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Application of GIS in Site Selection for Solid Waste Collection Points in Ikenegbu Extention Layout Owerri

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Abstract: In Nigeria, waste disposal have been ineffective both in the urban and rural areas. Wastes are indiscriminately dumped on open plots of land and particularly along streets rendering the roads impassable and reducing the aesthetic value of the area. Several attempts have been made to solve the problem to no avail. Selection of waste collection points is therefore necessary in other to prevent the indiscriminate dumping of waste which is hazardous to human health. This study used Geographic Information Systems (GIS) to select suitable locations for waste collection points at Ikenegbu extension layout. A database was created and GIS systems were used in the analyses. This resulted in the generation of digital maps which can be very much useful in decision making for waste management or any other earth related problem. These maps were designed (digitized and georeferenced) in AutoCAD land development 2i and analysed with the inputed database in ArcView 3.2a through the usage of its analytical capabilities like buffering, overlay by union, clipping and query operations to determine the most suitable sites for solid waste collection in the area.

Key words: Waste disposal, indiscriminate, health, streets, aesthetic value, Nigeria

INTRODUCTION

Statement of the problem: Rapid population growth and urbanization has increased the volume and range of residential and commercial solid waste generated in Owerri Municipal area. The accumulation of these wastes resulting from human activities has continued to pose a serious threat to the health of inhabitants of Ikenegbu. In Owerri like other Nigeria cities, there has been a phenomenon increase in the volume and range of solid waste generated daily within the past few years.

The collection and disposal of these wastes is one of the most environmental problems as well as a major public health issue and vital factor affecting the quality of life in Owerri. NEST (1991) attributes the volume of solid waste generated daily in the urban centers to population growth, migrant population, urbanization, industrialization and general economic growth.

In Owerri, the volume of solid waste has overwhelmed urban administrators' capacity to plan for their collection and disposal. Thus, it is very common to find heaps of garbage on streets, roads and open spaces in the municipality with its attendant problems (Date, 1995). The collection and disposal of this large waste with conventional methods have become increasingly difficult. In Ikenegbu extension layout, there are few and inadequately positioned waste collection points. As a result these wastes are disposed indiscriminately. These pile up and block drains after a heavy rainfall.

Thus, there is need to create an ideal environment where waste collection and transportation could work to contribute to a clean environment having considered the existence of a waste dumpsite at the southern part of the town.

The selection of suitable sites for solid waste collection in Ikenegbu extention layout is the focus of this study. GIS technology is therefore employed in locating the suitable sites for effective solid waste management/collection points in Ikenegbu extension layout of Owerri municipality.

Study location: The study area is Ikenegbu extension layout in Owerri municipality. The area is at the Western part of the town. Owerri municipal council is one of the 27 local government areas of Imo state, neighbored by Owerri North and Owerri West.

The municipality is the capital of Imo state and serves as the Central Business District (CBD) of

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adjourning areas. Owerri is framed by latitude 5°29'N, 8°41'S, 7°11'E and 9°26'W. The metropolis has an area of 100 km^2 (38.6 mL^2). Presently, the town has grown significantly as the area recorded a population of 401,873 at 2006 (www.imostategov.org; Enclycopaedia Britannica, 2010) (Fig. 1 and 2).

Geographic Information Systems (GIS): A Geographic Information System (GIS) integrates computer hardware, software, geographic data for capturing, managing, analyzing and displaying all forms of geographically referenced information (ESRI, 1996; John and Star, 1989; Odedare, 2009; Lo and Yeung, 2003). GIS can be applied in location analysis or site selection as it is used in this study.

The standard of solid waste management is determined by the performance of some activities. The basic elements involved with solid waste management from the point of generation to final disposal has been grouped as:

- Waste generation
- On-site handling, storage and processing
- Collection
- Transfer and transport
- Disposal

Problems associated with solid waste management: Generally, problems of solid waste management in the urban centers are collection, storage, transportation and disposal of the waste materials (Huang, 1998; Adesida and Igboku, 1998).

These problems are generally due to lack of adequate personnel, poor city structure, poor town planning, inadequate infrastructure and equipment, poor handling of vehicles for collection and transfer of waste as well as financial constraints.

