Downloaded from http://journals.tums.ac.ir/ on Wednesday, May 22, 2013

Iran. J. Environ. Health. Sci. Eng., 2009, Vol. 6, No. 3, pp. 173-180

MUNICIPAL SOLID WASTE CHARACTERISTICS AND MANAGEMENT IN NIGERIA

T. Ch. Ogwueleka

Department of Civil Engineering, University of Abuja, Abuja, Nigeria

Received 16 November 2008; revised 10 May 2009; accepted 15 July 2009

ABSTRACT

Municipal solid waste management has emerged as one of the greatest challenges facing environmental protection agencies in developing countries. This study presents the current solid waste management practices and problems in Nigeria. Solid waste management is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal. The waste density ranged from 280 to 370 kg/m^3 and the waste generation rates ranged from 0.44 to 0.66 kg/capita/day. The common constraints faced environmental agencies include lack of institutional arrangement, insufficient financial resources, absence of bylaws and standards, inflexible work schedules, insufficient information on quantity and composition of waste, and inappropriate technology. The study suggested study of institutional, political, social, financial, economic and technical aspects of municipal solid waste management in order to achieve sustainable and effective solid waste management in Nigeria.

Keywords: Waste disposal, Waste Collection, Municipal solid waste, Nigeria, Recycling, Waste Management

INTRODUCTION

Nigeria is located in Western Africa on the Gulf of Guinea. The country land borders with the Republic of Benin in the West, Chad and Cameroon in the East, and Niger in the north and has a coastline of at least 853km. Nigeria has a varied landscape, from the Obudu Hills in the southeast through the beaches in the south, the rainforest, the Lagos estuary and savannah in the middle and south west of the country and the sahel to the encroaching Sahara in the extreme north. The country has two main rivers: Niger and Benue. The two rivers converge and empty into the Niger Delta, the world's largest river delta. Nigeria is a developing country, with a land area of 923,768 km^2, and a population of about 140 million with growth rate of 2.38. Nigeria is the most populous country in Africa and ninth most populous country in the world. With populations distributed at 48.3% urban and 57.7% rural and population density at 139 people per square km.

The country has GDP per capita of $1,800 and population below poverty line is 60%. Nigeria has a labour force of 50.13 million. The country comprises thirty-six states and one Federal Capital Territory, which were further subdivided, into 774 Local Government Areas. Life expectancy is 47 years (average male/female). The government provides education free at primary school level. 68% of the population are literate and the rate of men (75.7%) is higher than for women (60.9%). The climate is equatorial in south, tropical in centre and arid in north. 33.02% of the land is arable.

The Federal Government of Nigeria has promulgated various laws and regulations to safeguard the environment. These include Federal Environmental Protection Agency Act of 1988. The Federal Ministry of Environment administers and enforces environmental laws in Nigeria. It took over this function in 1999 from the Federal Environmental Protection Agency (FEPA), which was created under the FEPA Act.

Pursuant to the FEPA Act, each state and local government in the country set up its own environmental protection body for the protection and improvement of the environment within its jurisdiction. Municipal solid waste management is a major responsibility of state and local

*Corresponding author: *ogwueleka@yahoo.co.uk*
Tel: +08035061048

Downloaded from http://journals.tums.ac.ir/ on Wednesday, May 22, 2013

government environmental agencies. The agencies are charged with the responsibility of handling, employing and disposing of solid waste generated. The state agencies generate fund from subvention from state governments and internally generated revenue through sanitary levy and stringent regulations with heavy penalties for offenders of illegal dumping and littering of refuse along streets (Ogwueleka, 2003).

Municipal solid waste management(MSWM)

Municipal solid waste (MSW) is defined to include refuse from households, non-hazardous solid waste from industrial, commercial and institutional establishments (including hospitals), market waste, yard waste, and street sweepings. Municipal solid waste management (MSWM) refers to the collection, transfer, treatment, recycling, resources recovery and disposal of solid waste in urban areas. The goals of municipal solid waste management are to promote the quality of the urban environment, generate employment and income, and protect environmental health and support the efficiency and productivity of the economy.

