# An analysis of solid waste generation in a traditional African city: the example of Ogbomoso, Nigeria

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**ABSTRACT** This paper reports on patterns of household solid waste generation in the three distinct ecological zones that make up the city of Ogbomoso: the traditional core zone, the transitional zone developed under colonial rule and the suburban zone. It gives details of how total waste volumes and the components of waste varied over time in each of these zones – and there was considerable variation in these by day of the week and by month. For example, in the suburban zone, total waste generation for January was around half that for December; and although average incomes are higher in that zone, the per capita quantity of household waste (measured by weight) was not higher. Comparing household waste generation across the three zones showed that as education, income and social status increase, per capita waste generation declines, especially with regard to heavier organic waste products which account for more than three-quarters of the total waste generated in the study area. This is in part influenced by the differences in employment/livelihood patterns between the zones, and the study highlights how livelihood patterns and residents' possibilities for livestock raising influence the scale and composition of household waste. Finally, the paper highlights the importance for waste management of considering solid waste generated by enterprises in residential areas, including those run from home.

**KEYWORDS** livelihoods / organic waste / solid waste generation / urban ecological zones

## I. INTRODUCTION

There has been little documentation of the quantity and composition of solid waste generated in different areas of African cities and this has limited the capacity to develop effective solid waste management. Studies on solid waste generally consider the city as a single entity and fail to take into account either the variations in waste generation from one zone to another or changes over the year.[1] This case study of Ogbomoso considers both of these factors and provides a stronger information base to:

- plan for the equipment required for the collection and transport of waste;
- make decisions on possibilities for waste reduction through sorting and recycling, and disposal methods;
- enact appropriate by-laws to prevent the generation of avoidable waste components;

1. Adedibu, Afolabi (1983), "Solid waste characteristics and management in Ilorin", *Journal of the Nigerian Institute of Town Planners* Vol III, No 1, pages 33–41; also Oluwande, P (1974), "Investigation into certain characteristics of refuse from Western state of Nigeria", *Journal of Solid Waste Management* Vol 9, No 2, pages 22–32.



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- target environmental education on waste reduction appropriately; and
- establish current and future needs for solid waste disposal sites.

## II. THE ECOLOGICAL ZONES OF TRADITIONAL AFRICAN CITIES

In Nigeria and many other African nations, there have been three historical periods in the development of traditional cities: pre-colonial, colonial and post-Independence. Each period produced a separate ecological zone, homogenous in terms of physical layout, ethnic composition, socio-economic status and environmental amenities. Examples in Nigeria where these zones are identifiable include Ilorin, Ibadan, Benin City, Bida and Minna.[2]

The first type of ecological zone – the traditional core or urban centre – dates from the pre-colonial era. In most cases, this area is surrounded by security walls, consists of closely built houses that are connected by footpaths, and lacks road access, a pattern that suited the social and economic conditions of the time when they developed. Houses provide sleeping space but also work space for residents involved in such traditional occupations as farming, dyeing, blacksmithing and cloth weaving as well as petty trading. This ecological zone houses the king's palace, important shrines and the main traditional markets located very close to the palace. Standards for housing construction (technique and materials), layout and available facilities are low, and this zone generally houses a higher proportion of low-income earners than the other two zones.[3]

The second ecological zone – the transitional zone – was planned and built after the establishment of British colonial rule due to the need to accommodate growing numbers of middle-income residents, most of them employed in the formal sector. Housing is of a higher quality, density is lower than in the traditional centre, residents have a higher socioeconomic status, ethnic composition is more varied and there is greater access to government and social services.

A well-planned layout and heterogeneous building types characterize the post-Independence suburban zone. A high proportion of the higher-income and better-educated residents of these areas are engaged in white collar jobs, including the civil service, and this zone has good quality environmental services. In general, housing density, population, household size and intensity of land use decrease as one moves from the traditional centre through the transitional zone to the suburban zone.

Analyzing the urban environment on the basis of these different zones has some specific advantages. Each zone exhibits certain consistent features in terms of location, the types, structures and layouts of housing, and commercial activities, which reflect the social, economic and cultural attributes of the residents. This can simplify the analysis of various urban issues, including a consideration of solid waste management.

