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Implications of Geographic Information System in Mapping Solid Waste Collection Points in New Owerri, Imo State

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Abstract

The unsanitary condition in which solid waste is temporarily dumped and disposed of has generated environmental concern through pollutions and health hazards. This calls for a need to map out suitable collection points and disposal point for effective and efficient management of solid waste to promote hygienic environment. Therefore, GIS offers solution in this regard as a decision support system for most suitable site selection. Consequently, different layers (roads, stream and land use) were created to serve the purpose of manipulation and analyses to procure most suitable site for collection point of solid waste generated in New Owerri, Imo State using Arc view 3.2a software.

Introduction

The collection and disposal of solid waste is today a major public health issue and a vital factor affecting the quality of our Nigerian cities. It is one of the most intrinsic causes of environmental problems today found mainly in the deterioration of environmental parameters (air, land and water quality); which leads to destruction of the aesthetic beauty of the environment, traffic jam, flooding and environmental air pollution. The increase in the volume of solid waste being generated daily in most Nigerian cities especially in Owerri municipal is due to rapid population growth of migrant population, urbanization and general economic growth (NEST 1991). In many Nigerian cities, the volume of solid waste generated has overwhelmed the capacity of urban administrators to plan for its collection and disposal. Thus, in the case of Owerri Municipal, major solid waste generated is from residential and commercial activities. The volume has recently grown above planned limits, becoming a threat to the initial sufficient and effective collection and disposal of solid waste. The unimaginable rapid population growth together with the poor and unsustainable planning has given the municipality less significant

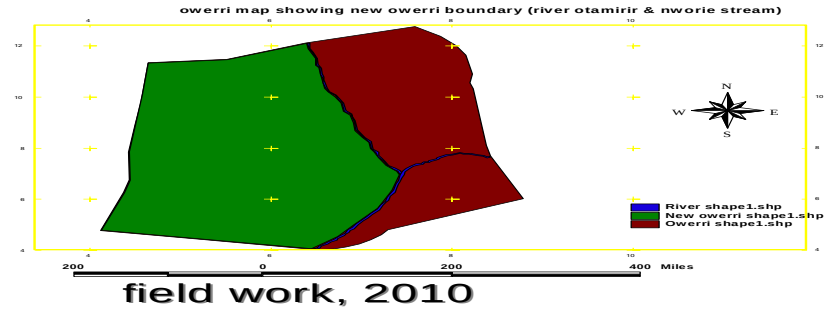
and no suitable solid waste collection point. Solid waste are disposed of indiscriminately; often on open spaces such as markets places, road sides "as in Aladimma" and area A of World Bank dump, in between dual major roads "as in Douglas Road dump", streets, river banks, gutters etc, and during heavy rain falls. This causes traffic jam, imposes threats to the health of man and his environment at large. However, the advent of Geographic Information System (GIS) in Nigeria has paved way for the analysis of points for the collection and disposal of solid waste after considering certain factors and criteria. GIS role in solid waste management is as large as its many aspects of planning and operation which is dependent on the spatial data.

Study area

The study area is New Owerri within Owerri Metropolis, Imo State. New Owerri by land mass covers over 55% of Owerri metropolis area. It is located on the south west part of Imo State. New Owerri is bound in the north by New Road, Irete, in the east by Old Owerri (along Nworie River), in the south by Nekede (along Otanmiri) area and in the west by Umuguma.

New Owerri comprises World Bank areas, Federal Low Cost Housing Estate area, Concord Hotel area, the new State Secretariat area, Federal Secretariat area, Nekede extension, zoo area, Umugwueze and Umuejechi Nekede area, New Industrial Layout and other layouts identified as Area A, B, C to Y and more.

Fig 1 Layout of map of Imo State showing Owerri area only



Research methodology

Data acquisition

The main data required for this project are land related data such as maps, coordinate values, names and length of roads, status of land uses, etc.

Data source

The data source for this research relied mainly on secondary data; they are the Owerri Street Guide map and the Owerri master plan collected from the State Ministry of Land and Survey, New Secretariat, Owerri. This contains the land use data at a scale of 1: 20,000, layout maps of New Owerri, the map of Imo State showing Owerri Municipal area and Owerri West area. Other secondary sources includes documented materials such as magazines, newspapers, libraries, written texts, related journals, maps and satellite imagery of the study area gotten from Google earth in the Internet.

