

Turning Waste to Wealth in Nigeria: An Overview

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ABSTRACT In Nigeria, there are no sewage treatment plants hence liquid wastes are managed in an indiscriminate manner. Sullage gets into drains and flows into rivers and streams. Human excreta are managed separately through ventilated improved toilets, pit toilets or septic tanks. In some areas like markets and other public places, excreta are mixed up with solid waste, thus creating nuisance in the recycling facilities. People litter the roads with no civic concern. The markets generate a variety of wastes, for example, corn cobs, vegetable wastes, packaging materials, etc. The household wastes also contain other materials such as paper, glass, metal, plastic, and other non-biodegradable materials. However, some of them are excellent raw materials for various industries in the country. Hazardous waste facilities have not yet been established and hazardous wastes are co-mingled for disposal with municipal solid wastes, despite laws to the contrary. There is the limited involvement of civil society in the execution of waste management projects. This paper reviews current waste management practices in Nigeria and suggests strategies for its improvement. Sustainable Integrated Waste Management which is the selection and application of suitable technologies and management programmes to achieve specific waste management goals was recommended for the country.

INTRODUCTION

What are Wastes?

Waste is defined as any unavoidable material resulting from domestic activity or industrial operation for which there is no economic demand and which must be disposed of (Sridhar 1996). In Russia, it is said that there is no precise word for waste but the usage is that "a material waiting to be reused". There are a variety of wastes, liquid or solid, emanating from human activities (domestic), agricultural or industrial activities (neither domestic nor hazardous), and hazardous or special. Faeces, indeed is also included in solid wastes. Among the liquid wastes, sullage, sewage, livestock and industrial wastes are known among communities.

It is very important to understand the wastes, their nature, problems associated with them, and how to dispose them off hygienically. In Nigeria today, there are no sewers or underground drainage system and as a result all liquid wastes find their way into water courses. There are no urinals or toilet facilities in many public areas. Schools are devoid of functional toilets. Solid wastes are found everywhere and anywhere. In Nigeria, waste is generated at the rate of 0.43 kg/head per day and 60 to 80 per cent of it is organic in nature (Sridhar

2006; Ogwueleka 2009). A cow brought for slaughtering produces about 328.4 kg of wastes in the form of dung, bone, blood, horn and hoof. Sheep and rams produce about 0.9 kg waste per head per day (based on observation). The markets generate a variety of wastes, for example, corn cobs, vegetable wastes, packaging materials, etc. The household wastes also contain other materials such as paper, glass, metal, plastic, and other non-biodegradable materials and some of them are excellent raw materials for various industries in the country. People litter the roads with no civic concern. All these wastes contain a lot of valuable resources in the form of nitrogen, phosphorus, potassium and other chemicals which are useful (Hammed et al. 2011). Microorganisms play an important role in biogeochemical cycles and convert these valuable resources into harmless and useful products. However, there are certain wastes arising from industries or healthcare facilities which may be hazardous, infectious and need to be treated as special wastes.

Study Area: Nigeria at a Glance

Nigeria is located in western part of Africa on the Gulf of Guinea and has a total area of 923,768 km² (356,669 sq mi). It is the most populous in

Africa and second largest economy in Sub-Saharan Africa after South Africa (Uzochukwu 2003). It is comparable in size to Venezuela, and is about twice the size of California. It shares a 4,047 kilometers border with Benin (773 km), Niger (1497 km), Chad (87 km), Cameroon (1690 km), and has a coastline of at least 853 km (The World Fact book 2011). Nigeria lies between latitudes 4° and 14°N, and longitudes 2° and 15°E. The highest point in Nigeria is ChappalWaddi at 2,419 m (7,936 ft.). The main rivers are the Niger and the Benue River which converge and empty into the Niger Delta, one of the world's largest river deltas and the location of a large area of Central African Mangroves (Fig. 1). Nigeria is a developing country, with a population of about 140 million and a growth rate of 2.38 according to the 2006 Nigerian census. It has populations distributed at 48.3% urban and 57.7% rural and population density at 139 people per square km.

