

The Impact of Spatial Distribution of Solid Waste Dumps On Infrastructure in Samaru, Zaria, Kaduna State, Nigeria Using Geographic Information Systems (GIS)

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Abstract: This study dwells on analyzing the impact of the spatial distribution of solid waste dumps on infrastructural facilities in Samaru, Zaria, Kaduna State, Nigeria. The primary data sources were GPS survey, Satellite imagery of Zaria and personal observation. Seven major dumpsites were identified. The dumps were situated on drainages, road networks, in and around school premises as well as adjacent to residential buildings. The implication of such distribution include obstruction of free flow of water and traffic; pollution of air, surface and ground water as well as breeding of pests and rodents which transmit diseases like malaria, cholera and typhoid fever as well as destruction of the aesthetic value of the environment. The recommendations of the study include: the use of Remote Sensing and GIS for proper planning and monitoring of protected dumps which would be far from infrastructural facilities; adoption of the Integrated Waste Management (IWM) approach which involves reduce, reuse and recycle; education and sensitization of people and the establishment of sanitation monitoring team to inspect the environment regularly and prosecute offenders.

Key words: Geographic information systems, infrastructure, solid waste dumps, waste management

INTRODUCTION

The management of solid waste is a major public health issue and an important factor affecting the quality of the environment. The problem of solid waste disposal especially in our cities has become one of the most difficult environmental problems facing the world today (NEST, 1991). Among all the wastes (solid, liquid and gas), solid waste is the most popular and most difficult to manage locally. This is because solid waste does not flow, evaporate, diffuse, dissolve or be absorbed into the surrounding unlike liquid and gaseous wastes (Ogunbiyi, 2001 in Victor and Choji, 2006). The problem of waste management is even becoming more complex with the increasing rate of urbanization.

The United States Federal Statute on Resources Conservation and Recovery (1976) refers to solid waste as any garbage, refuse, sludge which could be solid, liquid, semi-solid or contaminated gaseous material resulting from industrial, commercial, mining and agricultural operations as well as from community activities. Solid waste can be classified based on composition, source as well as physic-chemical properties. The classes of solid waste based on source are: municipal (domestic, institutional and commercial), agricultural, mining and mineral, radioactive and industrial wastes. Among these sources, industrial and municipal wastes contribute the highest volume annually (Victor and Choji, 2006). For the purpose of this work, municipal solid waste is favored.

In several African cities, dumping and burning are the common disposal methods. For instance, in Kigali, Rwanda, 84% of the solid waste generated is burnt openly. Problems of solid waste management are mainly attributed to inadequate equipment and staff as well as the inefficiencies associated with central Government Agencies (Aryeetey-Attoh, 2003).

The solid waste management issue in Nigerian cities is even more alarming. The volume and range of solid wastes generated daily in Nigeria has been increasing within the last few years and this is mainly due to the high population growth, urbanization, industrialization and general economic growth. About 20 kg of solid waste is generated per capita per annum in Nigeria that is 2.2 million tones yearly based on the 1989 estimated population of 110 million; the estimated volume of solid waste generated in selected urban centers in Nigeria was projected to double by the year 2000 (NEST, 1991) this means increasing the problem of management.

In many Nigerian cities, the volumes of solid wastes have overwhelmed the capacity of urban administrators to manage. Only about 30-50% of generated wastes are collected in most Nigerian cities and recycling of waste is not practiced to a significant level (United Nations System in Nigeria, 2001). Afon (2006) also discovered a wide gap between the rate of waste generation and the rate at which it is evacuated in Oyo town. Due to high rate of urbanization in Nigeria like other countries of the world, much more solid waste is generated than can be

disposed, hence, the solid waste disposal problem experienced in most cities of the Nation. Between 1980 and 2000, the growth rate of the urban population in Nigeria was 5.8% while the total population growth was about 3%; this implies high urban growth rate. (Knox and McCarthy, 2005; Redman and Jones, 2004). One of the consequences of this high growth rate is the problem of waste management.