## III. THE STUDY AREA

Ogbomoso, a predominantly Yoruba-speaking city, was founded in the middle of the sixteenth century by groups of hunters. The town's real physical and economic growth dates back to the 1820s, when various important and powerful towns around Ogbomoso were destroyed in the

2. See Akorede, V (1975), "Ilorin – a study in urban geography", MA Thesis, University of Lagos, Nigeria; also Ayeni, Bola (1994), "The metropolitan area of Ibadan: its growth and structure", in F Akintola and G Ikporukpo (editors), *Ibadan Regions*, Department of Geography, University of Ibadan, Nigeria, pages 72–84; Onokorahaye, Andrew (1995), *Benin: A Traditional African City in Transition*, BSSA, University of Benin, Nigeria; and Gana, R (1996), "A comparative analysis of development control implementation in Minna and Bida, Niger state, Nigeria", PhD thesis, Department of Geography, University of Ilorin, Nigeria, pages 87–106.

3. Afon, Abel (2005), "Solid waste generation in selected cities of Oyo state, Nigeria", PhD thesis, Department of Urban and Regional Planning, Obafemi Awolowo University, Ile-Ife, Nigeria.

course of inter-tribal wars. More than 140 communities found refuge in Ogbomoso and most of these people never returned to their former settlements. The establishment of the colonial administration, the advent of the missionaries and the establishment of schools, the expansion of trading activities and relative peace in Ogbomoso contributed to the rapid growth of the town. The deportation of indigenous Nigerians by the Ghanaian government in 1969, when many Ogbomoso residents returned home, also affected the development of the town, as many of the returnees established industrial concerns. The population grew from 25,000 in 1885[4] to more than 166,000 by 1991,[5] and the built-up area expanded from 5.8 square kilometres in 1950 to 10.2 square kilometres in 1970, to 24.3 square kilometres in 1995.[6] In 2003, Ogbomoso was estimated to cover 27.5 square kilometres[7] and it is the second largest city in Oyo state, after Ibadan. There are two local government areas, namely Ogbomoso North and Ogbomoso South, and they have their headquarters at Kinnira and Arowomole, respectively. Together with the contiguous areas of Surulere, Orire and Ogo-Oluwa, they constitute the Ogbomoso administrative zone in Oyo state (Figures 1 and 2).

The city's growth created various urban problems, including that of inadequate provision for solid waste management. All three ecological

4. Bowen, Thomas (1957), *Central Africa: Adventures and Missionary Labour in Several Countries in the Interior of Africa from 1859 to 1866,* Southern Baptist Publication Society, Charleston, South Carolina, USA.

5. National Population Commission Nigeria (1991), *Nigerian Population and Housing Census Figures*, Federal Government Press, Lagos.

6. Popoola, Bolaji (1997), "An analysis of the urban periphery of Ogbomoso, Oyo state", MURP thesis, Centre for Urban and Regional Planning, University of Ibadan, Nigeria.

7. Abolade, Olajoke (2004), "An assessment of the effects of urban growth incursion into rural lands in Ogbomoso, Oyo state, Nigeria", MSc Thesis, Institute of Ecology and Environmental Studies, Obafemi Awolowo University, Ile-Ife, Nigeria.

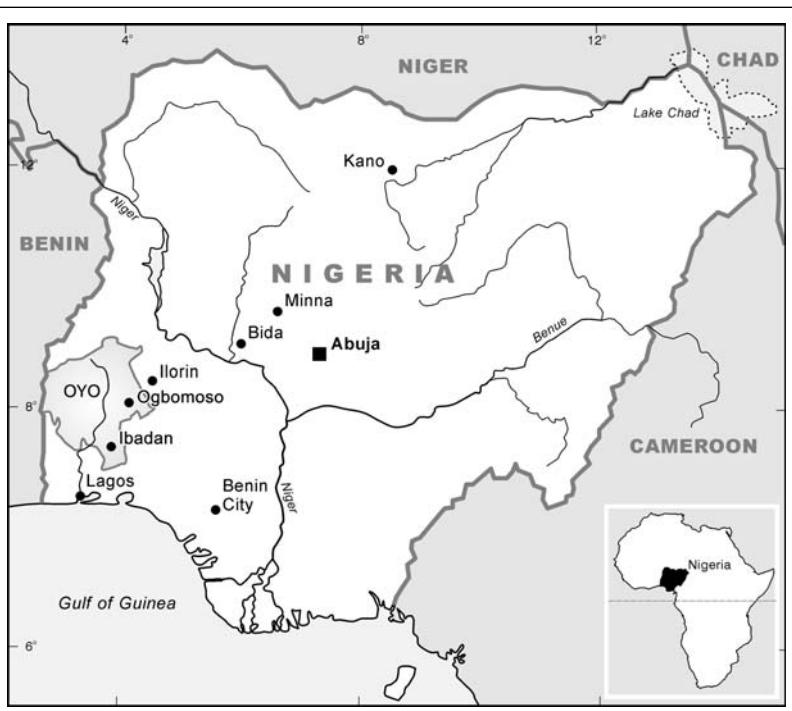


**FIGURE 1**
**The study area in the context of Nigeria**

SOURCE: Adapted from Duce, M and A Ojo (1982), *Senior Secondary School Atlas* (revised edition), Macmillan, Ibadan, page 13.