The efficiency of managing waste depends on the relationship between waste generation and disposal, size of staff, the quality and quantity of equipment at the disposal of the workers.

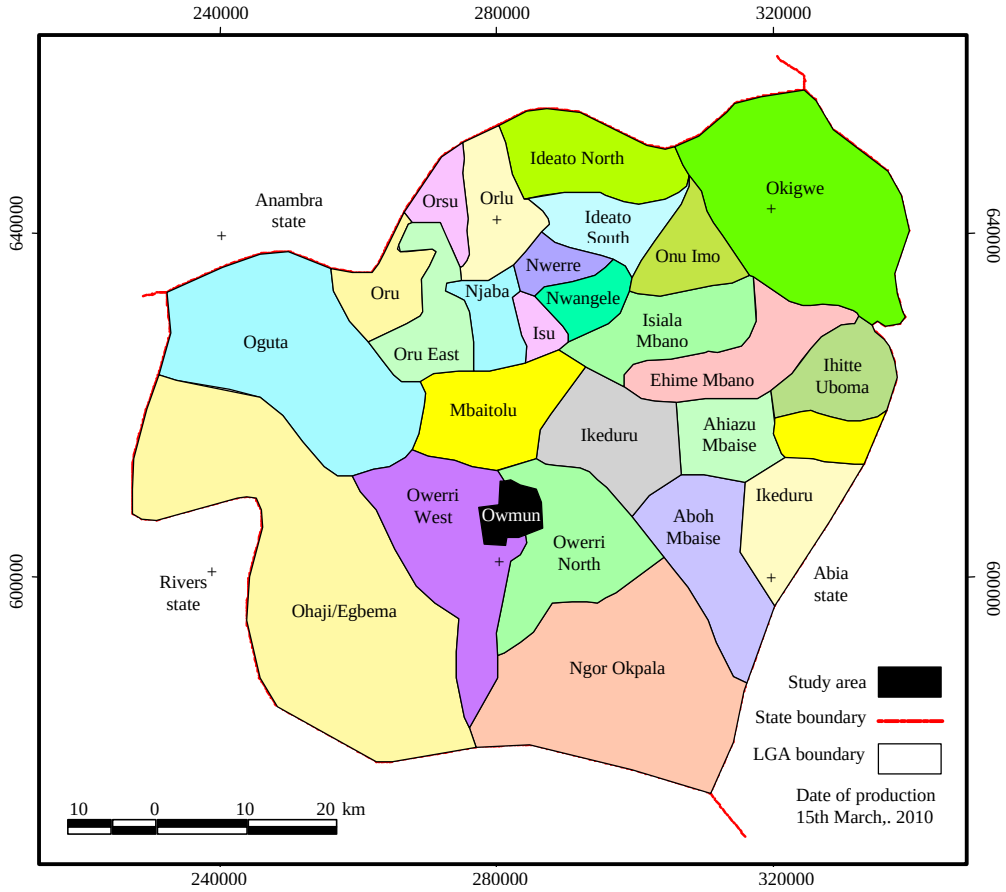

Fig. 1: Map of Imo state showing her local government areas; Owerri Capital Development Authority (OCDA), Owerri