Solid waste management has emerged as one of the greatest challenges facing state and local government environmental protection agencies in Nigeria. The volume of solid waste being generated continues to increase at a faster rate than the ability of the agencies to improve on the financial and technical resources needed to parallel this growth. Solid waste management in Nigeria is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal of solid waste.

The quantity of solid waste generated in urban areas in industrialized countries is higher than in developing countries; still municipal solid waste management remains inadequate in the latter. Solid waste in developing countries differs from developed countries. Most developing countries, Nigeria, inclusive have solid waste management problems different from those found in industrialized countries in areas of composition, density, political, and economic framework, waste amount, access to waste for collection, awareness and attitude. The wastes are heavier, wetter and more corrosive in developing cities than developed cities.

In developing countries, local authorities spend 77-95% of their revenue on collection and the balance on disposal (Ogwueleka, 2003), but can only collect almost 50-70% of municipal solid waste (MSW). In the past, the focus has been on the technical aspects of different means of collection and disposal(World Bank, 1992), but recently, attention has been on enhancing institutional arrangement to service delivery, with a special emphasis on privatization (Cointreau, 1994). Nigeria is presently experimenting with the privatization of this sector. The Federal Government has instituted National Integrated Municipal Solid Waste Management Intervention Programme in seven cities of Nigeria. The seven cities are Maiduguri, Kano, Kaduna, Onitsha, Uyo, Ota, and Lagos. Lagos state government established municipal solid waste management policy to encompass private sector participation in waste collection and transfer to designated landfill sites.

This paper aims to examine current solid waste management practices and problems in Nigeria. The specific aims are the following:

-to present the current state of municipal solid waste in Nigeria, and the challenges it faces.
-to document solid waste problems in Nigeria.
-to recommend and discuss applicable solutions to the solid waste management system.

MATERIALS AND METHODS

In this study, nine cities namely Lagos, Maiduguri, Kano, Ibadan, Makurdi, Port-Harcourt, Onitsha, Nsukka, Abuja were chosen as urbanistic representatives of the current solid waste management in Nigeria. The selection of the municipalities is based on the existing situation with different waste management problems, size, and challenges. Lagos is the former capital of Nigeria and the largest city in Nigeria. Abuja is the capital city of Nigeria. Kano, Onitsha and Port-Harcourt are commercial cities while Makurdi is the capital city of Benue State in the middle belt regions of Nigeria. Ibadan is one of the major urban centres. Maiduguri metropolis has been an administrative, cultural and religious centre. The locations are given in Fig. 1. The study was undertaken from April to October, 2007 and carried out in three steps.

Step 1: Documents, records and academic

Downloaded from http://journals.tums.ac.ir/ on Wednesday, May 22, 2013

Fig. 1: Map of Nigeria

literature relating to municipal solid waste management in
Nigeria were studied.

Step 2: Thirty six (36) state environmental agencies workers involved in municipal solid waste
management were interviewed to update information in the document and records collected.

Step 3: Twenty dump sites were visited at Abuja, Makurdi, Lagos, Nsukka, Onitsha, Port-Harcourt,
Kano. Also the residents, scavengers, private contractors were interviewed to confirm the collection, disposal and treatment procedures, recycling practice and problems facing solid waste management.

RESULTS

Waste collection and transportation in Nigeria

The collection of solid waste is the function of state and local government environmental protection agencies. Informal solid waste collection operations exist in parallel with official agencies in some major cities like Onitsha, Lagos etc. Informal collectors provide the service for a fee. In most urban areas, stationary containers system is adopted for waste collection; the waste containers remain at the points of waste generation. This method requires the delivery of waste by the residents to a storage container. These confiners are generally at open spaces along street ends or junctions. These confiners are placed 500-800 m apart. The some bins are fixed on the ground and some are movable. The agencies find this system less convenient and less expensive than house-to-house service. House-to-house service is very rare in Nigeria.