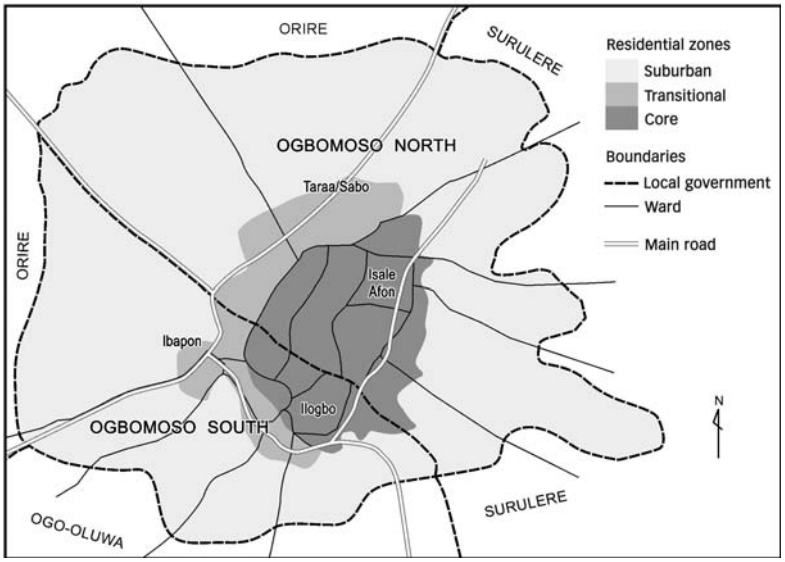


**FIGURE 2**
**Ogbomoso: the three ecological zones and four selected wards**

SOURCE: Adapted from Afon, Abel (1998), "Residents' perception of environmental quality in the core residential area of Ogbomoso, Oyo state, Nigeria", MSc thesis, Department of Urban and Regional Planning, Obafemi Awolowo University, Ife-Ife, Nigeria.

zones have many areas that are covered with uncollected solid waste and this creates problems as much solid waste collects in the town's streams and rivers. In 2005, there were only three serviceable waste collection vehicles for the whole town, one owned by the local government of Ogbomoso South, the other two by Ogbomoso North. Solid waste management is the responsibility of the environmental health unit within the local government's Department of Health. No standards have been established for waste storage, so residents use a range of receptacles. There is no provision for house-to-house collection, no provision for waste containers at central points, and waste cans in more central locations have been phased out. There are no private waste collectors in the town, either formal or informal. There is no legal solid waste disposal site in the town and the waste collected by the few serviceable vehicles is dumped illegally and indiscriminately, with no costs recovered from residents. A review of the annual budget allocations of the two local governments between 1998 and 2004 shows that waste management and related issues have been neglected and there are no statistics on the quantity and composition of waste.

## IV. METHODOLOGY

Two sets of primary data were collected for the study in 2004. The first was drawn from questionnaires from two wards in each of the two local government areas. These wards were selected to represent each of the

three identified zones (the core/traditional, intermediate/transitional and the suburban). In Ogbomoso North, wards 3 and 10 were selected (Isale Afon and Taraa/Sabo) while wards 14 and 17 (Ibapon and Ilogbo) were selected in Ogbomoso South (Figure 2). Houses from each ward were selected through stratified systematic sampling; the first building was selected randomly and then every subsequent tenth building. Since the study's unit of investigation was the household, all households in each of the selected buildings were surveyed. A total of 718 questionnaires were administered in the four wards.

The second set of data was based on a measurement of the solid waste actually generated in one-quarter of the buildings selected for the questionnaire; in all, 2.5 per cent of the households in the sampled wards had their waste measured. This exceeds the minimum acceptable sample size of 1 per cent recommended for such a study.[8] All households in the selected buildings had their waste measured, to take into account the possibility of households combining their waste. Table 1 presents the number of buildings, households and residents from which waste was measured in each zone.