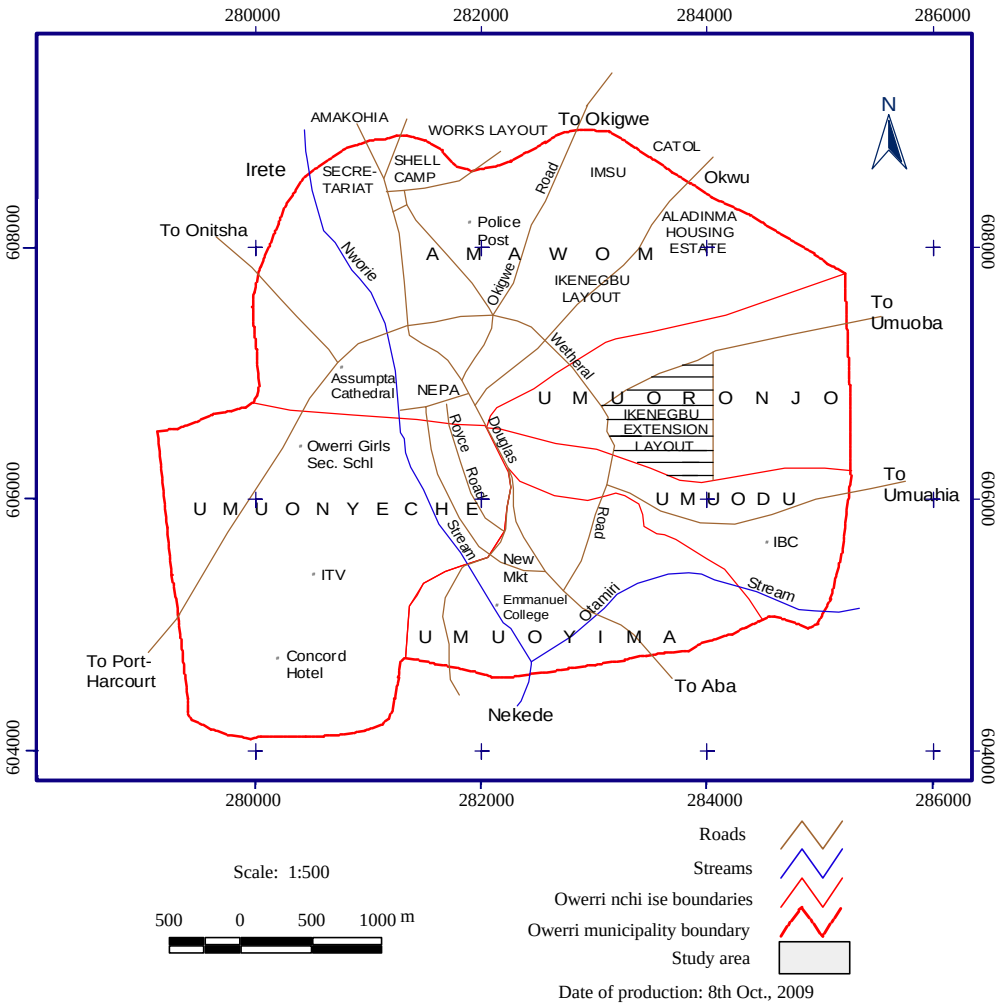

Fig. 2: Map of Owerri municipality showing Ikenegbu extension layout; Owerri Capital Development Authority (OCDA), Owerri

MATERIALS AND METHODS

The main data required are land related data such as maps, coordinate value, name and length of roads, status of land uses, etc. Data obtained also include the geographical coordinates of three points using the Garmin 76 as well as a ground thruthing field observation embarked upon to confirm the features on the maps of Owerri municipality land use map, satellite imagery of the study area. Data were also got from other maps and the internet.

Data conversion: The maps used in this project were in analogue format which were converted into digital format through the process of vectorization (scanning and digitizing). Geometric data were acquired through the use of Garmin 76 GPS, a handheld Global Positioning Systems (GPS) equipment which was used to collect the coordinate values of points in the study area. The coordinate points are as follows:

- First reference point (MCC Uratta/Wetheral Junction) N 05°29'10", E 07°02'23"
- Second reference point (Wetheral/Mbaise Road Roundabout) N 05°28'48", E 07° 02"24
- Third reference point (Chukwuma Nwoha/Egbu Road Junction) N 03°28'39", E 07°03'04"

Geo-referencing: This is the process of bringing the scanned map into its true earth (location) coordinate on the computer system using an acceptable referencing system. The Universal Traverse Mercator (UTM) with referencing to Minna datum was used. The geographical