Different types of vehicles are used for solid waste collection in Nigeria. The compactor trucks, side loaders, rear loaders, mini trucks, tippers, skip trucks and open back trucks are the commonly used collection trucks. It was observed that 60% percent of trucks available are always out of service at any one time. In Onitsha, the few available trucks breakdown frequently due to overuse (Agunwamba *et al*, 2003). The collection vehicles are in a state of disrepair in most cities of Nigeria. There is inadequate service coverage in most urban areas and in rural areas there is no collection. Rural dwellers have no access to waste collection service. They dump waste at any vacant plot, public space, and river or burn it in their backyard, thereby polluting the air. Less than 60% of (MSW) generated is collected in developing countries (Ogwueleka, 2003). Solid waste generation exceeds collection capacity. Zurbrugg (2003) describes that one to two thirds of the solid waste generation in developing countries is not collected. There is no regular

Downloaded from http://journals.tums.ac.ir/ on Wednesday, May 22, 2013

routine collection.

Currently, transfer stations are not common in Nigeria. There are cases where such were once in existence but are not longer functional. In Abuja, the land earmarked for waste transfer station has been converted to other land use. In Nigeria, municipal solid waste is collected and taken by collection vehicles directly to the disposal site. The waste accumulates in open dumps at roadsides. The open dumps provide harbourage for diseases causing organisms, bacteria, insects, and rodents.

Local agencies do not have adequate capacity to handle the increasing solid waste mainly due to limited budgets. In most urban areas of Nigeria, the collection of fees and refuse are subcontracted to private companies, which have higher efficiency than government agencies. The current interest involving private companies in solid waste is driven by failure of government agencies to provide adequate services. Private participation in waste management has not been successful in Nigeria because such companies are profit driven and they are not monitored or regulated by government. Also due to the unprofitable nature of solid waste business, inefficiency and dishonesty on the part of some of the contractors and late payment of contractors by the agencies worsen the situation. For example, in Ibadan in 1991, there were twenty-five registered private waste collectors but only ten were found to be operational (Onibokun, 1999). The solid waste collection efficiency in Nigeria ranged from 5 percent in some semi-urban areas to 50 percent in urban areas.

Waste characteristics

The waste generation rates ranged from 0.66 kg/cap/d in urban areas to 0.44 kg/cap/d in rural areas as opposed to 0.7-1.8 kg/cap/day in developed countries (Cointreau, 1982). The waste generation rate is typical of low income towns. The rate of waste generation is highly influenced by the population income. In Nigeria 25 million tonnes of municipal solid waste are generated annually. Table 1 shows the waste generation rates and breakdown density for urban and rural areas in Nigeria. Waste densities and moisture are much higher in developing countries which require different technology and management systems (Cointreau *et al*., 1984). The density of solid waste in Nigeria ranged from 250 kg/m^3 to 370 kg/m^3 higher than solid waste densities found in developed countries. Density defines the number of capacity of waste storage and collection facilities required. High density reduces the effectiveness of compaction vehicles for waste transfer.

Table 1: Urban solid waste generation

City	Population	Agencies	Tonnage per month	Density (Kg/m^3)	Kg/capita/day
Lagos	8,029,200	Lagos Waste Management Authority	255,556	294	0.63
Kano	3,248,700	Kano State Environmental Protection Agency	156,676	290	0.56
Ibadan	307,840	Oyo State Environmental Protection Commission	135,391	330	0.51
Kaduna	1,458,900	Kaduna State Environmental Protection Agency	114, 433	320	0.58
Port Harcourt	1,053,900	Rivers State Environmental Protection Agency	117,825	300	0.60
Makurdi	249,000	Urban Development Board	24,242	340	0.48
Onitsha	509,500	Anambra State Environmental Protection Agency	84, 137	310	0.53
Nsukka	100,700	Enugu State Environmental Protection Agency	12,000	370	0.44
Abuja	159,900	Abuja Environmental Protection Agency	14, 785	280	0.66