The inadequate management of solid waste is causing a lot of problems to the local environment since these wastes are often indiscriminately dumped on open plots of land and particularly along or on streets. The unsanitary conditions of collecting, processing and disposing solid waste contribute immensely to urban environmental degradation (NEST, 1991). Those found on drains obstruct the free flow of water resulting to urban flooding which destroys lives and property as well as displacement of people (Ibrahim, 2008; NEST, 1991). Those deposited along motorways constitute obstruction to the free flow of traffic while generating offensive odour to the neighborhood and unpleasant sight to the inhabitants. Inadequate management of solid waste also pollutes soil and contaminates ground water due to pollutants from the waste which leach through to the water causing the outbreak of diseases like cholera and typhoid fever which has claimed a lot of human lives (Akinola, 2008; Kinnamann *et al.*, 1999 in Aondoakaa and Ishaya, 2007; Botkin and Keller, 1998). As a result of the environmental

condition in the urban areas, Nigerian cities have been described as some of the dirtiest, most unsanitary and the least aesthetically pleasing in the world (Mabogunje, 1996 in United Nations System in Nigeria, 2001).

The Federal Environmental Protection Agency (FEPA) was established in 1988 to control the growing problem of waste management and pollution in Nigeria (Onibokun *et al.*, 2003 in Aondoakaa and Ishaya, 2007). FEPA's aim was to achieve at least 80% effective management of the volume of municipal solid waste generated at all levels and ensure environmentally sound management (Vision, 2010, 2003 in Aondoakaa and Ishaya, 2007). But their aim is still very far from being achieved, in fact as far as Zaria is concerned, from being achieved, in fact as far as Zaria is concerned, their impact is yet to be felt. The problem according to Akinola (2008) is due to massive indifference of the people and their lost of effective and responsible relation to the environment as a result of colonialism. However, Danyaya (2009) is of the opinion that the insouciant attitude of Nigerian Government at all levels is responsible for the haphazard and arbitrary practices in respect to waste disposal which results in hazardous conditions in the environment.

In United States and many other countries in the world, open dumps have been banned however, many countries in the world such as Nigeria still use them.

Waste dumps are located wherever land is available irrespective of safety, health hazards and aesthetic degradation. Common sites are abandoned mines and quarries, natural low areas like floodplains as well as hillside areas. The waste is often piled as high as possible and sometimes burnt while in other cases, it is periodically leveled and compacted. Generally, open dumps provide breeding ground for pests, create health hazard, pollute the air, soil and sometimes ground and surface water as well as deteriorate the beauty of the area (Botkin and Keller, 1998).

This situation in Samaru, Zaria is not different from other urban areas in Nigerian where due to poor waste management, illegal open waste dumps are found dotting the streets without any consideration to the aesthetic and health hazards due to such practice. These dumps are distributed indiscriminately irrespective of the presence of infrastructural facilities in such locations which are normally endangered. Therefore, the aim of this study is to analyze the impact of the spatial distribution of solid waste on infrastructure in Samaru, Zaria, using Remote Sensing and Geographic Information Systems (GIS).

Study area: Samaru is found in Sabon Gari LGA located between Ahmadu Bello University, Basawa and Bomo. It is a growing urban settlement within Zaria located approximately between latitudes 11° 10' and 11° 11' N of the Greenwich Meridian and longitude 7° 37' and 7° 40' E of the Equator Fig. 1.

Though the origin of Samaru can be traced to a primordial stream with a tree in a place known as Gangan Uku or old Samaru, its expansion started with the establishment of the Nigerian College of Art, Science and Technology in 1951. The college was later transformed to Ahmadu Bello University (A.B.U) in 1962 and this led to a rapid influx of people into the area for both educational and occupational reasons. Other Institutions were later established leading to further increase in population. Samaru has a climate similar to Zaria as a whole with a distinct variation in rainy and dry seasons (Sawa and Abdulhamid, 2009).

Samaru is predominantly residential. According to the 1991 population census, Samaru had 12,978 people with 7,417 males and 5,561 females. Based on the 3.0 growth rate of the 1991 census, the population of Samaru was projected to about 18,039 by 2009. With such a population growth, it is expected that a substantial volume of waste would be generated daily. But there is no legal public waste management infrastructure in the area as a result, illegal waste dumps spring up indiscriminately.