Also, a form of primary data obtained include the geographical coordinates of three points using Google earth software, the name of the areas and streets, the length of roads as well as a ground thruthing field observation embarked upon to confirm the features on the maps. ;

Geometric data acquisition

Geometric data were acquired through the use of Google earth software from the Internet to supply the coordinate values of points in the study area (in geodetic format).

The coordinate points are as follows:-

(i) First reference point (Assumpta Cathedral Owerri),N 05^0 29' 18.97",E 07^0 01' 15.36"

(ii) Second reference point (Imo Concorde Hotel),N 05^0 28' 21.67",E 07^0 01' 10.69"

(iii) Third reference point (junction between NMT1 and WMT2 highway along Umuguma) N 05^0 28' 46.63",E 06^0 59' 51.85"

Spatial analysis, discussion and result presentation criteria for selecting sutiable solid waste collection points

In the selection of solid waste collection points, the following selection criteria set based on the United Nations Standard Criteria Requirements were adopted. They are:

- the collection point should be 10m away from roads (for easy collection and to prevent road blockage),
- the collection point should not be less than 70m away from water bodies e.g. rivers, they should be 40m away from public use areas,
- they should be 20m away from commercial areas, they should be 20m away from residential areas (thus within the proximity of prospective users),
- a collection point must be at least 100m away from one another, the population density must determine the number of collection points within each layout, it must be along the road/street junctions **(** Nathawat, M. S. and Shrivastava U. 2001**)**

Cartographic modelling

GIS analysis used in this project includes buffering, overlay operations (unioning), clipping and spatial queries. These operations were carried out to analyze all the established criteria necessary for the location of solid waste collection points.

(i) Buffering of roads, rivers, residential, commercial and public use land uses (buffer of 100m at an interval of 10m).

(ii) Union of buffered results

(iii) Clipping of unioned results with boundary

Buffering operation

The operation performed by the buffer command generates one or more polygons “BUFFER ZONE” surrounding geographic features. In this study, buffering operation of 100m at an interval of 10m was carried out on all the entities.

Overlay operations

This is a GIS analytical tool used to merge two themes representing different data sets to generate a new set of information.

For this project, the following overlay operations were performed;

(i) First overlay: The buffered residential land use theme was overlaid (unioned) with the buffered public use, land use theme to have another output theme called union of residential and public use land uses.

(ii) Second overlay: The buffered commercial theme was overlaid with the union of residential and public use theme to produce a new output theme called; union of commercial, public use and residential land uses.

(iii) Third overlay: The buffered road theme was overlaid (unioned) with the buffered river theme to have another output theme called union of road and river.

(iv) Fourth overlay: The unioned road and river were overlaid with the union of commercial, public use and residential land uses, to produce a new output theme called; the final union made up of the union of commercial, public use, residential, river and roads theme.

Single criteria query

Single criteria query was used to determine the possible areas for solid waste collection points for all the land uses including roads. This didn't produce the final result but gave an insight to the possible areas where the collection containers can be placed. This was done using the set criteria as stated in 4.2. It was inputted into the query builder as follows; 10m from roads (Roads=10m) for easy collection and to prevent road blockage, 20m from residential areas (Res=20m) and 20m from commercial areas as well (com=20m) so it will be within the proximity of users and 40m from public use (public use =40m) so it would not constitute nuisance to people using public facilities.

Multi criteria queries

Multi criteria queries were used to determine the suitable sites as well as the most suitable sites for solid waste collection within New Owerri area. This query combines more than one entity in a particular land uses to select the suitable sites within the land thereof. Three multiple criteria queries were carried out in this project.

(i) First; the identification of most suitable points within residential and commercial area at 20m interval respectively

(ii) Second; the identification of suitable points on areas within residential and public land use at 20m and 40m interval respectively.

(iii) Third; the identification of the most suitable points on areas with commercial and public land use at 20m and 40 interval respectively

The result of these queries showed sites that are suitable for users at the same time in the two land uses. 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.