Source: All Sites Engineering Ltd

The composition of waste

Income and economic growth have impact on the composition of wastes. High-income earners consume more packaged products, which result in a higher percentage of inorganic materials – metals, plastics, glass, and textile. Waste characteristics vary according to season, income level, population, social behaviour, climate, and industrial production, the size of markets for waste materials and the extent of urbanization, effectiveness of recycling, and work reduction. Because of non-uniformity of collection methods, the environmental agencies do not provide separate solid waste management for the six classification of solid waste. The majority of substances composing municipal solid waste include paper, vegetable matter, plastics,

Downloaded from http://journals.tums.ac.ir/ on Wednesday, May 22, 2013

metals, textile, rubber and glass. Table 2 shows a comparative analysis of municipal solid waste composition in some major cities in Nigeria. It can be seen that great majority of the total solid waste generated in Nigeria is organic. The high level of reuse of recyclable waste reflects the extent of poverty in the developing countries. In developing countries, waste stream is over 50% organic material (Hoornweg *et al.,* 1999). Studies in Bandung, Indonesia and Colombia, Sri Lanka have found residential waste composed of 78% and 81% compostable material, and market waste 89% and 90% compostable, respectively (Cointreau, 1982).

Table 2: Composition of waste stream characteristics

	Nsukka β	Lagos μ	Makurdi ±	Kano μ	Onitsha ¥	Ibadan α	Maiduguri #
Putrescrible	56	56	52.2	43.0	30.7	76	25.8
Plastics	8.4	4	8.2	4.0	9.2	4.0	18.1
Paper	13.8	14.0	12.3	17.0	23.1	6.6	7.5
Textile	3.1	--	2.5	7.0	6.2	1.4	3.9
Metal	6.8	4.0	7.1	5.0	6.2	2.5	9.1
Glass	2.5	3.0	3.6	2.0	9.2	0.6	4.3
Others	9.4	19.0	14.0	22.0	15.4	8.9	31.3

Others = dust, ash, ceramics, rubber, soil, bones
α Diaz and Golueke (1985) , β Ogwueleka (2003) , ± Ogwueleka (2006), ¥ Agunwamba et al (1998), μ Cointreau (1982), # Dauda and Osita (2003)

Resource recovery and recycling

There are no formal recycling of resource recovery programmes in Nigeria (Ogwueleka, 2003) and no policy on composting. Currently, recovery/ recycling operations are carried out mostly by the informal sector. In most big markets, the scavengers pack refuse for a fee and salvage any recyclable prior to the disposal of the waste. 60% of wastes collected in Nigeria are organic waste and only 8% are recovered for reuse.

Recycling is a method of solid waste management like controlling or incineration, but is environmentally more desirable (Ruzi, 2001). Recycling can help the economy by recovering and reusing valuable materials. Recycling reduces the amount of waste need to be collected, transported and disposed of, and extends the life of disposal facilities, which saves money to the agency. Waste recycling and composting activities should be encouraged since this approach is considered to be the right measure in attaining sustainability in waste management. Efficient recycling and composting could save 18.6% in waste management costs and 57.7% in landfill cost (Agunwamba, 1998). In Onitsha, 40% of artisans and small-scale industries receive 48% of their raw materials from scavengers. The role of the informal sector in waste collection is significant. This sector is responsible for removing 30 percent of total generated waste in the urban areas.

Majority of the scavengers are between 17 and 30 old years. They operate without proper protective wares. Scavengers are driven by poverty and desire to earn a living. The informal private sector comprises unregistered, unregulated activities carried out by individuals, families, group or small enterprises. The sector is labour intensive. This sector provides employment opportunities for a large group of people. Scavenging and recycling should be encouraged. The stakeholders are consumers/scavengers, middlemen, and manufacturers. The contributions of each stakeholder in the recycling process need to be evaluated. The official population of scavengers has not been known.