8. Pfamatter, R and R Schertenleib (1996), *Non-governmental Refuse Collection in Low-income Urban Areas: Lessons Learned from Selected Schemes in Asia, Africa and Latin America*, Swiss Federal Institute of Environmental Science and Technology, Zurich, Switzerland.

The survey was conducted using 36 trained research assistants who were students from the Department of Urban and Regional Planning at Ladoke Akintola University of Technology, Ogbomoso.

Each research assistant surveyed a maximum of three buildings and an average of seven households daily. The survey for each month of the year lasted for a week and data were obtained for each day of the selected week. Each month's measurement of waste was usually preceded by a visit to explain the project and solicit cooperation; also to distribute labelled containers in which the households' solid waste would be stored.

Residents use a range of waste receptacles, including baskets, plastic containers, open metal drums, paper/cardboard cartons and polythene bags.[9] For the purposes of this study, polythene bags were provided to the selected households because they are cheap, very light and convenient to replace. Four polythene bags were provided to each selected household and labelled according to the waste component(s) to be put inside. The first was for paper, broken bottles and metal waste, leaf material, nylon and polythene, rags and rubber material, all of which can be easily separated for measurement. The second was for animal dung only; the third was for ashes; and the fourth was for food waste and fruit peels. The research assistants separated the contents of the first bag and all waste was measured daily over a period of one year to show the effects of the different seasons.

9. See reference 1, Oluwande (1974); also see reference 3.

**TABLE 1**
**The number of buildings and households surveyed for waste measurement**

| Ecological zone | Buildings | Households | Residents |
|---|---|---|---|
| Core | 17 | 54 | 359 |
| Transitional | 28 | 59 | 405 |
| Suburban | 27 | 72 | 445 |
| **Total** | **72** | **185** | **1,209** |

## V. RESEARCH FINDINGS

Unless otherwise stated, all the tables in this section of the study were drawn from the survey carried out in 2004.

### a. Variations in the residents' socioeconomic attributes

Four resident attributes were considered – education, occupation, income and household size. Two of these factors, income and household size, have been widely acknowledged as important influences on solid waste generation.[10] In this setting, occupation and education (which influences occupation) were also clearly relevant. For example, in the core zone, where fewer residents have secondary and tertiary education, the population engages mostly in farming and petty trading, which significantly affects the quantity and composition of waste generated. Educational status influences food choices and materials purchased and consequently waste generation.[11] Table 2 shows how the residents' educational status varies between the three zones – with the proportion of residents with secondary and tertiary education increasing as one moves from the core through the transitional zone to the suburban zone. Table 3 shows how occupational profiles varied by zone.

The estimated average monthly income of respondents in the core, transitional and suburban zones was N9,382, N11,639 and N13,253, respectively (US$ 72.20, US$ 89.50 and US$ 101.95, respectively).[12]

**TABLE 2**
**Educational status of respondents in the different zones**

| | Ecological zone (number and percentage of total for all zones) | | | |
|---|---|---|---|---|
| **Educational background** | **Core (%)** | **Transitional (%)** | **Suburban (%)** | **Total (%)** |
| No formal | 98 (13.7) | 45 (6.3) | 26 (3.6) | 169 (23.6) |
| Primary | 47 (6.6) | 32 (4.4) | 11 (1.5) | 90 (12.5) |
| Secondary | 42 (5.8) | 82 (11.4) | 108 (15.1) | 232 (32.3) |
| Tertiary | 14 (1.9) | 83 (11.6) | 130 (18.1) | 227 (31.6) |
| **Total** | **201 (28.0)** | **242 (33.7)** | **275 (38.3)** | **718 (100.0)** |

**TABLE 3**
**Occupational profiles in the different zones**

| | Ecological zone (number and percentage of total for all zones) | | | |
|---|---|---|---|---|
| **Occupation** | **Core (%)** | **Transitional (%)** | **Suburban (%)** | **Total (%)** |
| Farming | 56 (7.8) | 18 (2.5) | 6 (0.8) | 80 (11.1) |
| Artisan | 16 (2.2) | 26 (3.6) | 17 (2.4) | 59 (8.2) |
| Trading | 101 (14.1) | 79 (11.0) | 83 (11.6) | 263 (36.7) |
| Civil service | 17 (2.4) | 57 (8.0) | 102 (14.2) | 176 (24.6) |
| Others | 11 (1.5) | 62 (8.6) | 67 (9.3) | 140 (19.4) |
| **Total** | **201 (28.0)** | **242 (33.7)** | **275 (38.3)** | **718 (100.0)** |

