, Agbabiaka Lanjorin to mention just a few lacked the presence of these dumpsters due to the narrow road which cannot accommodate the size of dumpsters.

The setting aside of every last Saturday of every month by the state government as environmental sanitation days have been very effective in the management of the environment and this exercise has greatly arouse the culture of the people towards sanitation.

IMPLICATIONS FOR PLANNING AND DEVELOPMENT

The refuse depots distribution have not been

well-planned, with the agency's employee's efforts of maintaining a clean environment in Ilorin, through their efforts of sweeping the roads, drainage, clearing of the bushes among others, all aimed at combating waste problems. However, there is need for more effective management and sanitary workers in the area of equipment expansion and dedication to bring about job effectiveness. Waste dumpsters have been made functional by regularly clearing of the wastes from the depots; this effort has greatly help by not translating into health problem zones for the inhabitants of Ilorin metropolis. However, more efforts should be intensified to make the dumpsters accessible to the residents.

CONCLUSIONS

The spatial disparities and similarities between disposal and management of wastes, between residential areas have been observed to be basically an environmental crisis as a result of poor sanitary conditions in Ilorin metropolis over the few years. 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, equipments 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 and relevant in solving waste disposal problems as well as proper maintenance of refuse depots.

RECOMMENDATIONS

Based on the foregoing, the following recommendations if implemented by policy makers and authorities concerned with waste matters, would further help improve environmental problems on management and disposal of waste.

The realization that collection and processing of waste is not the exclusive domain of the government, thus calling for a more comprehensive partnership between the community and government whose each actor has a role to play towards waste minimization and waste disposal.

Provision of adequate funds by the government should be made to solve the problem of waste management. The money made available to the waste sub-sector is inadequate for main-tenance of the equipments and acquiring of new ones, though these have improved but more still needed to be done in terms of availability of dumpster in Ilorin.

Government should convert the narrowed drainage to slab-type so as to ensure easy flow of water particularly in areas like Gaa Akanbi, Taiwo, Maraba, Oro Road, Town Planning Junction etc. Professionals such as planners, geographers, physical scientists should be consulted in the planning of the environment while personnel should be well- trained in effective environmental management.

Finally, Government should commence in earnest its recycling programmes at Gbagede near Ganmo, the savings can sometimes be considerable in addition to reducing manufacturing and material costs.

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