The informal collectors use pushcarts, barrow etc. These collectors provide service in areas where the agencies cannot. In some public places and markets, people pay scavengers to clean the front of their shops. Scavengers salvage repairable and rentable materials to sell for recycling. In Nigeria, scavengers are seen as menace. Materials recovery facilities (MRFs) are used as dump sites at Uwani in Enugu and Lagos.

Treatment and disposal system

In Nigeria like most developing countries, wastes are commonly dumped in open dumps, uncontrolled landfills where a waste collection service is organised. Dumps are located along or beside major roads. In Makurdi, Benue State, the dump site is 2 km away from the city along Naka road. In Onitsha, refuse spreads into the road, blocking traffic and the wastes are burnt open on

Downloaded from http://journals.tums.ac.ir/ on Wednesday, May 22, 2013

the side of the road.

Open dumping of waste cannot be considered as a long-term environmental method of disposal. The dangers of open dumping are many; health hazard to scavengers at the dump site, pollution of ground water, spread of infectious diseases, highly toxic smoke from continuously smouldering fires and foul odours from decomposing refuse.

Eight landfills exist in Lagos State. In Abuja, the present controlled dumpsite is along outer northern expressway, (ONEX). There is no tipping fee. Waste can be disposed in several ways but sanitary landfill is the only land disposal options that enable control and effective mitigation of extreme emission and of surface and groundwater contamination. Sanitary landfill requires much greater initial investment and hence higher operating costs than controlled dumps. Sanitary landfill technologies were introduced in Lagos and Onitsha two decades ago. But presently the landfills are not operational. Open dumping is the most common practice. There is no landfill regulation or standard that provides a basis for compliance and monitoring. Wastes in open dumps are set on fires in order to reduce the volume of the wastes.

Incineration is the high temperature combustion of wastes. Incineration and waste to energy (WTE) is not practiced in Nigeria except in the hospitals where medical wastes are incinerated at a small scale. Construction and start up maintenance costs of incineration facilities are too expensive for developing countries. Incineration requires strict control of toxic fumes and disposal of toxic residues (ash) in sanitary landfill. Three incinerators build in Lagos in 1979 were never used. Two of them were dismantled in 1989 and the third was converted into a civic centre. The failure of these incinerators demonstrated that incinerators are not sustainable. The waste in developing countries contains so much moisture that fuel has to be added to maintain combustion. Low calorific value and low combustible components of solid waste in Nigeria make incineration uneconomical (Ogwueleka, 2003). This suggests that composting could be a very viable recovery alternative.

In rural areas, food from households is feed to animals, some are home composted and used to condition the soil. The waste could be converted to compost or used to generate biogas. Composted material could be used as fertilizer. Composting programme does not exist in Nigeria but there are back yard composting efforts in Nigeria. Composting is the process of aerobic biological decomposition of organic materials under controlled condition of temperature, humidity and pH. Windrow composting is the least expensive and can be most appropriate to the socio-economic and climatic conditions in developing countries. International Non-Governmental Organisations (NGOs) have sponsored small scale composting in Nigeria but the practice has not had significant impact in Nigeria (UNEP-IETC, 1996).

DISCUSSION

Waste management constraints and problems facing local agencies

Poor funding is one of the main reasons for poor collection and disposal of refuse. Lack of funds has forced most environmental protection agencies in the country to hire vehicles and maintain few staff on a permanent basis (ESESA, 1998). The waste management fee is insufficient to cover for waste management. Environmental agencies do not have adequate capacity to handle the increasing solid waste mainly due to limited budgets. Low morale of environmental protection agencies workers due to poor remuneration and stagnation in promotion also affect solid waste management. In Anambra State in 2002-2003, Anambra State Environmental Protection Agency staff salaries were withheld for 18 months. Environmental protection agencies are understaffed and adequately staffed with poorly trained workers. The agencies are faced with financial difficulties in meeting the large payment of wages. Hardly a year goes by without threats of strikes by workers demanding past due wages. Late approval of budgets by the parent ministry has also resulted in cash flow problems. In some cities revenue from solid waste management collections are simply rolled into the general treasury, as opposed to returning to waste related operations and cumbersome procurement procedures.