10. Collins, John and Bryan Downes (1977), "The effects of size of the provision of public services: the cases of solid waste collection in smaller cities", *Urban Affairs Quarterly* Vol 12, No 3, pages 333–347; also Marchand, Rogier (1998), "Marketing of solid waste management services in Tingloy, the Philippines: a study on affordability and willingness to pay", UWEP Working Document No 9, Gouda, the Netherlands; and Cointreau, Sandra (1982), "Environmental management of urban solid waste in developing countries: a project guide", Urban Development Technical Paper No 5, World Bank, Washington DC.

11. See reference 1, Oluwande (1974); also Egunjobi, Layi (1986), "Problems of solid waste management in Nigerian urban centres", in E O Adeniyi and I B Bello Imam (editors), *Development and the Environment*, Proceedings of the 12th National Conference, NISER, Ibadan, pages 308–318.

12. At the time of the survey, there were approximately 130 nairas to one US$.

## b. Solid waste generation in Ogbomoso: an explanation

Tables 4, 5 and 6 present waste generation patterns in each of the zones over a 12-month period. They show the following:

- the highest volume of waste was generated in December, known to be a time of festivity and also a peak harvest time;
- the amount of waste produced in December increased with distance from the core zone, as the transitional and suburban zones witnessed an increase in population during times of festivity;
- the least waste generation was recorded in April in the core zone, in May in the transitional zone and in January in the suburban zone;
- waste production was highest in the core zone and lowest in the suburban zone. The quantity of waste generated in the core zone also varied less over the year than in the other zones, since the population of the core zone is stable throughout the year and the main occupations of the residents (farming and petty trading) encourage a uniform production of waste;
- leaf waste accounted for the greatest volume of waste, and the core and transitional zones produced almost double the quantity generated by the suburban zone, reflecting the residents' greater engagement in primary activities. Moreover, many residents purchase food items wrapped in leaves. Another very common waste was paper and the volumes increased as one moved from the core zone to the suburban zone, reflecting residents' educational status and occupations. The generation of nylon and polythene waste increased from the core zone to the suburban zone, while the quantities of food and fruit peels decreased;
- animal dung production was lowest in the transitional zone and highest in the suburban zone (three times higher than in the transitional zone). This reflects the fact that animals can be kept in enclosed areas in the suburban zone, making it possible for residents to collect the dung for the measurement purposes. In the core and transitional zones, animals are only brought inside at night. More households in the suburban zone also keep animals on a subsistence and/or commercial basis than in the other two zones;
- the quantity of broken bottles and metal waste increased from the core zone, where it was particularly low, towards the suburban zone, as the consumption of manufactured products in bottles correlates with education and income;
- the generation of ashes declined going from the core zone to the suburban zone. This is because more residents in the core zone use wood as fuel for cooking than in the two other zones;
- waste generation during the rainy season and early part of the dry season, when harvesting is at its peak, was higher than during the completely dry season;
- the proportion of organic waste decreased with distance from the core zone, varying inversely with income. For the whole town, organic waste represented 79.1 per cent of the total, which is very close to the proportion of organic waste for the cities of Lagos and Kano, estimated at 79 per cent and 65 per cent, respectively;[13] and
- the study also considered how waste generation varied over the week and in each zone. The highest quantity of waste was generated