Waste management presents problems in a mega city like Lagos and other major Nigerian cities which are linked with economic development, population growth and the inability of municipal councils to manage the resulting rise in industrial and domestic waste. Haphazard industrial planning, increased urbanization, poverty and lack of competence of the municipal government are seen as the major reasons for high levels of waste pollution in major Nigerian cities. Some of the 'solutions' have been disastrous to the environment, resulting in untreated waste being dumped in places where it can pollute waterways and groundwater (Ogbonna et al. 2002).

Environmental and Health Problems from Wastes

Wastes pose serious environmental and health problems, promote insect vectors like mosquitoes and flies (Cairncross and Feachem 1993), rats and mice, cause fire hazards, flooding of streams, development of aquatic weeds, odour problems, nuisance, and so on. According to Pichtel (2005), the environmental impacts can be clustered into six categories which include: global warming, photochemical oxidant creation, abiotic resource depletion, acidification, and eutrophication. Some of these problems are related to their major constituents, viz. carbon, nitrogen, phosphorus and sulphur. Certain toxic heavy metals like lead, mercury, cadmium, minerals and manmade synthetic chemicals present in wastes may contribute to environmental degradation that leads to poor health, dis-

ease or death. The wastes produced in Ibadan may move on and end up in Sokoto, Maiduguri, Abeokuta or Ghana due to movement within and outside the generation site. There is a need to treat such wastes and bring them back into the cycle of life so that ecological harmony is maintained.

Waste Management Practices and Constraints in Nigeria

In Nigeria, liquid wastes are managed in an indiscriminate manner. There are no sewage treatment plants. Sullage gets into drains and flows into rivers and streams. Human excreta are managed separately through ventilated improved toilets, pit toilets or septic tanks (Hammed 2013). In some areas like markets and other public places, excreta are mixed up with solid waste, thus creating nuisance in the recycling facilities. Solid waste management is the discipline associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in a manner that is in accord with the best principle of public health, economics, engineering, conservation, aesthetics, and other environmental considerations. It is also responsive to public attitudes (Sridhar 2006). Integrated Solid Waste Management (ISWM) is defined as the selection and application of suitable techniques, technologies, and management programmes to achieve specific waste management objectives and goals.

In the waste management strategies, a variety of methods are in vogue depending on the type of waste to be disposed of, the level of economic development of the country and the commitment of the Government. Solid Waste management methods include waste minimization (or reduce), reuse, and recycling before thinking of disposal. A school in Abeokuta has collected all worn out tyres and used as fence around their playground. It is very impressive. Normal Municipal solid waste contains about 60 to 80 per cent organic and biodegradable materials. Composting technologies have been developed to convert these wastes into compost and organo-mineral fertilizers (Sridhar et al. 1985, 1991, 1993; Adeoye et al. 1993; John et al. 1996; Egbewumi et al. 1997; Sridhar and Adeoye 2003). The remaining components are useful materials. If these materials are taken out, what is to be disposed will be minimal (Table 1).

Table 1: Recyclables and their uses from solid wastes

<i>Waste</i>	<i>Recyclable value or use</i>
Hair, bristles, wool, feather	Brushes, lanol, fertilizer, wigs, blankets, carpets, fabrics, yarns pillows Mattresses
Hoofs, horns	Buttons, combs, hair pins, novelties, washers, glue, gelatin fertilizer
Bones	Buttons, cutlery, handles, ornaments, glue, gelatin, bone meal
Hides, skins, feet	Horse whips, seats, belts, hand bags, book binding, shoes, gloves, Oil, Glue, Gelatin
Intestines	Stockfeed, surgical ligature, musical (guitar) strings, tennis strings, sausages and Putty containers
Blood	Fibrin foam, purified bovine albumin, dried blood and blood meal
Ruminal contents, excreta	Methane gas, manure
Fats	Soap, machine oil, candles, leather dressings
Glands and special organs	Pharmaceutical products (insulin, gall stones, corticosteroids), Pepsin, Cholesterol, Liver extract, Cartilage
Aluminum	Soft drink and beer cans, cutlery
Paper	Newspaper, packaging materials, crate of egg, tissue paper
Plastics (various types)PETE/1	Bottles, milk jugs, pipes, thin film packing, battery casings etc.
Glass	Various glass products, decorative pieces, brick aggregates
Ferrous metal	Tin cans, metal works
Non-ferrous metal	Aluminum, copper, lead, etc, various items
Yard wastes, organic wastes	Compost, biogas
Construction wastes	Filling materials
Tyres	Road paving, building, shoe soles
Batteries	Recycling for lead, copper, plastics and reuse
Waste oilRice husk	Reuse after refiningBriquettes, cement substitute etc.