MATERIALS AND METHODS

This study was conducted in Samaru, Zaria, Kaduna State, Nigeria in the year 2010. The sources of data used for this work were both primary and secondary. The

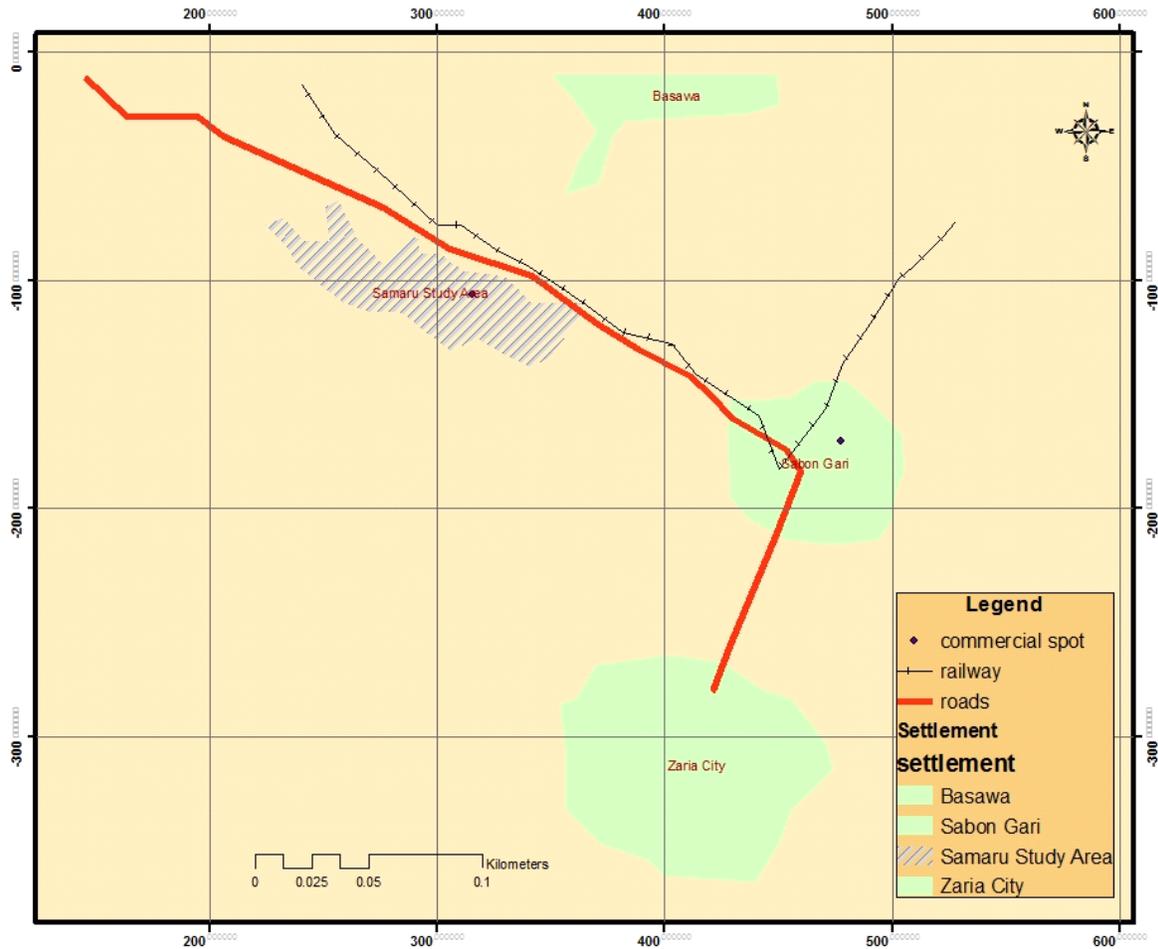


Fig. 1: Zaria showing Samaru (study area) Ikonos (2008)

primary data were acquired through Global Positioning System (GPS) survey of the study area and satellite imagery of Zaria. The Satellite imagery was captured by Ikonos (2008) Satellite with a spatial resolution of about 1m. The GPS survey was carried out to collect the coordinates of the major waste dumpsites in Samaru.