13. See reference 10, Cointreau (1982).

**TABLE 4**
**Solid waste generation by households in the core zone (kilogrammes)**

| Waste components | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paper | 60.8 | 56.2 | 69.9 | 56.9 | 60.7 | 56.1 | 58.4 | 58.6 | 57.7 | 64.7 | 63.8 | 66.1 | 729.0 | **15.7** |
| Leaf | 78.9 | 97.8 | 97.9 | 86.4 | 90.0 | 88.0 | 94.1 | 86.7 | 96.7 | 99.0 | 99.9 | 110.4 | 1125.8 | **24.3** |
| Food waste and fruit peel | 84.2 | 84.0 | 84.5 | 78.2 | 79.2 | 74.7 | 77.9 | 82.3 | 77.7 | 87.3 | 97.6 | 94.1 | 1001.7 | **21.6** |
| Nylon and polythene | 42.0 | 41.0 | 41.9 | 39.2 | 37.4 | 36.2 | 38.8 | 43.2 | 39.2 | 42.6 | 39.7 | 43.8 | 485.0 | **10.4** |
| Rubber materials | 14.7 | 13.4 | 15.6 | 16.0 | 10.9 | 12.7 | 15.0 | 13.4 | 15.5 | 14.0 | 13.7 | 17.5 | 172.4 | **3.7** |
| Animal dung | 41.9 | 42.2 | 40.9 | 37.1 | 39.5 | 36.6 | 40.6 | 38.3 | 42.8 | 41.8 | 40.3 | 43.8 | 485.8 | **10.5** |
| Ashes | 42.1 | 39.6 | 40.7 | 33.9 | 37.6 | 32.7 | 29.2 | 41.3 | 39.2 | 41.5 | 37.9 | 41.7 | 457.4 | **9.8** |
| Rag | 9.1 | 9.7 | 10.0 | 8.0 | 10.4 | 9.1 | 9.5 | 7.8 | 8.5 | 9.9 | 10.5 | 11.5 | 114.0 | **2.5** |
| Broken bottles and metals | 5.4 | 4.4 | 4.7 | 4.7 | 5.6 | 5.2 | 5.8 | 9.5 | 5.6 | 6.9 | 7.0 | 6.6 | 71.4 | **1.5** |
| **Total** | **379.1** | **388.3** | **406.1** | **360.4** | **371.3** | **351.3** | **369.3** | **381.1** | **382.9** | **407.7** | **410.4** | **435.5** | **4643.4** | |
| **%** | **8.2** | **8.4** | **8.7** | **7.8** | **8.0** | **7.6** | **7.9** | **8.2** | **8.2** | **8.8** | **8.8** | **9.4** | | **100.0** |

**TABLE 5**
**Solid waste generation by households in the transitional zone (kilogrammes)**

| Waste components | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paper | 66.8 | 47.6 | 67.0 | 63.5 | 49.1 | 56.6 | 44.6 | 74.4 | 71.9 | 44.8 | 73.3 | 41.7 | 701.2 | **17.0** |
| Leaf | 78.1 | 99.8 | 62.5 | 67.8 | 100.6 | 73.0 | 123.5 | 73.2 | 87.5 | 94.0 | 93.6 | 100.7 | 1054.2 | **25.6** |
| Food waste and fruit peels | 50.3 | 39.3 | 49.5 | 50.9 | 45.9 | 48.5 | 49.6 | 57.8 | 54.3 | 71.5 | 58.0 | 55.6 | 631.0 | **15.3** |
| Nylon and polythene | 44.2 | 34.2 | 43.5 | 40.7 | 33.3 | 39.6 | 34.8 | 51.3 | 44.4 | 37.7 | 48.9 | 37.5 | 490.0 | **11.9** |
| Rubber materials | 17.7 | 13.4 | 14.5 | 14.9 | 13.6 | 13.9 | 20.8 | 21.2 | 15.6 | 28.5 | 15.0 | 62.5 | 251.5 | **6.1** |
| Animal dung | 25.6 | 21.9 | 20.7 | 23.1 | 15.6 | 24.4 | 34.5 | 27.3 | 27.0 | 35.3 | 30.9 | 36.6 | 322.9 | **7.8** |
| Ashes | 24.2 | 21.0 | 24.4 | 25.2 | 18.0 | 29.7 | 20.4 | 27.6 | 27.6 | 41.9 | 29.1 | 50.9 | 339.8 | **8.2** |
| Rag | 11.7 | 5.0 | 8.1 | 8.1 | 4.4 | 4.5 | 7.3 | 11.7 | 13.2 | 4.1 | 13.3 | 10.2 | 101.5 | **2.5** |
| Broken bottles and metals | 18.8 | 12.3 | 15.5 | 19.9 | 12.2 | 27.7 | 9.7 | 16.9 | 17.8 | 32.7 | 18.0 | 27.7 | 229.0 | **5.6** |
| **Total** | **337.4** | **294.5** | **305.7** | **314.1** | **292.7** | **317.9** | **345.2** | **361.4** | **359.3** | **390.5** | **380.1** | **423.4** | **4121.1** | |
| **%** | **8.2** | **7.1** | **7.4** | **7.6** | **7.1** | **7.7** | **8.4** | **8.8** | **8.7** | **9.5** | **9.2** | **10.3** | | **100.0** |

on Saturdays, which is a work-free day for civil servants and other organized private sector workers. This is when general house cleaning is carried out and food is prepared for the following week, and it is also a day that witnesses more celebrations, for example housewarmings, weddings, funerals etc.