Figure 2: Union of suitable sites

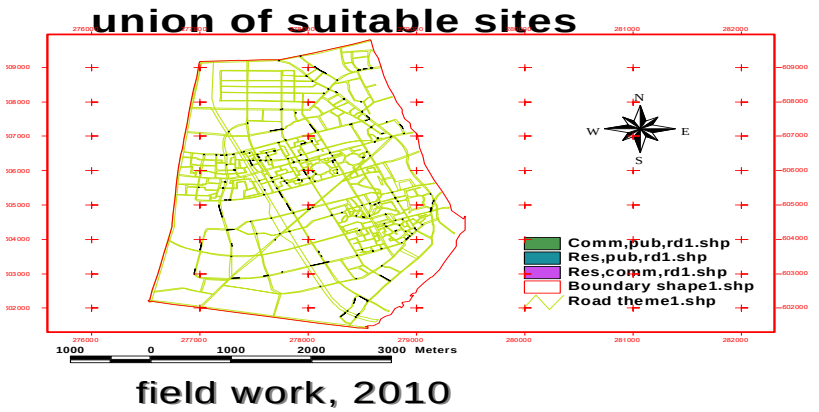
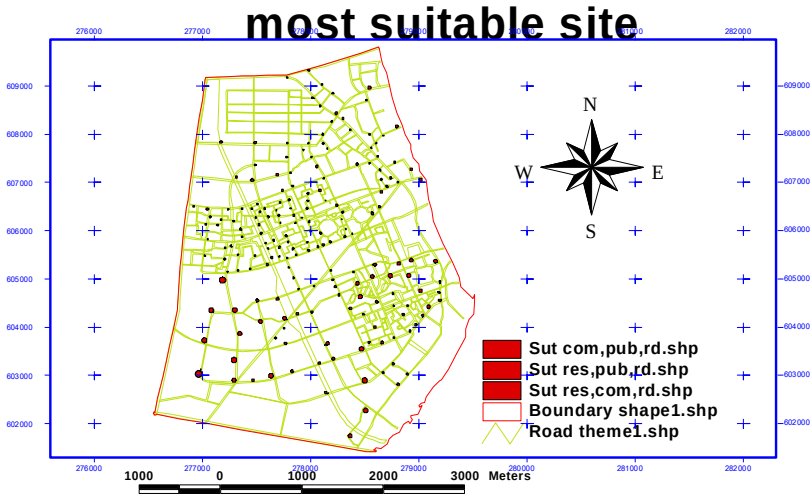


Figure 3: Layout of most suitable site



Discussion of result

The polygon clipping operation were queried multiply to have a combined suitable sites (fig. 2), which again were overlaid to have the a final suitable sites (fig 3), after which points that were within 100m proximity were expunged using the measure tool on Arcview window, thus giving the most suitable sites for locating solid waste collection points in New Owerri.

The collection points were identified as points in relation to their coordinate values and layout. The following coordinate values represent the locations specified by the Geographic Information Systems as well as the attributes of the points. Thus, in all the sited collection points, the distances to similar land use type are the same as stated in the criteria with respective distances of; road=10m, commercial land use=20m, public land use=40m, river >70m and residential land use=20m.

Industrial Layout-This has nine collection points with the coordinate values

Amakaohia Pocket Layout-This has five collection points with the coordinate values

Arugo Layout-This has four collection points with the coordinate values

Umujechi Nekede Village Layout/New Owerri South-This has four collection points with respective coordinate values

Umugwule Nekede Village/New Owerri South-This has only one collection point of 279965.00E & 602888.18N.

Umumbazu Nekede Village/New Owerri South-This has two collection points with the coordinates

Public Building/New Owerri South-This has only one collection point with coordinate values of 279189.26E&602670N.

Conclusion

The use of GIS technology is a better way of decision making on complex issues related to the earth (land suitability) and the people living therein, such as agriculture, forestry, health, resource management, land administration, water resource planning, location analysis, etc. 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 the selection of suitable sites for waste collection points. The geographic database was tested by defining and executing some criteria which yeilded results. Thus, this has shown the capabilities of GIS as a system to solve spatial problems and provide information to aid decision making.

Recommendations

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

- Decision makers and stakeholders in the management of solid waste should adopt Geographic Information System (GIS) as a tool in decision making in their everyday operations.
- Digital land use maps should be introduced in the aspect of waste collection, since it is an important tool for the planning and

management of waste in given geographical entities. It helps in having a holistic view of the entire area at a glance.

- GIS laboratories should be introduced in higher institutions and government agencies. This would enable the production and updating of spatial data such as maps.
- GIS projects should be funded by the government, private agencies and other organizations. This would enhance human development and growth especially in our developing economy.
- Large scaled projects should be carried out in phases for efficient and effective actualization of good result and high visibility.

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