Inappropriate sitting, design, operations and maintenance of dumps and landfills have

Downloaded from http://journals.tums.ac.ir/ on Wednesday, May 22, 2013

increased transfer and disposal cost and also inadequate onsite storage facilities.

Lack of institutional arrangement: lack of expertise and manpower to run solid waste management programme in Nigeria. Majority of environmental agency workers have little or no functional background or training in engineering and management, so the operations result in ineffective and inefficient solid waste management. There is no reliable measurement of generated waste. Non-appreciation of the magnitude of the waste management is a problem. The role of the informal sector has not been recognised by environmental agencies.

The cities networks, traffic congestion and narrow roads contribute to the inefficient waste collection in Onitsha, Lagos, Benin etc. In Onitsha and Lagos collection vehicles spend three to four hours per day collecting waste, typically making two trips to the disposal sites. Harsh condition of roads and infrastructures has led to constant break down of the collection trucks. In Nigeria, slums and squatter areas appear in the poor neighbourhood of most cities with narrow, hilly, bad and unpaved streets. This makes it impossible for environmental agencies to service the areas. Where it does, it damages the vehicles.

Non-rational routes for collection services are problems. Solid waste collection vehicles are assigned to districts without any serious waste analysis, route selection is left for drivers. In most cities in Nigeria, solid waste collection is done in an adhoc manner, which contributes to high solid waste collection cost and the crippling fuel crisis. The vehicles are not full on some trips to the disposal site.

Failure to optimize collection vehicle productivity by selecting crew size and shift direction contributes to high collection cost. In developed countries, the labour cost is cheap compared to the cost of equipment. The developing countries need low capital cost and high labour intensive. Nigeria has abundance of unskilled and inexpensive labour. In Makurdi optimizing crew size resulted in cost saving of 32.69% of the collection cost (Ogwueleka, 2004).

In most cities of Nigeria, compaction trucks are used. These trucks are uncommon, expensive and difficult to repair. Maintenance of uncommon equipment is always difficult. Compactor trucks are designed to handle low density waste. Solid wastes in developing countries like Nigeria contain large organic matter and high density which makes compaction unnecessary. This is insufficient information about the quantities and quality of the waste generated within their areas. The waste component weight will affect the size of the equipment, and the quantity of energy to be produced.

The vehicles are obsolete and too expensive to operate and maintain. The containers are old and too few. For example, Borno State Environmental Protection Agency (BOSEPA) has a total of nine vehicles in Maiduguri, seven tippers, one loader and one gully emptier, out of which only four tippers and one loader are functioning (Dauda and Osita, 2000).

Strategies towards improvement of MSWM

The common approaches to municipal solid waste management used by development agencies and international donor agencies often fail in developing countries inclusive of Nigeria. The conventional approaches usually involve solutions that are centralized and undiversified do not distinguish the different needs and heterogeneity of city. They are bureaucratic that only consider the formal sector, ignoring informal sector. They are capital intensive approaches involving advanced technology and equipment. Most developing countries, Nigeria inclusive have solid waste management problems different from those found in developed countries in areas of composition, density, political and economic framework, and in waste amount, access to waste for collection, awareness and attitudes, so a different approach is needed. The socioeconomic conditions in the third world are so different from those of the developed world, that a different approach is needed. To achieve sustainable and effective waste management there is need to consider the political, institutional, social, financial, economic and technical aspects of MSWM in Nigeria.

Developed countries enjoy a relative abundance of capital and have high labour cost while developing countries like Nigeria have a relative scarcity of capital and an abundance of

Downloaded from http://journals.tums.ac.ir/ on Wednesday, May 22, 2013

unskilled and inexpensive labour. So any waste management systems with intensive in capital that save in labour cost does not make sense to us. Nigeria needs low capital cost and labour intensive solutions that reduce poverty.

