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An Analysis of Municipal Solid Waste in Kano Metropolis, Nigeria

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ABSTRACT This paper reports the result of municipal solid waste analysis undertaken in Kano metropolis through the collection of secondary data from the government agency (Refuse Management and Sanitation Board, REMASAB) responsible for the management of solid waste, interviews with stakeholders and field surveys specifically to address the apparent gap in this information that is crucial for successful management. Field surveys were carried out in three residential zones that are representative samples of the city to understand the practice and identify the lacunae. The results show that the household sector in Kano metropolis produces the largest amount of waste in the city accounting for 62.5% and the waste generated by various institutions in Kano accounts for only 5.8%, while industries located within residential areas contributed 2.9%. It is estimated that Kano metropolis generates about 3085 tones of solid waste per day. It is also found that Kano metropolis's solid waste consists to a large extent of organic and other biodegradable matter (43%) and constitutes 68.26% by weight of solid waste generated in the study area. The results indicate that that solid waste is not properly managed since there is no ideal landfill and recycling is limited. The paper highlighted the implications of the result for the environment and sustainable management of solid waste. For example, because of poor management ,the waste emits dangerous gases into the atmosphere and bacterial isolates were recovered from the waste sample, three of which were coliform bacterial *(E. coli, Klebsielle* sp and *Shigella* sp.). It is recommended, among other things, that the government should put in place facilities and opportunities to enhance proper management of solid waste and promote recycling and reuse of waste and should embark on environmental awareness campaigns to sensitize the citizen develop the right attitude about waste disposal.

1. INTRODUCTION

Proper management of solid waste is critical to the health and well-being of urban residents (World Bank 2003). In Kano metropolis ,like most cities in the developing world, several tons of municipal solid waste is left uncollected on the streets each day, clogging drains, creating feeding ground for pests that spread disease and creating a myriad of related health and infrastructural problems. A substantial part of the urban residents in the old city and suburban informal settlements of Kano metropolis also have little or no access to solid waste collection services. This is due to lack of proper land use planning which resulted in the creation of informal settlements with narrow streets that make it difficult for collection trucks to reach many areas. The result is that a large portion of the population is left without access to solid waste management making them particularly vulnerable (Nabegu 2008a).

Municipal solid waste management is an important part of the urban infrastructure that ensures the protection of environment and human health (World Bank 2002, 2003). The accelerated growth of urban population with unplanned urbanization, increasing economic activities and lack of training in modern solid waste management practices in developing countries complicates the efforts to improve solid waste services. The changes in consumption patterns with alterations in the waste characteristics have also resulted in a quantum jump in solid waste generation (Ludwig et al. 2003). In addition, solid waste management is hampered by a lack of data at all levels from the ward, district and municipality, and where available, is generally unreliable, scattered and unorganized (World Bank 2002, 2003). As a result, planning of solid waste management has remained a difficult task.

Some studies have been carried out on waste management in Kano metropolis. Saleh (2008) studied the contributions made by scavengers and showed that over 25,000 people are directly involved in the activity and that 15% of municipal solid waste that would have gone in to the municipal solid waste stream is removed by them. Nabegu (2008) investigated the operations of the state agency responsible for waste management

in the metropolis and reported that a significant portion of the population, 80%, does not have access to waste collection services, only 20% of the waste generated is actually collected and vast majority of users of the service 92% consider the service very poor. The economic potentials and organization of the informal plastic waste recovery sector was also studied which showed that besides being a source of livelihood for nearly 30,000 individuals, it provides cheap raw materials for plastic industries (Mukhtar 2008).

Composition of municipal solid waste provides a description of the constituents of the waste and it differs widely from place to place (Kuruparan et al. 2003). The most striking difference is the difference in organic content which is much higher in the low income areas than the high income, while the paper and plastic content is much higher in high income areas than low income areas. This reflects the difference in consumption pattern, cultural and educational differences. In higher income areas disposable material and packaged food are used in higher quantities; this results in the waste having higher calorific value, lower specific density and lower moisture content. In the case of lower income areas, the usage of fresh vegetables to packaged food is much higher. This results in a waste composition that has high moisture content, high specific weight and low calorific value (Dhussa et al. 2000; Klundert and Scheinberg 2001).