Recyclers abound cities and one can often find them at the dumpsites picking these valuable materials. They get injured at times if they are not careful. These recyclable wastes find their way to big industries. All aluminum goes to Saki, Oyo state, Nigeria where they are converted to cooking pots. All plastic is transformed into plates, spoons, chairs, and other things used in households. All broken beer bottles end up again as good and clean bottles for industries which are starving for raw materials. More and more State Governments are heading towards private sector involvement to offset the governmental bureaucracy, cost saving and sustained hygiene and health benefits.

The various technologies available are given in Box 1. The waste of developing countries does not have sufficient calorific value to self-sustain incineration. It implies that the waste will not burn without the addition of fuel. In most developing countries, hazardous waste facilities have not yet been established and hazardous wastes are comingled for disposal with municipal solid wastes, despite laws to the contrary. Figure 2 shows different types of wastes generated in the country urban ecosystem, their health impacts as well as suggested methods for their effective management. Incineration, a capital and energy intensive op-

tion is 5-10 times more costly than sanitary landfill, and composting is 2-3 times more costly. However, incineration is a choice for the disposal of healthcare wastes which contain infectious or hazardous components (WHO 2004; ALCO/

Box 1. Technology options for solid waste management

Waste Management Hierarchy: In the waste management hierarchy, Reuse, Recycle and Disposal are used. Disposal is the last option. Australia and New Zealand are moving towards 'Zero waste' to landfill disposal.

Controlled Landfill: A controlled landfill has daily soil cover and perimeter drainage to minimize leachate generation.

Sanitary Landfill: This involves use of an appropriate liner and keeping the waste in layers; the waste should be sprinkled with water or leachates and the methane generated should be recovered for energy.

Composting: This is an aerobic biological process where putrescible organic wastes such as animal wastes are mixed with municipal wastes, crop residues or saw dust and kept in windrows for several weeks for thermophilic degradation by microorganisms. The finished product is a good soil conditioner and is ideal for Nigerian soils for good crop yields.

Incineration: Incineration is used for burning any waste which cannot be reused or recycled. High temperature incinerators are useful for managing infectious and certain industrial wastes.

World Bank 2007). Sanitary landfill is usually the lowest cost of the environmentally acceptable solutions. It costs roughly 3-8 times more than open dumping with some grading to maintain truck access to the working face.

Waste management is at once a technical, cultural and financial problem (Sridhar 2006). In waste management practice, various steps are involved. Collection, transportation and hygienic disposal are the three phases of waste management. These steps should operate in harmony. Most often we fail at the proper collection stage. Most of the refuse bins we use in the country are about 200 litres capacity. A mother when she assigns the child to sweep the floor and remove the dirt has no time to supervise how the child is carrying out the task. A teacher who punishes a late comer by asking him/her to pick the litter has no time to see where the picked up waste is being dumped by the humiliated child wanting to rush to his/her lesson. She empties on her way to the dumping site and dumps

none at the stipulated site. Even the materials, tools or equipment used in collection of the wastes need to be examined more closely. Wherever possible, one should think of using appropriate materials, tools and technology. The broom made in India or China may not be ideal to work with in Ibadan or Calabar. For a dust bin to be used, plastic or metal is a debate as the durability and affordability is a question in a given community or situation.