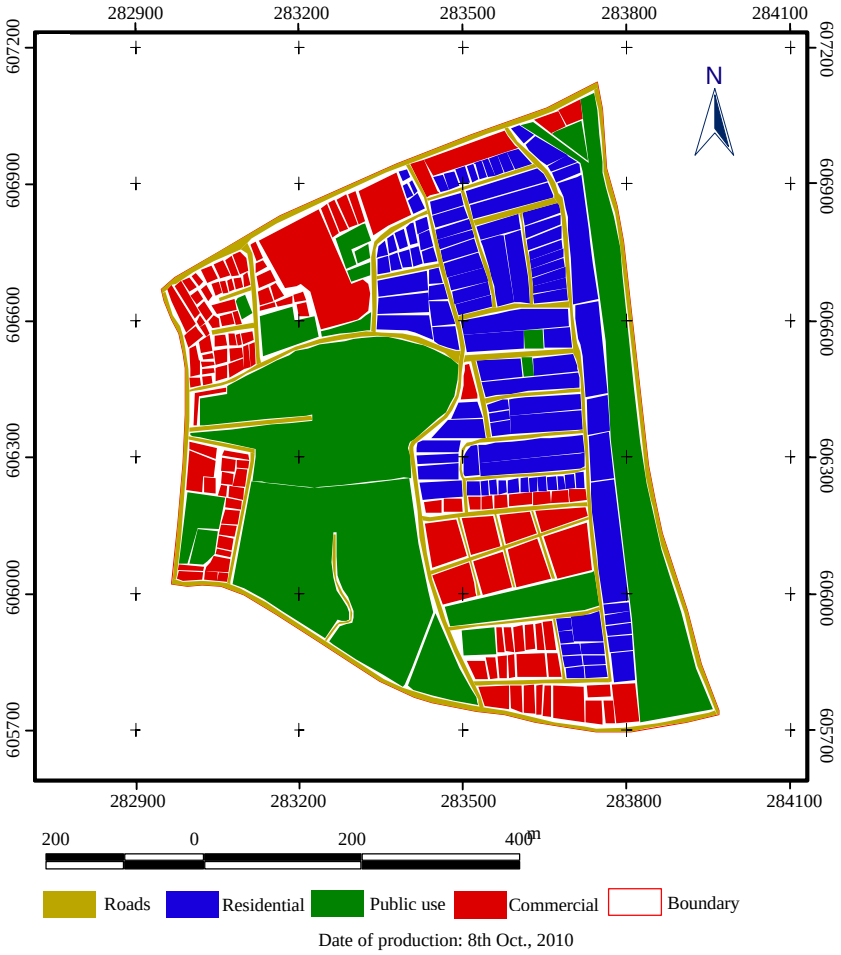

Fig. 3: Map of Ikenegbu extension layout; Researcher in 2010

co-ordinates were converted to rectangular (using the Geo-calc software) which is the acceptable referencing system for geo-referencing maps in the AutoCAD software.

Digitizing: The features on the map were digitized as points, lines and polygons and were classified into themes for proper identification, differentiation, thematic map creation and other analytical operations. The onscreen digitizing was done with the use of AutoCAD Land Development 2i where the map was digitized. The analogue map digitized in AutoCAD was exported to Arc View where area features were polygonized.

Criteria for selecting sutiable solid waste collection points: In selecting the collection points, the United Nations Standard criteria requirement was adopted as follows (Fig. 3):

- The collection point should be 10 m away from roads (for easy collection and to prevent road blockage)
- The collection point should be 70 m from water bodies e.g., rivers
- They should be 20 m away from public facilities such as hospitals, places of worship, stadium complex, open spaces for recreational purposes, etc.
- They should be 10 m away from commercial areas
- They should be 10 m away from residential areas (thus within the proximity of prospective users)
- A collection point must be 100 m away from another
- They must be along the roads

Spatial queries and results: Single criteria query was used to determine the possible areas for solid waste collection points for all the land uses including roads. This was done using the set criteria as stated. It was inputed into the query builder as follows; 10 m from roads (roads = 10 m) for easy collection and to prevent road blockage, 10 m from residential areas (Res>10 m) and 10 m from commercial areas as well (com>10 m) so, it will be within the proximity of users and 20 m from public use (public use >20 m) so, it would not constitute nuisance to