The 'blind technology transfer' of machinery from developed countries to developing countries and its subsequent failure has brought attention to the need for appropriate technology (Beukering et al. 1999) to suit the conditions in developing countries (type of waste, composition, etc.). Identification of waste composition is thus, crucial for the selection of the most appropriate technology for treatment, taking essential health precautions and space needed for the treatment facilities. Despite this recognition, there has been no study on the analysis of municipal waste composition in Kano metropolis. This paper attempts to fill this gap by providing data on the composition, and sources of municipal waste in three different zones of the city for the purpose of understanding the type of waste generated, waste flow and implication for management.

2. STUDY AREA AND METHODOLOGY

Kano is the largest city in the Sudan Region of Nigeria. It is located between latitude 12^{o} 25 to 12^{o} 40N and longitude 8^{o} 35N to 8^{o} 45E. Kano city has for centuries been the most important commercial and industrial nerve centre of Northern Nigeria attracting millions from all parts of the country and beyond. Immigration and natural growth rate of 3% is expected to continue to increase the population and waste stream in the years to come. With a population presently estimated at 3.5 million, Kano metropolis is among the fastest growing cities in Nigeria. With a population density of about 1000 inhabitants per km^2 within the Kano closed-settled zone compared to the national average of 267 inhabitants per km^2. It is also one of the most crowded. The city also has a large migrant worker population which has been increasing at the rate of 30 to 40 per cent per annum (UNDP 2004). These figures indicate that waste generation is likely to be significant in Kano metropolis and that its management would require innovative strategies.

The climate of the study area is the tropical wet and dry Aw by Koppen's classification. Climatic factors play a crucial role in the municipal waste management of the study area. For example, during the wet season, heat and humidity cause the municipal solid waste to be of higher moisture content thus increasing the weight of the refuse. In addition, high humidity with heat causes the organic portion of the waste to decompose quickly leading to problems in handling and disposal, which directly affects the environmental health of the waste workers and the inhabitants.

The study was organized in stages as follows:

Stage 1: This stage involved a desk study in which documents and records relating to municipal solid waste management in Kano metropolis, by the Refuse Management and Sanitation Board (REMASAB), were studied to obtain background information as well as data on existing municipal solid waste management in the city.

Stage 2: This stage involved interviews with department heads from REMASAB. Information obtained was used to update the data collected during the desk study. The questionnaire was structured to capture the operation, finance, management; problem and future projection of the agency and the understanding of the staff of the agency on the identified problems were captured from the questionnaire.

Stage 3: Twenty- five residents, each from

three identified residential zones selected , which represents 10% of the total residents that volunteered to provide information. The questions asked during the interviews were tailored to derive information on coverage of the service, availability of disposal/collection points, general assessment of the services, perceived problems as well as solutions, willingness to pay for the services etc and examination of household waste generation through segregation and physical separation of waste components over a period of three month. To determine sample locations within Kano metropolis, a basic knowledge of the urban area of Kano was helpful, guided by the assertion of Gordon (1983) that an urban area is usually defined to comprise of three levels within which data could be collected: the city proper (in this study the old walled city), metropolitan transition area (in this study the G.R.A.) and urban agglomeration (in this study suburban area). Identified residential zones were subdivided into equal grids using Kano metropolis as base map. Table of Random Numbers was used to choose the study areas.

In addition to the above, twenty- five people involved in scavenging which represents 14% of those in the activity that were willing to partake in the study were randomly selected for interview. Morphological and Biochemical tests to identify the bacterial isolates were carried out on samples collected from dump sites in the three identified zones in accordance with methods described by Corry et al. (1982). Bulk density, weight and waste composition was determined by manual separation and weighing to determine the bulk characteristics of the different samples.

Stage 4: The researcher also participated in the day to day operation of the agency during which valuable operational difficulties were experienced firsthand.

3. RESULTS AND DISCUSSION

3.1 Sources of Municipal Solid Waste

Table 1 shows the contribution of identified sources of municipal solid waste in Kano metropolis**.** The household sector in Kano metropolis produces the largest amount of waste in the city accounting for 62.5%. This is in contrast to a study of Bangalore, India, where commercial sector was reported to account for the largest amount of 39% (Rotich et al. 2006; Ramachandra and Bachamanda 2007). The differences between Kano and Bangalore can be explained by the fact that even though the two cities are in developing countries, enormous variation exists in the level of development between them in terms of the size of the middle class where Bangalore has 28% of its urban population made up of middle class and Kano metropolis less 8%. There is also a difference in culture which impacts on the sources and types of waste generation.

The waste generated by various institutions located in Kano accounts for only about 5.8 per cent. Industries located within residential areas generate a small amount of solid waste, 2.9% and most of it is recovered for recycling and reuse, and only a small per cent finds its way into the city waste stream.