The coordinates of the waste dumps collected were imported into Microsoft excel and tables or data sheets for the points and their attributes were created which was imported into the GIS environment after projecting the layout. In ArcGIS 3.2a environment, the layout was projected to Universal Transverse Mercator (UTM). The satellite imagery was captured into the GIS environment where it was processed and geo-referenced. The major infrastructural facilities in the area were indentified and digitized. The infrastructural facilities include roads, schools, residential and commercial buildings, and drainage networks. The coordinates of each identified dumpsites were then overlaid on the imagery covering the study area using the overlay analysis of the GIS. The map

of the spatial distribution of the dumpsites and their proximity to infrastructural facilities was created.

RESULTS AND DISCUSSION

The result reveals the spatial distribution of solid waste dumps in Samaru. Seven major dumpsites were discovered as shown in Fig. 2.

Based on the analysis, the locations of the dumps show serious negative implications on infrastructural facilities in the area. Some of the dumps were on drainages thereby obstructing the free flow of water and this could eventually lead to flooding and erosion which are common in Samaru during the rainy seasons. A good number of the dumps were adjacent to and even within residential structures where they not only destroy the aesthetic value of the areas but also constitute breeding grounds for vectors like mosquitoes and flies which transmit diseases like malaria, typhoid fever and cholera which constitute part of the highest killer diseases