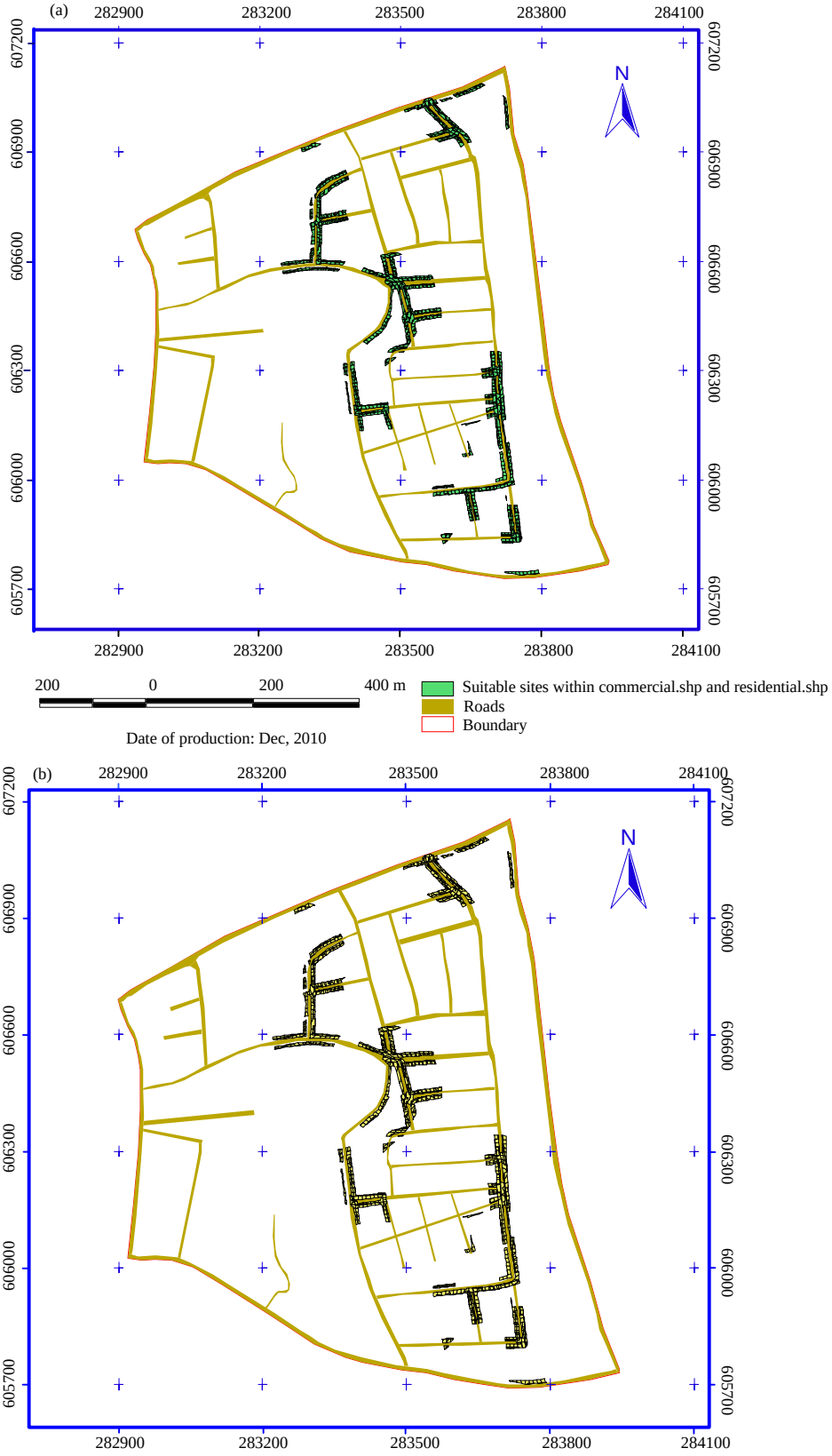

Fig. 4: a) Suitable sites within commercial land use; b) Suitable sites within residential land use; Researcher in 2010

people using public facilities. Multi criteria queries were used to determine the suitable sites as well as the most suitable sites for solid waste collection within the area. This query combines more than one entity in a particular land use to select the suitable sites within the area. The input of a multi-criteria query to determine the suitable site within commercial areas is stated thus residential distance > = 10 and public use distance > = 20 and road distance = 10 and land use = commercial. The result is a union of points or areas where the land uses meet/intersect with the set criteria in place within a particular land use type (Fig. 4a and b). According to the map sourced from Owerri Capital Development Authority, Ikenegbu extension layout is characterized mainly by commercial areas as well as residential areas. Thus, there is need to make more bins available to the area, especially the commercial areas. As a result, query was performed of suitable sites for commercial, residential and public uses. The search was inputted thus; Com = 10 and Res <>10 and Pub use<>20.