Table 1: Sources of municipal solid waste in Kano metropolis

S. No.	*Sources*	*Percentage*
1	Residential	62.5
2	Commercial	26.9
3	Industrial	2.9
4	Institutional	5.8
5	Others	1.9

Source: Fieldwork 2007

3.2 Waste Type, Composition and Quantum

According to estimates, by the state agency responsible for waste management in Kano metropolis, the city generates currently approximately 3,000 tones of solid waste per day. However, from the research, it was estimated that Kano metropolis generates about 3085 tones of solid waste per day. The difference is mainly due to the fact that in this study, waste from industries located within residential areas is also considered as a compo-nent of the total urban solid waste generated in Kano metropolis.

From the samples of solid wastes collected from the different dump sites and sampled households in the three zones, eight different types of wastes were categorized. These are food scarp, paper cardboard, textile and rubber, plastic material, glass, metal, ash and dirt and vegetables. Table 2 shows the different categories of waste observed in the three residential zones of Kano metropolis.

Analysis of waste type shows that Kano metropolis's solid waste consists to a large extent of organic and other biodegradable matter (43 %)

Table 2: Waste type and composition in three residential zones of Kano metropolis

Categories	*City*	*G.R.A.*	*Suburban*
Food scrap	38	5	40
Paper cardboard	6	34	5
Textile rubber	7	10	4
Plastic material	10	17	6
Metal	5	20	3
Glass	7	12	1
Ash, dirt	18	1	20
Vegetable	9	1	21

Source: Fieldwork 2007

and the 57% non biodegradable made up of substantially dirt, ash and other household trash - typical of low income developing country (Ramachandra and Bachanda 2007). Due to the composition of the waste, especially the findings in this study of substantial presence of faecal matter in the waste, many health and environmental issues are foreseen.

Biodegradable wastes which are generated in very high quantity, could however, be diverted from the dumpsites and landfills, effectively reducing the bulk of municipal solid waste for disposal and the space required for the purpose causing a reduction in the municipal expenses. The diverted organic waste could be utilized by adopting appropriate technologies for processing it into bio-fertilizers or as a source of green energy. While promoting sustainability, it would help prevent the degradation of the urban environment. By integrating the principles of sustainability and resource efficiency into our consumer culture, we can begin a transition away from the end-of-the-pipe practice of waste disposal, such as containment, remediation and pollution control to a process that maximizes recovery of resources, eliminates toxic materials, prevents pollution, and minimizes the economic liabilities associated with environmental degradation and clean-up activities. Waste management invest-ments can then be shifted to resource recovery and development strategies that could relieve the governments of the heavy burden of financing and managing the waste disposal systems.

The percentage of recyclables like paper, glass, plastics, metals, cardboard, packaging material and rubber is negligible. Although economic prosperity is one reason for the generation of more recyclables waste materials, as observed in developed countries (Chandarasekar 2002), the low content in Kano metropolis may also be explained by the fact that traditionally such waste materials are segregated at source for reuse (Nabegu 2008b).

However, despite the low presence of non-biodegradable wastes in the dump sites, it has nonetheless, led to economic utilization of such wastes, since the recycling and re-use of non-biodegradable wastes into new forms is now a common practice. Though informally organized, it provides a substantial employment in view of the fact that a ready market exists in the many industrial enterprises located in Kano. It was estimated that there are roughly 25,000 waste pickers in the city whose average per capita collection is about 15 kilograms per day. Collecting about 312 tones of waste per day, the waste pickers recover about 10 % of waste generated. The waste collected goes to various small and large recycling units located in the city. Formal involvement of government in this sector will in no small way help reduce youth unemployment and reduce the volume of waste and provide cheap raw material to industry (Saleh 2008; Mukhtar 2008; Nabegu 2008a).

3.3 Waste Bulk and Density

Further analysis of waste reveal that the waste in Kano metropolis can be categorized in to two types: namely, the rather light and predominantly non-biodegradable waste in the G.R.A.and the heavier biodegradable waste in the city and the suburban zones. Table 3 shows the percentage bulk weight of the different items of waste in the three zones. Biodegradable wastes accounts for 68.26% of the average weight of the entire waste samples, while the non-biodegradable had 31.74%, showing clearly the predominant waste in Kano metropolis is biodegradable. However, marked variations exist among the zones. Thus, in the GRA, a total of 57.84% of the waste consists of non-biodegradable, whereas the city has only 20% and the suburban zone 22.86%. Differences in the type of waste among the zones reflect the differences in standard of living and consumption pattern between the zones.