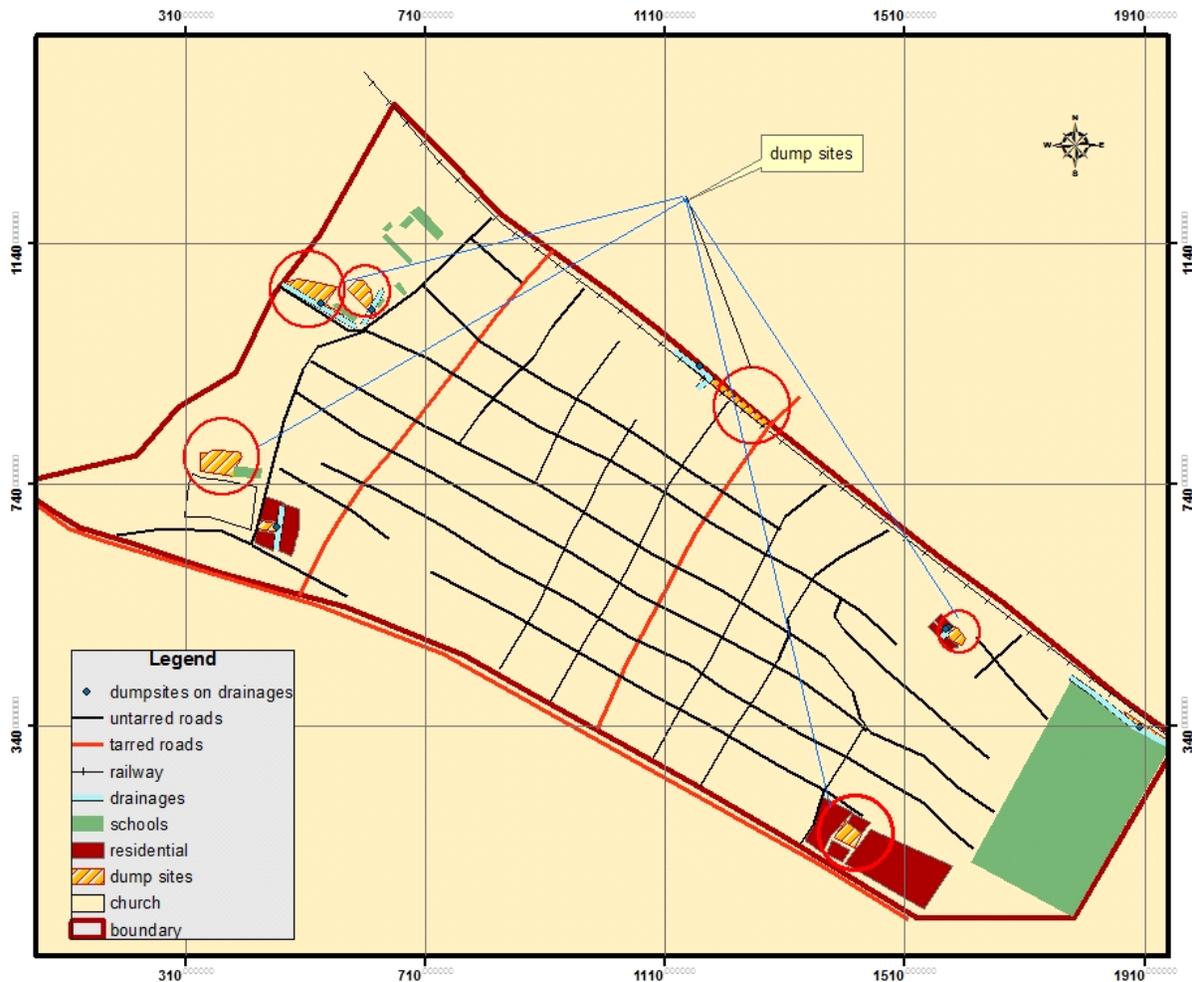


Fig. 2: Spatial distribution of waste dumps and infrastructures in Samaru, Zaria Field Survey (2010)

in Nigeria. In some cases, they pollute surface and ground water hence, exposing the inhabitants to the consumption of contaminated water and food which is inimical to their health. The residents in these areas were also exposed to offensive odour and polluted air.

Other dumps were sited either beside schools or within the school premises particularly public primary schools. It was discovered that one of the largest dumps in the area was situated in Amina Memorial primary school thereby, creating an unsanitary environment in the area. The school where the habit of cleanliness is expected to be inculcated into the pupils has turned out to be a dumping site for refuse thereby, exposing the children to contaminated air and disease vectors and consequently, health hazard. Transportation networks were also not left out of the menace. Dumps were located by the roads and rail line obstructing free flow of traffic.

These dumps were illegal and no attempt was made to evacuate them from the sites. They grow by day and were only reduced by burning but in some cases, the

biodegradable components were collected and used as organic manure to aid plant growth. The Local Government was not doing anything to solve the problem. There was neither any public waste collection infrastructure nor any planned strategy for the evacuation of waste in the area.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

The high rate of urbanization particularly in developing countries has resulted in overwhelming growth of solid waste which pose great management problem especially in urban areas. Due to the increasing volume of solid waste coupled with poor management strategies, in Nigerian cities, proliferation of illegal waste dumps has become the order of the day and Samaru is not an exception. Illegal open waste dumps of various sizes tend to dot the streets. Some of these dumpsites are situated on drainages and transport networks where they

constitute barrier to free movement of water and traffic. Others are in or by residential buildings and schools hence, creating breeding grounds for pests and rodents that transmit diseases which claim lives thereby, reducing the productivity rate while polluting the air, surface and ground water.

Based on the outcome of this research, the following are recommended:

- If dumps must be used, they should be properly planned, monitored and sited away from residential buildings, schools and other infrastructural facilities using Remote sensing and Geographic Information Systems (GIS). They should also be properly protected and constantly evacuated to prevent the breeding of pests and rodents as well as pollution of air and water.
- Our waste management strategies should shift from simply moving waste from one site to another and not really managing it. The Integrated Waste Management (IWM) concept should be adopted. This concept can be defined as a set of management alternatives which include, reuse, source reduction, recycling, composting, landfill and incineration. The ultimate aim of Reduce, Reuse, and Recycle (3R's of IWM) is to reduce the amount of urban waste that would eventually end up in landfills, incinerators or other waste management facilities. Better design of packaging can reduce waste by 10%; recycling by about 30% while large scale composting can achieve 10% reduction. This implies that recycling is the major player in reduction of urban waste stream. (Botkin and Keller, 1998). High recycling rates of clean, source separated materials should be encouraged. This can be achieved through Public Private Partnership (PPP).
- Education and Enlightenment or sensitization programs should be intensified and brought down to the grass root. Proper education on the hazards of the indiscriminate disposal of refuse should be made available. Where possible, it should be incorporated into the school curriculum at both primary and secondary levels. The media publicity is not enough since not everyone has access to the media.
- The establishment of a sanitation monitoring team to inspect the environment on a regular basis and prosecute defaulters accordingly.

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