RESULTS AND DISCUSSION

The maps for commercial and residential areas were overlaid to have a combined suitable sites which again was queried to have the suitable sites, after which points that were within 100 m proximity were expunged using the measure tool on ArcView window thus (Fig. 5) giving the most suitable sites for locating solid waste collection facilities in Ikenegbu extension layout. The collection points in the most suitable sites were labeled A-M for identification of the points in relation to their coordinate values. The available portions specified by the system are the most suitable sites. Thus, the government can now use their discretion to place the bins (containers) at strategic points as specified. If the bins are properly placed at these points, Ikenegbu extension layout will be:

- A healthy environment for the inhabitants
- Void of health hazards associated with indiscriminate dumping of solid wastes
- Made a clean area in contrast to other cities of Nigeria and in line with the state governments' programme of ensuring a clean and green city
- Void of induced flooding caused by blocking of drainage as a result of indiscriminate dumping of solid wastes
- Made a model area in terms of efficient and effective solid waste management

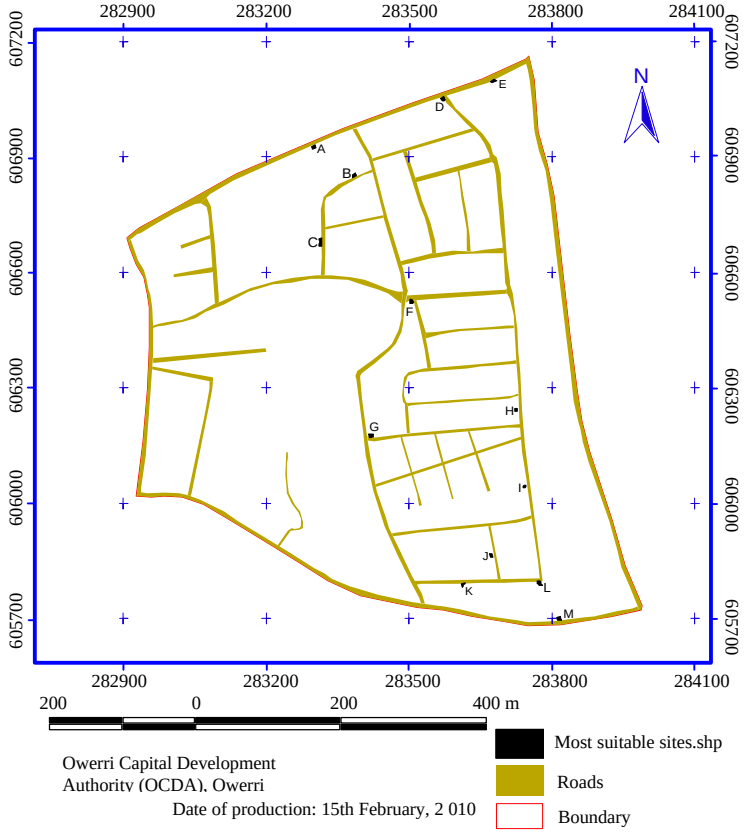

Fig. 5: Most suitable sites; Owerri Capital Development Authority (OCDA), Owerri

CONCLUSION

The use of GIS technology is a better way of decision making on complex issues related to man and his environment. In this study, GIS technology was applied for decision making in municipal solid waste management via the selection of possible and suitable points for solid waste collection.

This was done in line with the purpose and set criteria for selection of suitable sites for waste collection points. The geographic database was tested by defining and executing some criteria which gave a favourable result.

RECOMMENDATIONS

As a result of the findings of the study, the following recommendations are made for proper solid waste management:

- The study of GIS should be encouraged in higher Institutions and agencies. This will help in the production and updating of data and map
- Geographic Information System (GIS) should be employed as a tool in decision making in environmental management issues
- Digital land use maps should be used in waste collection. It gives a holistic view of the entire area at a glance and helps in planning and management of waste and earth related matters

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