The study shows a specific density of 0.31m^3 and average weight of 564kg/ in a cubic meter in G.R.A., while in the city the yield was 923kg per cubic meter with a specific density of 0.55tm3 and in the suburban zones it was 1030kg per cubic meter with a specific density of 0.63t/m^3. However from comparative studies from Kaduna and Jos, the two biggest cities close to Kano, domestic

Table 3: Percentage waste bulk collected in the three zones

Type of waste	*G.R.A (%)*	*Sub-urban (%)*	*City (%)*
Food scrap	4.20	30.84	31.56
News paper	17.20	2.90	2.10
vegetables	13.30	23.00	22.00
Textile	9.30	4.60	3.80
Glass	20.55	3.96	2.75
Metal	9.49	2.60	2.20
Rubber/Plastic	18.50	11.70	11.30
Ash	1.10	18.30	22.5.4
Miscellaneous paper	6.35	2.10	1.74

Source: Fieldwork 2007

solid waste yield is 1120kg/cubic meter while the Specific density is 0.4t/m^3. Lower figures found in this study indicate that the substantial loss in weight and bulk is probably a result of incineration and decomposition as a result of the long intermediate storage at the collection points.

A high solid waste density also has many implications for the 'traditional' methods of collection and disposal; collection and transfer trucks which are able to achieve compression rates of up to 4: 1 in industrialized nations may achieve only 1.5:1 in Kano GRA and much less in the city and the suburban areas, and landfill compression technology which averages volume reduction of up to 6: 1 in industrial nations may only achieve 2: 1 compaction with increased waste densities. Compactor trucks would, therefore, probably not be useful in the city and the sub urban areas. In the GRA, which has relatively less waste density, such technologies may be more appropriate. Additionally, the high moisture content and organic composition of wastes in the city and suburban areas may lead to problems of increased decomposition rates, with high average daily temperatures high moisture during the rainy season would only compound these problems presenting additional challenges with insect populations and conditions conducive to disease.

Decomposition of waste into constituent chemicals is a common source of local environmental pollution which is again compounded by the issues associated with rapid urbanization. As land becomes scarce, human settlements encroach upon landfill space, and local governments in some cases encourage new development directly on top of operating or recently closed landfills. A major environmental concern is gas release by decomposing garbage. Methane is a by-product of the anaerobic respiration of bacteria, and these bacteria thrive in landfills with high amounts of moisture. Methane concentrations can reach up to 50% of the composition of landfill gas at maximum anaerobic decomposition (Cointreau 1997). In the absence of proper methane venting and/or flaring, the gas seeps into porous soil surrounding the waste and eventually migrates into homes, posing risk. Carbon dioxide is a second predominant gas emitted by landfills; although less reactive, buildup in nearby homes could be a cause of asphyxiation.

A second problem with these gases is their contribution to the greenhouse gasses (GHGs) which are blamed for global warming. Both gases are major constituents of the world's problem GHGs; however while carbon dioxide is readily absorbed for use in photosynthesis; methane is less easily broken down, and is considered 20 times more potent as a GHG (Johanesen 1999). Hoornweg et al. (1999) state that for every metric ton of unsorted municipal solid waste (containing 0.3 Mt carbon), 0.2 Mt are converted to landfill gasses. Of this gas, carbon dioxide and methane each comprise .09 Mt. Since it is believed that landfill gasses supply 50% of human-caused methane emissions and 2-4% of all worldwide greenhouse gases (Johanesen 1999), this is clearly an area of concern in global environmental issues.

Also, as a result of the dearth and high cost of chemical fertilizers, farmers directly use domestic waste in agriculture (Nabegu 2008). Due to the composition of the waste, especially the findings in this study of substantial presence of faecal matter in the waste many health and environmental issues are foreseen.