Where an animal cart can be used to transport the waste, a mammoth skip eater cannot work. How many times one has watched helplessly when a road is blocked for hours when such a big vehicle tries to collect the waste from a narrow road junction like Sabo market in Ibadan? Has anybody in the inner core area of Ibadan seen Ibadan Solid Waste Management Authority's vehicles clearing their refuse? The answer is no, and arguably not possible. In addition to these, governance of wastes is a serious problem in Nigeria. There has been continuing shifting of responsibilities

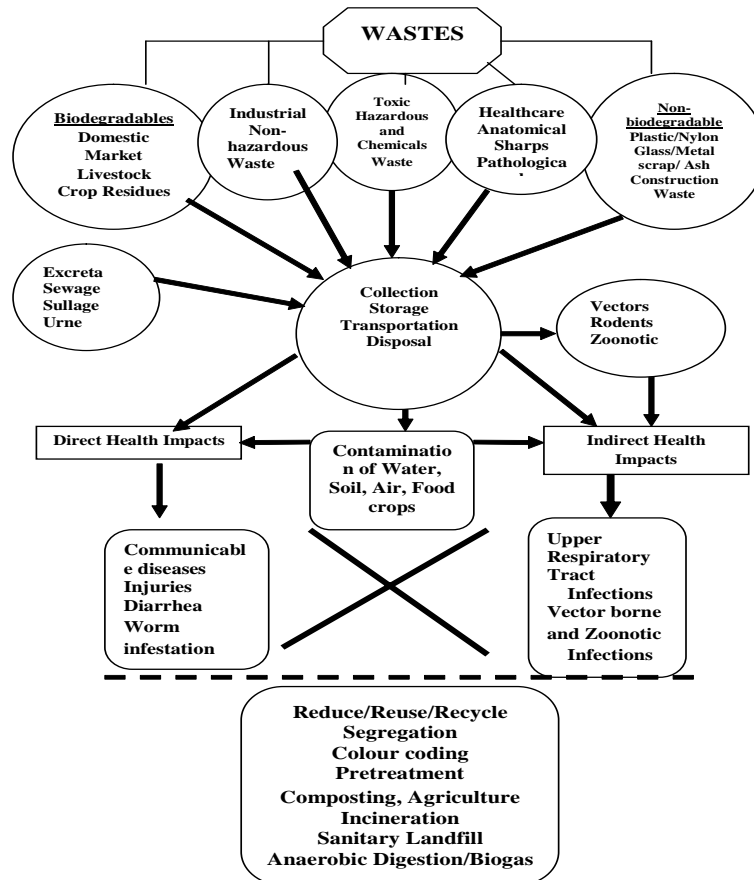


Fig. 2. Wastes in the urban ecosystem

among agencies and the various tiers of government and between these and the private sector. Many actors are now active in waste management. Although waste management is now generally considered a local issue, Federal/State governments and national institutions play big roles and bear considerable responsibilities (Federal Republic of Nigeria 1999). Whatever the types of arrangement between the different tiers of government, the higher tiers definitely dominate the lower ones. The local governments greatly depend on, and are usually controlled by, the Federal/State governments. This is particularly so for access to resources and political maneuverability. Usually, institutions for waste management are in conflict with the local governments (particularly, if waste management has been privatized). This often leads to politicization of waste management and reduces the local authority's opportunities to monitor and evaluate activities.

There is the limited involvement of civil society (through formal representation in policy formulation and executing bodies); the limited citizen participation in operation and maintenance; and the limited involvement of small contractors in the execution of projects. Households have no influence on solid-waste management systems, as they are rarely consulted about the system to be adopted by the authorities and most often they do not attend meetings when required. Thus there is wisdom in promoting segregation of waste among communities.

Waste to Wealth Options

As much as possible, one should aim at waste minimization or reduction, reuse, and recycling before dumping the wastes into a dust bin. Recycling the non-biodegradables will help the individual and also the local industry. In recent years, many industries are starved of raw materials. For recycling to be successful, separation should start at household level. If paper, plastic, aluminum, iron and glass can be separated and kept in separate bins or baskets, it is normal that our waste will be reduced for the clearing agent and we will pay less for his services? Besides saving some money from the agent one makes some extra money from the sale of these recyclables. Ask the picker boy on the refuse dump site: 'How much money he makes at the end of the day in Nigeria?' The reply is very modest with a smile. He makes at least a

₦100 a day if he is regular and is early enough at the dump site. There are many industries that recycle these materials. The whole of Kishi Township is a town of metal recyclers, numbering over 3000. There are over 100 plastic recyclers in Lagos, in Ibadan and practically every city in Nigeria. There is money in it both for the householder, the picker and even the industry.

