



Solid waste management and re-use in Maiduguri, Nigeria

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ALTHOUGH, WASTE MAY generally be considered as omnipresent in any human set up, however, if its presence/generation poses a threat to human existence in any way, then its safe disposal becomes imminent.

In Nigeria, recent upsurge in waste generation and hazardous dumping due to poor management has translated into a serious problem. The heaps of refuse that are dumped indiscriminately along our streets, drainages/gutters, etc., not only spoils scenic resources, pollutes soil and water resources but also constitutes a potential health hazards to plants, animals and people.

This study will focus on Maiduguri metropolis as the study area. Historically, Maiduguri has been an administrative, cultural and religious center. Presently the capital of Borno State, it controls commerce, governance and cultural developments of the center. The city is considered as the commercial hub of the northeastern region of the country, partly due to its location as it shares border with Cameroun and Chad republics. The city, with a population of about 629,486 (1991 census) occupying a land area of about 550 square kilometers, enjoys not only local commercial activities but also international. The consequence of such increased commercial activities facilitates high human traffics that suggest high generation of wastes, which eventually rendered the available waste disposal infrastructures ineffective.

Maiduguri, like many other cities in Nigeria, rarely has available information on solid waste, due to principally financial constraint and people's attitude towards waste management. Prior work on waste management in Maiduguri (1)(2) revealed a number of important information related to the waste generally and its management problems in particular. To tackle the problems, a number of both technical and non-technical solutions were offered (1)(2), out of which sanitary landfill was proposed as an Integrated Wastes Management Facility (IWMF) in Maiduguri (2). However, this study deemed that. As far as IWMF is concerned, sanitary landfill should be considered and should be given the lowest priority. The aim of this study is therefore primarily to determine the sources, rate of generation, composition and modes of disposal of the solid wastes within the metropolis. Secondly, the study will attempt to propose a more reasonable and efficient integrated wastes management methodology that will capitalize on efficient resource re-utilization prior to final disposal.

Research methodology

In order to obtain the required data and information, the study that was conducted between January and March 2002, adopted a methodology that includes; formal and informal interviews, questionnaire administration, interest group discussions, and fieldwork and observations. However, to facilitate the sampling procedure, Maiduguri, the study area was divided into 3 groups based on the classification provided by the municipal planning authority, thus; low, medium and high-density areas. Furthermore, 5 wards were considered from each area, and 20 houses were randomly selected from each of the wards, taking into consideration low, medium and high-income households. In total, 300 houses were surveyed with a 99.3% response rate. To determine the rate of generation and composition of the waste, 9 houses were randomly selected from each of the sampling area, 3 each representing low, medium and high-income households. 100% response rate was recorded for the 27 houses investigated. The households are requested to put in their waste in the provided bags, which are collected and replaced by new ones daily. Weighing and sorting were then conducted. This process was repeated for 1 week each. In addition, to enable the determination of the extent of materials recovery by scavengers, the collected waste is taken to the dumping sites by the authors, while the scavengers are allowed to pick whatever they desire before further weighing.

Results and discussion

Sources and rate of generation of solid waste

The identified sources of waste in the metropolis includes; Household/Commercial, Agricultural, Industrial, Institutional (e.g. schools, hospitals, prisons, markets, banks, hotels, etc.) and Municipal (street sweepings and roadside litter, landscape and tree trimmings, dead animals, etc.). However, this study restricted its findings to household waste only. Of the 300 households investigated, 64.7% indicated that most of their waste accrues from cooking related activities which includes processing of foodstuff prior to cooking, discarded portions of food materials, etc. The fact that Maiduguri is still an agricultural community manifested itself in this work. In this case, 20.0% of the respondents, especially in the low density area claimed that most of their waste originates from agricultural practices, the constituent of which are in form of straws, stalks and

stems of plants that are considered residue of agricultural practices. Other sources of the agricultural wastes include animal dung and carcasses. Packaging materials constitute about 10.0%, while those accruing from miscellaneous sources such as fallen leaves from trees totaled 4.7%. However, 0.7% was invalidated.