3.4 Occurance of Bacterial Flora

Table 4 shows the cumulative percentage occurrence of the bacterial flora isolated from 30 samples of the wastes. Of the six bacterial isolates recovered from the waste sample, three were coliform bacterial (*E. coli*, *Klebsielle* sp and *Shigella* sp.). Percentage occurrence of Shigella sp, and Klebsiella sp did not also differ significantly ($p<0.05$). Shigella sp and Proteus sp had the same percentage occurrence. Presence of coliforms such as E.coli, Klebsiella sp clearly indicates that the waste in the zones, especially the city and suburban areas is contaminated with faecal matter. All the bacterial isolates recovered from the waste samples in the three zones have been directly implicated in food borne infections

Table 4: Percentage frequency occurance of bacterial isolate from waste dump in the three zones

Bacteria isolate%	*Occurrence of bacterial isolate*		
	G.R.A	*City*	*Suburban*
Samonella Sp	16.10	39.40	46.70
Klebsiella Sp	22.30	41.60	43.30
Proteus Sp	11.70	31.80	33.30
Escherichia coli	56.40	88.90	86.70
Staphylococus aureus	43.80	80.60	76.70
Shigella	27.60	45.20	43.30

Source: Laboratory Analysis 2007

such as typhoid, diarrhea and gastroenteritis. These diseases occur sparingly in all the zones.

Human fecal matter presence in all the solid waste dump sites of the three zones in Kano metropolis presents a potential health problem not only to waste workers, but also to scavengers, other users of the same municipal drop-off point, and even small children who like to play in or around waste containers. The usual disease pathways include placing contaminated hands in the mouth or eating food, through vector insects such as cockroaches or mosquitoes, or by directly inhaling airborne dust particles contaminated with pollutants

In this study, it was also observed that wastes were dumped in the open space on the street at close proximity to the houses and public places and some were dumped very close to the river, while others were dumped right into the river, especially in the city and the suburban zones. Disposal of solid wastes into water bodies may be detrimental to aquatic organisms. This assertion is supported by CPCB (2000), that bacteria like E.coli often lead to depletion of the dissolved oxygen, thereby endangering the survival of aquatic organisms. Release of wastes with high quantity of nitrates and phosphate compounds into rivers could result in obnoxious algae blooms (Moss et al. 2008). Wastes disposed at Yan Awaki (city) along and inside the Jakara river could also be washed down by rain and flood into larger water bodies which are used for irrigation and water supply to many communities from the Wasai dam where the Jakara river was impounded posing serious health hazards.

3.5 Waste Management Service Coverage

Table 5 shows the perception of respondents as to the extent of coverage in the provision of waste collection services in Kano metropolis.

Table 5: Municipal solid waste service coverage

Coverage	*Percentage*
Up to 20%	69
Up to 30%	23
More than 50%	7

Source: Fieldwork 2007

A majority (69%) of the respondents are of the view that the services cover no more than 20% of the city residents. Thus, solid waste collection in Kano metropolis extends to only a limited part of the population. One of the main reasons limiting coverage is the lack of accessibility to most areas of the old city and the new settlements on the fringe of the city. The old city predates town planning as we know it today, consequently most of the alleys leading to the city are too narrow to allow equipments to access the waste. The new areas on the fringes are inhabited mostly by low income immigrants and those who have moved out of the city and are built without planning. A number of options have been considered to solve this problem including the use of donkeys to evacuate the waste to collection centers that are accessible. A further option is to use small providers' of service from the community as practiced with some measure of success in Lagos. The providers of this service evacuate waste from individual houses often using simple hand push trucks from places where conventional equipment can not access. This system can provide also the much needed employment for the teeming youths of the city.

3.6 Waste Disposal Practice

Table 6 shows the various waste disposal practices in Kano metropolis. More than two- third of the residents do not use authorized dumpsite for their waste.

According to the state agency responsible for waste management- refuse management and sanitation board (REMASAB), solid waste in Kano metropolis is to be dumped by the public at designated collection areas which are made up of

Table 6: Disposal methods by residents

Place	*%*
REMASAB bin	3.75
Authorized dump site	16.25
Unauthorized empty plot	66.25
Burning	3.75
Personal bin	13.25

Source: Fieldwork 2007

metal boxes that are easily loaded on to trucks mechanically or made of block. Even where these are available, the waste are thrown in a more or less uncontrolled manner and the file of waste does not allow free access to waste points and often produce unpleasant and hazardous smoke from slow burning fires. The present disposal situation is expected to deteriorate even more with rapid urbanization, as settlements and housing continue to encircle the existing dump and the environmental degradation associated with these dumps directly affect the population.

However, the practice of disposing mixed waste without treatment has a price to pay in terms of collection, transport and disposal costs, loss of valuables (recyclables, reusable and repairable) and the impact on the environment due to air, water and soil pollutions, and associated health risks that ultimately impact the economy. This economic impact creates lack of resources for municipal solid waste management and hence a vicious cycle is generated unless remedial measures are taken to break the circuit, the cycle continues and expands leading to further environmental degradation.