## c. Variations in waste multipliers

Table 7 shows how the daily average waste generation per capita, per household and per building varies by month for each of the zones. For the whole town, the average daily per capita generation was 0.13 kilogrammes. Per capita waste generation was found to decline going from the core zone (the least wealthy zone but with the highest waste generation per person) to the transitional and suburban zones, as residents' incomes

**TABLE 6**
**Solid waste generation by households in the suburban zone (kilogrammes)**

| Waste components | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paper | 50.8 | 43.3 | 40.7 | 48.0 | 43.8 | 58.9 | 60.1 | 76.0 | 73.7 | 72.5 | 70.9 | 66.8 | 705.5 | **17.3** |
| Leaf | 36.6 | 35.2 | 29.7 | 37.7 | 30.6 | 37.7 | 42.9 | 65.2 | 54.0 | 54.2 | 52.8 | 74.8 | 551.4 | **13.5** |
| Food waste and fruit peels | 40.1 | 23.8 | 25.2 | 30.6 | 22.6 | 32.5 | 35.0 | 47.2 | 47.6 | 45.1 | 45.2 | 43.1 | 438.0 | **10.7** |
| Nylon and polythene | 26.8 | 30.9 | 34.8 | 33.5 | 30.6 | 34.5 | 38.9 | 65.7 | 52.9 | 53.9 | 50.3 | 54.9 | 507.7 | **12.4** |
| Rubber materials | 17.0 | 11.3 | 13.2 | 15.8 | 11.9 | 14.5 | 15.5 | 21.8 | 27.0 | 24.5 | 25.0 | 25.7 | 223.2 | **5.5** |
| Animal dung | 33.9 | 91.4 | 90.2 | 110.0 | 87.1 | 95.6 | 22.3 | 83.0 | 95.4 | 98.5 | 93.8 | 98.9 | 1000.1 | **24.5** |
| Ashes | 12.0 | 10.8 | 12.5 | 16.9 | 15.5 | 15.9 | 21.7 | 27.7 | 32.8 | 29.6 | 29.3 | 30.7 | 255.4 | **6.3** |
| Rag | 4.9 | 5.2 | 5.0 | 8.0 | 5.4 | 7.4 | 13.1 | 13.0 | 14.9 | 15.6 | 15.5 | 29.8 | 137.8 | **3.4** |
| Broken bottles and metals | 12.2 | 13.9 | 13.0 | 15.6 | 12.2 | 17.3 | 22.0 | 25.3 | 29.3 | 32.2 | 33.7 | 35.9 | 262.6 | **6.4** |
| **Total** | **234.3** | **265.8** | **264.3** | **316.1** | **259.7** | **314.3** | **271.5** | **424.9** | **427.6** | **426.1** | **416.5** | **460.6** | **4081.7** | |
| % | **5.7** | **6.6** | **6.5** | **7.7** | **6.4** | **7.7** | **6.6** | **10.4** | **10.5** | **10.4** | **10.2** | **11.3** | | **100.0** |