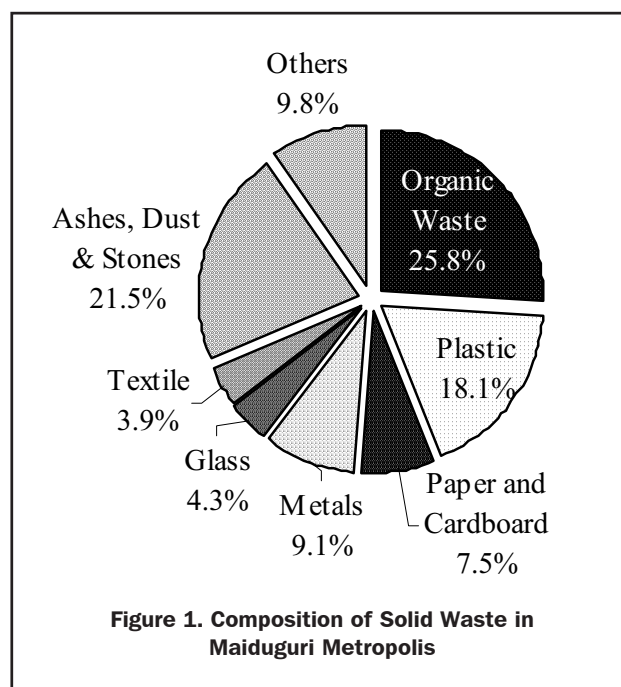
In order to calculate the rate of waste generation as a function of waste produced in kilogram per person per day, waste generated by the 27 households per week was determined based on the procedure stated in 2.0 above. Average waste generated per household per week was found to be about 12.25 Kg/week. The average household in the metropolis consists of 7 people; hence the rate of waste generation (dry weight) per capita per day was determined to be 0.25 Kg. Using the projected population of Maiduguri metropolis for 2002, which is 888,174, about 222,044 tons of solid waste was found as waste generated by households.

Composition of solid waste

To determine the composition, 3 different samples consisting of 100 Kg of the collected waste were sorted out into various major fractions that constitute the overall waste. Average of the 3 samples is taken and the result is presented in Fig. 1. Organic waste, which constitutes the largest portion of the waste stream mainly consists of leaves, yard trimmings, food remnants, agricultural wastes, etc. It is worthy to note that agricultural wastes in the form of straw, stems and stalks represent about 6.4% of the total solid waste in the metropolis, i.e. about 25% of the total organic waste. On the other hand, polythene shopping bags (black film) and packaged water bags (pure water) represent about 2.5% and 5.9% of the total solid waste, respectively, i.e., 22.6% and 13.8% of the total plastics in the waste stream, respectively. The high percentage of Ashes, Dust and Stones may be linked with cooking, disposal method and the geographical characteristics of the study area. The result fairly compares with the study undertaken by the Federal Government of Nigeria (2).

Modes of disposal of solid waste

Organizationally, the government agency responsible for collection and disposal of waste in the state is the *Borno State Environmental Protection Agency (BOSEPA)*. The study identified 4 formal (officially designated) refuse collection sites/dumping sites, thus; *Lamisula, Gamboru, Mairi/University* and *Gwange* wards, while over 200 collection centres have been traced within the metropolis, with numerous informal centres. Usually, waste generated by households, which require disposal are taken directly to the closest collection centre by the households themselves or via informal waste collectors (for a fee) for onward disposal to the center, before transferring to the dumping sites. The collected wastes at the dumping sites are then evacuated for final disposal in trenches by BOSEPA, which normally takes months. In view of the incapability of the BOSEPA in efficient disposal, the *Ministry of Environment*



and Natural Resources (MENR) contracted a private company *Confer Cleaning and Hygiene Services (CCHS)* to supplement the efforts of BOSEPA. As noted from the table, the services of BOSEPA is restricted to only transferring and disposal of waste from the collection centers and dumping sites, while the CCHS participates in not only that but also collection and disposing waste from other places. The summary of their services for the year 2002 is shown in Table 1.

A study conducted by the Federal Government of Nigeria, through the Federal Ministry of Environment in Maiduguri metropolis found that about 8.5 million tons of waste from all sectors of the society was generated in 2002, out of which only 177,635 tons accrued as household waste, representing merely 2.1% of the total waste. Based on the data available in table 1, only about 6% of the total waste generated has been collected and disposed. It is however worthy to note that, in most developing countries, much more of the waste arising is recovered, especially by scavengers, before it reaches the point of final disposal. This calls for a serious scrutiny as to how waste is disposed, especially in the households.