The researchers' various projects at the University of Ibadan have brought out significant contributions on the waste to wealth initiatives. They have introduced source segregation in some eight pilot communities in Ibadan and Lagos whereby they are able to separate plastic/nylon, metal and organic fraction from the household wastes. They have fabricated necessary machinery locally (without any imported component) to recycle plastic/nylon, metal scrap and organic matter and established the facilities (with various production capacities) at the following locations:

- (i) A 10-ton per day capacity "Pace Setter Organo-mineral Fertilizer Plant" was designed and built for Bodija market in Ibadan (1998), Nigeria which is the first prototype demonstration project in the country. This has aroused interest all over the country and the Federal Government has recommended similar prototype for the entire country as a part of "Waste to Wealth Initiative" and as a strategy for "Poverty Alleviation" and Sustainable Development. Based on this, UNDP and UNCHS have engaged our expertise in propagating this technology to 36 States in the country through Workshops. University of Ibadan, Sustainable Ibadan Project and Ibadan Waste Management Authority have bagged National and International Merit Awards and appreciation. The Technology is available under the Team "Environmental Development Foundation".
- (ii) A 5-ton per day capacity organo-mineral fertilizer plant was designed and built for Ayeye community, Ibadan (2002) where sorting of non-biodegradable and biodegradables were practiced; recyclables and the organo-mineral fertilizer are being sold.
- (iii) A 5-ton per day capacity food residual conversion to compost (2002) was developed for a flow station at Shell Petroleum Development Company, Forcados, Delta State;

- the compost produced is being used for maintaining their lawns and gardens.
- (iv) A 10- ton per day capacity “Pace Setter Integrated Waste Management Complex” was designed and built (2005) for Oyo State Government at Orita-Aperin, Ibadan where an organo-mineral fertilizer plant, a plastic recycling plant and a scrap metal recycling plant were designed and built for management of Solid waste generated in Ibadan.
 - (vi) A 10-ton per day capacity organo-mineral fertilizer plant (2 Nos), 2-tons per day plastic/nylon recycling plant and a 1-ton per batch metal scrap recycling plant were built for the Ondo State Government at Akure. The plant was commissioned by His Excellency, the President of Nigeria on June 24, 2006.
 - (vii) A 5 Ton/day organic fertilizer plant and 2 Tons/day plastic chops or flakes plant was established in Aleshinloye market which is a more recent one and is a model as the Traders Association owns and manages it.

The above examples may be referred to as “Cleaner Production Technologies” where the dirty wastes are being processed and value added to them. Plastic/nylon and metal finished products are being used as raw materials by the big-

ger industries. At Alesinloye market plant, waste water from abattoir serves as a potential source of nitrogen to enrich organic fertilizer (Hammed et al. 2011).

Way Forward

In a sound waste management strategy, every component of the waste should be taken into consideration in the management practice. Sustainable ISWM which includes all sectors of the environment that have stake in environmental management (Fig. 3) should be practiced. In the ISWM hierarchy, source reduction, reuse, recycling, waste combustion, and landfill are followed in that sequence. In USA, even the term ‘Waste Combustion’ is being replaced by ‘Waste Transformation’. Nigeria should adopt this approach as valuable resources are lost in the waste stream, enormous amount of finances are spent on simple collection and transformation and still more the landfill sites are not inexhaustible. Recycling infact creates more job opportunities.