**TABLE 7**
**Daily solid waste generation levels per person, per household and per building in the three zones**

| | Core | | | Transitional | | | Suburban | | | Whole town | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Months | Per capita | Per h/h | Per building | Per capita | Per h/h | Per building | Per capita | Per h/h | Per building | Per capita | Per h/h | Per building |
| January | 0.15 | 1.00 | 3.19 | 0.12 | 0.82 | 1.72 | 0.08 | 0.47 | 1.24 | 0.11 | 0.73 | 1.89 |
| February | 0.16 | 1.03 | 3.26 | 0.10 | 0.71 | 1.50 | 0.09 | 0.54 | 1.43 | 0.11 | 0.74 | 1.89 |
| March | 0.16 | 1.07 | 3.41 | 0.11 | 0.74 | 1.56 | 0.09 | 0.52 | 1.40 | 0.12 | 0.75 | 1.94 |
| April | 0.14 | 0.95 | 3.03 | 0.11 | 0.76 | 1.80 | 0.10 | 0.63 | 1.67 | 0.12 | 0.77 | 1.97 |
| May | 0.15 | 0.98 | 3.12 | 0.10 | 0.71 | 1.49 | 0.08 | 0.52 | 1.37 | 0.11 | 0.71 | 1.83 |
| June | 0.14 | 0.93 | 2.95 | 0.11 | 0.77 | 1.62 | 0.10 | 0.63 | 1.67 | 0.12 | 0.76 | 1.95 |
| July | 0.15 | 0.98 | 3.10 | 0.12 | 0.84 | 1.76 | 0.09 | 0.54 | 1.44 | 0.12 | 0.76 | 1.96 |
| August | 0.15 | 1.01 | 3.20 | 0.13 | 0.87 | 1.84 | 0.14 | 0.84 | 2.25 | 0.14 | 0.90 | 2.32 |
| September | 0.15 | 1.01 | 3.22 | 0.13 | 0.87 | 1.83 | 0.14 | 0.85 | 2.26 | 0.14 | 0.90 | 2.32 |
| October | 0.16 | 1.08 | 3.43 | 0.14 | 0.99 | 1.99 | 0.14 | 0.85 | 2.25 | 0.15 | 0.95 | 2.43 |
| November | 0.16 | 1.09 | 3.45 | 0.13 | 0.92 | 1.94 | 0.13 | 0.83 | 2.20 | 0.14 | 0.93 | 2.40 |
| December | 0.17 | 1.15 | 3.66 | 0.15 | 1.02 | 2.16 | 0.15 | 0.91 | 2.44 | 0.16 | 1.02 | 2.62 |
| Daily | 0.15 | 1.02 | 3.25 | 0.12 | 0.83 | 1.75 | 0.11 | 0.68 | 1.80 | 0.13 | 0.83 | 2.13 |
| Weekly | 1.08 | 7.17 | 22.77 | 0.85 | 5.82 | 12.26 | 0.77 | 4.73 | 12.61 | 0.89 | 5.79 | 14.88 |

and educational status increase. This is evident with regard to waste generation per capita and per household. Waste generation per building was also much higher in the core zone than in the other two zones. This is particularly notable in that it is generally assumed that waste generation per person increases with income. Higher-income groups generate more manufactured products waste than their low-income counterparts, who generate large quantities of heavier organic materials.[14] The averages for Ogbomoso appear low; for instance, one source suggested that the average daily per capita generation in low-income countries is between 0.4–0.6 kilogrammes,[15] which is far above the 0.13 kilogrammes established for Ogbomoso in this study.

14. See reference 1, Adedibu (1983); also see reference 10, Cointreau (1982); and Cargo, Douglas (1978), "Solid wastes: factors influencing generation rates", Research Paper No 174, Department of Geography, University of Chicago.

15. See reference 10, Cointreau (1982).

Some of the per capita figures for different waste components in the three zones were not what might have been expected. For instance, per capita generation of paper was expected to increase going from the core zone to the suburban zone, but this was not evident and is probably due to petty traders in the core zone who trade in waste paper. In the core/transitional zones, paper is also widely used for wrapping traditional food items (which previously had been wrapped mainly in leaves).

## VI. CONCLUSIONS AND RECOMMENDATIONS

The study highlights two important issues. The first is how much the quantity of solid waste generation varies over the year – which is evident in all three zones. Solid waste volumes per person, per household and per building in December were almost twice those in January in the suburban zone; there was also significant variation in the transitional zone, but less in the core zone. The second issue is the importance of employment/livelihood-related waste in total household waste flows – and it is these that help explain why waste volumes per person did not increase with income/educational status. The residents in the core zone, with lower average incomes and lower educational status, generate more waste per person than the residents in the other two zones. As described above, the composition of the waste generated also varies considerably across the three zones – and this reflects not only different consumption patterns but also which households have space to raise livestock within their home areas. Residents in the core zone have a higher quantity of waste with high organic content. There was no evidence that residents mix faecal substances with household waste; in the core residential zone, where some houses have no toilets, there are designated open spaces that people use both as toilets and as waste dump sites.

The findings of this study provide some details that can help in the design of a solid waste management system. It provides basic data on the scale and composition of household waste in different zones. It also highlights the very high proportion of organic waste in total waste flows – for the whole city, more than three-quarters of household waste is organic and could be composted, greatly reducing the volume of waste that would have to be disposed of. Perhaps the next step needed for addressing the problems of solid waste in Ogbomoso is an assessment of residents' willingness and ability to pay for a household waste collection service and the possibilities this might offer for supporting private waste collection services. The present situation, with local government doing practically nothing on waste management and residents being offered no service and paying nothing, cannot continue if the urban environment is to be free of heaps of uncollected waste on roads, river banks and open spaces.

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