In view of the above, the study attempted to find out other options of waste disposal by the households as opposed to the recommended method of disposing waste to the nearest collection centers, which serve as transfer stations or dumping sites. The result of the questionnaire survey conducted on the 300 households is shown in Table 2. From the result, burning of waste (without heat recovery) is the most commonly practiced method of waste disposal in Maiduguri, perhaps due to its cost effectiveness and convenience with which it can be conducted (mostly within or on the street near the premises), not minding the waste constituents and the associated health hazards. On the other hand, about half of the respondents claimed that they dispose their

Table 1. Waste disposed in Maiduguri metropolis in 2002

Source	Waste Disposed (Tons)	
	BOSEPA	CCHS
Refuse dumps (Collection sites)	324,012	393,675
Street sweeping and roadside litter	-	259,200
Markets (2)	-	69,120
Hospitals (7)	-	12,960
Banks (7)	-	1,542
Hotels (2)	-	274
Academic Institutions	-	180,100
Sub-total	324,012	916,869
Total	1,240,881	

waste by dumping. However, as earlier noted, the four officially designated dumping sites are grossly inadequate to cover the metropolis, dumping is sometimes made at any closest informal dumping site, otherwise, the waste is dumped indiscriminately. Tipping to formal dumping sites is similarly conducted in some organized communities. Another method that is being practiced to a lesser extent involves disposing waste to bury holes such as abandoned wells, pit latrines, slight land depressions in their houses or neighbourhood or even gutters near their houses. The last method they employ involves the combination of any of the above methods.

The result in Table 2 suggests some evidences as to why the total collected waste at the dumping sites is insignificant as compared to the generated waste. Another important factor that contributes to the reduction of waste before it reaches final disposal point is the activities of scavengers, which requires some investigations. In view of this, Table 3 presents the result relating the impact of human scavengers to the reduction of the generated solid waste.

From the table, about 11.4% of the total waste was reduced through the activities of the scavengers, with metals and glass (mostly in form of tins, cans, scraps, bottles, etc) as the major targets, each representing more than a quarter of their respective constituents. Obviously,

Table 2. Methods of solid waste disposal

Method	Frequency	Percentage (%)
Burning	123	41
Dumping	156	52
Burying	12	4
Others	7	2.3
Invalidated	2	0.7
Total	300	100.0

Table 3. Waste reduction through scavenging

Constituent	Dry weight %	Waste recovered by scavengers	
		Reduction (%)	% of constituent
Organic matter	25.8	2.3	8.9
Plastics	18.1	3.2	17.7
Paper & Cardboard	7.5	1.2	16.0
Metals	9.1	2.5	27.5
Glass	4.3	1.1	25.6
Textile	3.9	0.3	7.7
Ashes, Dust and Stones	21.5	0.0	0.0
Others	9.8	0.8	8.2
Total	100.0	11.4	

these have higher potentials for reuse and/or recycling. Plastics and Paper, which closely followed the metals and glass in terms possible reuse and/or recycling, were equally reclaimed at reasonable levels. The recovered materials by the scavengers are sold to wholesalers, who in turn would sell to re-users or to recyclers. However, the predominantly salvaged ones are worn shoes, broken buckets or bowls, while that of paper includes, old newspapers, books, cartons, etc. These results indicate the viability of materials recovery; hence waste reduction through the scavenging process.

Problems of solid waste management in Maiduguri

In general, no clear law or guidelines for non-hazardous solid waste management has been identified in Nigeria (3). However, relevant government organizations such as the Environmental Protection Agency (EPA) through their respective state agencies, and Federal Ministry of Environment form the framework for managing solid waste. Constitutionally, local governments are charged with the responsibilities for managing waste within their jurisdictions. Nevertheless, they are restraint from doing so due to lack of skilled manpower, equipment, resources, and necessary institutional capability. In Maiduguri, apart from the apathy of people towards waste management, BOSEPA that is responsible for waste management is faced with numerous problems. Prominently, poor funding, poorly trained manpower, inadequate equipment and machinery, ineffective collection technique and disposal methods have been found to be the major hindrances that affect efficient management of the solid waste. It should noted that, presently, the Borno State Environmental Sanitation Board, a division under BOSEPA, have a total of 9 vehicles for discharging their duties; 7 tipper lorries, 1 loader and 1 gully emptier, out of which only 4 lorries and 1 loader are functioning. Other issues that affect solid waste management in the metropolis include, inadequate dumping sites, inaccessibility to some collection centers due to unpaved or narrow streets, lack of maintenance of operational equipment, lack of precise guidelines and laws related to solid waste management, etc.