The physical characteristics of cities in Nigeria and developed countries differ. Nigeria has narrow, unpaved streets which cause collection vehicles break down due to the harsh conditions. In these areas pushcarts, tricycles, donkey carts, horse carts and pickup trucks can be used. Nigeria has a dynamic informal sector that has evolved around wastes. Informal waste collectors can be incorporated into public-private partnership.

The utilization of compactor trucks in Nigeria cannot be justified in most cases. Compactor trucks are equipped with a compactor mechanism to increase the density of the waste and thus minimize the number of collection trips. It has sensitive hydraulic mechanisms which can breakdown when an attempt is made to compact waste that is already dense. Compactor trucks were designed for low density waste. Wastes in Nigeria are high density, do not need compaction. Compactor trucks have high capital cost- high fuel usage and operating cost. Regular trucks should be used for waste collection. It requires less capital investment and easy maintaining.

There is need to train the waste personnel to management solid waste issues: formulate the policy for community based programme, waste reduction and recycling project; preparation of legislation. Replacement of the existing vehicles with modern equipment will reduce operating costs. Measurement stations should be installed in some of the landfills. Construction of new transfer station will reduce operating cost. Community participation and involvement of community based organisations in waste management.

ACKNOWLEDGEMENTS

I acknowledge the assistance of staff of Federal Ministry of Environment and state agencies in preparing this paper.

REFERENCES

Agunwamba, J. C., (1998). Analysis of scavengers' activities and recycling in some cities of Nigeria. Environmental Management, **32** (1): 116-127.

Agunwamba, J.C., Egbuniwe, N., Ogwueleka, T.C., (2003). Least cost management of solid waste collection. Journal of Solid Waste Technology and Management, **29** (3): 154-167.

Cointreau, S. J., (1982). Environmental management of urban solid waste in developing countries: a project guide. Urban Development Technical paper No 5. The World Bank, Washington, DC. June .

Cointreau-Levine, S., (1994). Private sector participation in municipal solid waste management service in developing countries. Vol. 1. The formal sector-UNDP/UNCHS/ The World Bank-Urban Management Programme. 52 pp.

Cointreau, S.J., Gunnerson, C.G., Huls, J. M., and Seldman, N.N.,(1984). Recycling from municipal refuse: A state of the Art Review and Annotated Bibliography, World Bank Technical paqper N0 30. The World Bank, Washington, DC.

Dauda, M., And Osita, O.O.,(2003). Solid waste management and reuse in Maiduguri, Nigeria. 29th WEDC International Conference towards the Millennium Development Goal, Abuja.

ESESA (Enugu State Environment Sanitation Agency), (1998), ESESA Report, 1998.

Hoornweg, D., Thomas, L., and Otten, L., (1999). Composting and its applicability in developing countries. Urban waste management working paper series 8. Washington, DC; World Bank.

Ogwueleka, T.C., (2003). Analysis of urban solid waste in Nsukka, Nigeria. Journal of Solid Waste Technology and Management, **29** (4): 239-246.

Ogwueleka ,T.C., (2004). Planning model for refuse management. Journal of Science and Technology, **3** (2) :71-76.

Onibokun, A.G., (1999). Managing the monsters: urban waste and governance in Africa. International Development Research Centre, Ottawa.

Ruzi Jr, J.A., (2001). Recycling overview and growth. In Lund H.F. (ed.): The McGraw Hill Recycling Handbook, Chapter 1, McGraw Hill Inc, New York.

UNEP-IETC, (1996). International Source Book on Environmentally Sound Technologies for Municipal Solid Management. Osaka/Shiga, UNEP International Environmental Technology Centre.

World Bank, (1992). World Development Report, Development and Environment, New York. Paper No 13.

Zurbrugg, C., (2003). Urban solid waste management in low-income countries of Asia, How to cope with the Garbage crisis, Available in the website: http;// www.sandec.ch.