Closing the organic loop can save money for the urban centers by providing alternatives to landfills, dumping, and incinerators. This is one way to meet the current demand for urban services, cutting costs by reducing pollution,

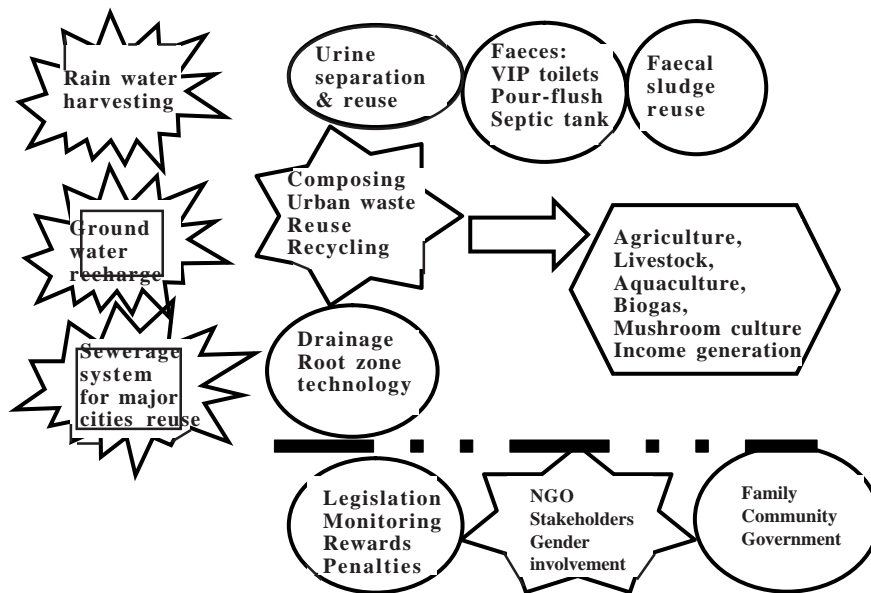


Fig. 3. Towards a sustainable integrated waste management

environmental degradation and disease, poverty alleviation, and employment and revenue generation, especially in the developing world. Although the direct costs of operating conventional landfills and wastewater facilities are known, the environmental degradation, health problems, and costs of ground water contamination are known only qualitatively. The true total costs of current waste disposal taking into account health and environmental impacts are not known particularly in developing countries. Until we adopt the ancient dictum that "Rain for River and Waste for the Land" which means that liquid waste should be treated and allowed into water bodies while solid waste should be recycled and used for agriculture and industries, developing countries remain impoverished agriculturally and food security is at risk. 'Waste to wealth' is a sustainable strategy that should be adopted by developing countries.

CONCLUSION

Waste management is capital and labor-intensive, consuming as much as 20 to 50 per cent of municipal operational budgets. Both capital and operational cost savings can be realized by effectively managing waste that would otherwise end up in rivers, lakes, or landfills, and using treated wastewater and sludge for biogas, irrigation and aquaculture. Also, hazardous waste facilities have not yet been established and hazardous wastes are co-mingled for disposal with municipal solid wastes, despite laws to the contrary. There is the limited involvement of civil society in the execution of waste management projects. Hence, to achieve specific waste management goals in Nigeria, Sustainable Integrated Waste Management which is the selection and application of suitable technologies and management programmes needs to be considered.

RECOMMENDATIONS

In order to achieve this and ensure a long lasting and sustainable solution to the problem of waste management in the country, there is need for: bring the waste pickers into the main stream of waste management and provide basic healthcare facilities for their operations and healthful living, registering adult waste pickers, providing vaccination for hepatitis A and B, tet-

anus, polio and typhoid, and providing annual medical examinations for them; providing education about personal hygiene, and the safe care/feeding of domestic livestock and pets to solid waste handlers and waste pickers; and providing solid waste handlers and waste pickers with Personal Protective Equipment (PPE) (for example, shoes/boots and gloves) since every stage involves human contact and exposure, leading to health risks.

At households, commercial establishments and institutional buildings, there is need for implementing source segregation of non-hazardous recyclable wastes, so that the economic incentive for waste picking at disposal sites is reduced. Segregation at source is also advisable for adding value to the waste. At hospitals and industries, there is need for implementing source segregation and separate collection of hazardous wastes. The major recyclables are organic, plastic/nylon and metal scrap; organic fraction which accounts for 60 to 80 per cent of the waste stream is a valuable resource and can be converted to organic or organo-mineral fertilizer; similarly, plastic/nylon (pure water sachets) and metal scrap can be recycled and sent to industry to supplement raw material. Finally, there is need to encourage recycling facilities at community or Local Government level with financial support from donor agencies and State Government.

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