A shallow valley formation and low lying area located at the outskirts of the metropolis provided for the final disposal are basically not landfills, since waste are simply dumped there. It is certain that the proper funding of the appropriate agencies responsible for the solid waste management could partly proffer solutions to the problems. However, in order to handle the growing volume of waste, the proper policies and guidelines must be enacted and implemented. It is necessary to first, educate the public about the consequences of poor management of waste. Secondly, reorganization of the existing facilities to incorporate the activities of the informal waste collectors, community participations (likewise NGOs) and scavengers in the management of waste should be encouraged. In any case, provision of adequate and accessible collection centers, dumping sites and establishment of Integrated Waste Management Facility that will be more beneficial to the society are badly desired in Maiduguri.

Proposal for efficient management of solid waste in Maiduguri

It is obvious that solid waste management may not necessarily be a profit oriented venture since the ultimate goal is to rid the society of the unwanted portion of what it generates. However, efficient methodology that will have multiple benefits entailing effective re-utilization of the said waste through upgrading of their values, which form the basis for resources conservation, should be encouraged. The Integrated Waste Management approach as practiced in the developed world will certainly not suit our local environment. Therefore, based on the composition of the solid waste and the peculiar socio-cultural situation of the metropolis, this study proposes a strategy as shown in Figure 2.

Conclusion

It was found that about 65% of household's waste are generated through cooking related practices, while agricultural and packaging wastes generates about 20 and 10%, respectively. 0.25Kg/capita/day was found to be the rate of generation of waste in the metropolis. About ¼ of the composition of waste are of organic origin, while plastics constitute about 1/5. Apart from dumping, waste disposal by burning is predominant, representing more than 40%. Apathy of public towards waste management, inadequate funding are the major problems affecting the BOSEPA. A befitting IWM strategy having multiple benefits has been proposed for the metropolis

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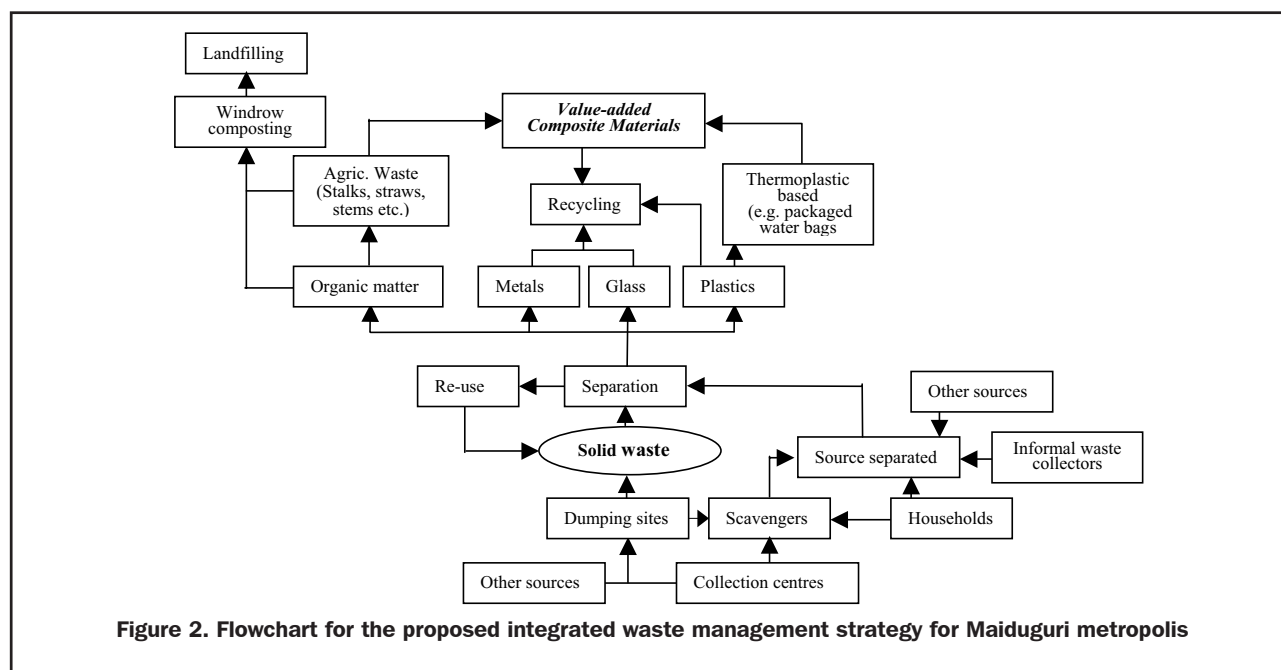


Figure 2. Flowchart for the proposed integrated waste management strategy for Maiduguri metropolis