It was also observed in this study, even the residents that collect and transport the waste to the collection/transfer point from where the waste should be collected immediately by REMASAB, collection is never immediate and this creates not only unhygienic dump but resistance from residents close to the collection points, thereby disrupting the whole operation. In this study, 70% of the residents do not have an authorized dumping site for their waste. This confirms a nationwide survey by the Federal Office of Statistics (1978) which found that 52% of urban households in Nigeria do not have access to an authorized dumping ground and Karshi (1981) also concluded that the single most critical problem confronting waste management in Jos metropolitan area is not equipment or manpower but indiscriminate dumping of wastes by the road side, gutters and other unauthorized dumping grounds by residents of the city. The same problem applies to most of the land fill sites which are located now within highly dense residential areas (Zoo Road Dump site, for example) and now it is difficult to find dump sites which are located at a reasonable distance from the collection area.

In this study, it was also observed that households are mainly interested in receiving effective and dependable waste collection service within their immediate vicinity. Only 11% of respondents are concerned with the broader objective of environmentally sound waste disposal, rather, households give priority to water supply and electricity.

Although households are the main contributors to waste generation, (Table 1) it may well be useful to know how this may change with economic development. A positive relationship between income levels and waste generation at the household level has been established (Nabegu 2008b; Rotich et al. 2006). At the same time, waste generation is conditioned to an important degree by people's attitudes towards waste especially their patterns of material use and waste handling, their interest in waste reduction and minimization, the degree to which they separate wastes and the extent to which they refrain from indiscriminate dumping and littering (Zurbrugg 1999). People's attitudes influence not only the characteristics of waste generation, but also the effective demand for waste collection services.

Attitudes have been positively influenced through awareness-building campaigns on the negative impacts of inadequate waste collection with regard to public health and environmental conditions, and the value of effective disposal. Such campaigns should also inform people of their responsibilities as waste generators and of their rights as citizens to waste management services. Whilst attitudes towards solid waste may be positively influenced by public information and educational measures, improved waste handling patterns can hardly be maintained in the absence of practical waste disposal options. Awareness-building measures should therefore be coordinated with improvements in waste collection services, whether public or community-managed. Similarly, people's waste generation and disposal patterns are influenced by those of their neighbors (Mehta and Satyamarayaran 1996). Thus, besides general awareness, improved local waste management depends upon the availability of practical options for waste collection and a consensus among neighbors that improvements are both important and possible.

Programmes to disseminate knowledge and to improve behavior patterns and attitudes regarding waste management, are therefore critical. For such programmes to succeed such programmes must be based on sound understanding of the social and cultural characteristics of the communities.

Pressure to improve solid waste services will arise only if there is awareness regarding the environmental and health impacts of poor waste collection service. The effectiveness and sustainability of municipal waste management systems thus ,will depend on the degree to which the served population identifies with and willingly take ownership of the systems and facilities.

CONCLUSION AND RECOMMENDATIONS

The conclusion drawn from this limited study is that the management of municipal solid waste would have to involve detailed study of the characteristics of waste as the variation in waste type. Municipal solid waste composition has effect on human health, environment and all the processes of waste management system from the storage, collection, transport disposal and choice of equipments. Furthermore, the variation in the composition of waste observed within the three different residential zones of Kano metropolis reflects local variation in standard of living and indicate that to achieve success in management, waste should be managed at the local level instead of the current practice of having a large centralized agency so that local variations can be taken into account. Thus, for any waste management framework for Kano metropolis and possibly also other Nigerian cities, a careful consideration of all these factors in relation to local conditions must be the basis of a sound and sustainable programme. To date, no concerted efforts have been made to consider these issues.

Regardless of the type of waste management selected, no amount of urban planning nor municipal solid waste management strategies will translate into reality unless the government takes the required initiatives and makes the necessary inputs available. These inputs do not necessarily have to be financial. For example, waste recycling can be promoted through consumer campaigns encouraging citizens to co-operate in waste separation and promoting to them the purchase of recycled products. Also, citizens should be requested to pay a realistic fee for waste services in return for the guarantee that indeed these services will be provided. Finally, no municipal solid waste management can be effective without proper monitoring of its disposal activities. Therefore, its effectiveness should be tested on a regular basis. There is also an urgent need to reassess all legislations regarding waste management with a view to stream lining them so that there is a comprehensive and clear role for all the agencies, various tiers of government, as well as the public including NGOs and community associations.

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