

Identification of Suitable Site for Solid Waste Disposal in Yola, Nigeria Using GIS Method.

Isa Muhammad ZUMO and Saidu Ahmad VOKNA, Nigeria.

Key words: waste, disposal, site, analysis.

SUMMARY

The data used in this research are topographical map, remotely sensed imagery and soil map covering the study area. Ground control points were acquired using the Global Positioning System (GPS) for georeferencing the maps and the imagery with respect to universal coordinate system (UTM) on WGS 1984 reference ellipsoid, zone 33 north. Five themes were created; they are buildings, roads, river, soil type and elevation model. Roads, rivers and built-up area were digitized from the image as a detail map. The elevation model was obtained from the contour lines in the topographical map. Soil type was obtained from the acquired soil map. The criteria adopted were based on physical nature of Yola and its socio economic level of people in that area. Multi Criteria Analysis (MCA) was adopted in buffering of roads, river, and city centre. Slope layer was created from the elevation model that was obtained from contours in the topographical map; soil selection was from soil map. These themes were reclassified and overlaid using the analyst tool in the ArcGIS environment. The buffered streams, roads, soil; built-up area and city centre was over laid. The result of this overlay gives a suitable site for solid waste disposal. The suitable sites were shown in red, The site within Kofare is the most suitable area. It has an area of 15.22hectares. The other moderately suitable site is on the southern part of Wuro Jabbe. It has an area of 5.21hectares.

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1.0 INTRODUCTION

The disposal of solid waste material includes materials from human and animal activities which are not useful to human life and can sometimes be dangerous. Solid waste includes Industrial Waste, Agricultural Waste, Sewage Treatment Materials, Garbage's, Rubbish, Ashes, Dead Animals e.t.c. (Majibar, 2008).

Waste disposal sites must be designed and managed in such a way that no harmful substances reach the biosphere and hydrosphere in unacceptable quantities in accordance with appropriate national regulations (Polys M 2007). The design concept for a disposal site also depends on the structure and behaviour of the subsoil.

Waste disposal can be done either as it is or after sustaining some processing by using thermal or physical means of processing method (Nishant, 2010). However, as a result of low level of technology, low income, high level of illiteracy in developing countries, open dumps is in preponderance. The processing method is thermal, when open dumps are set on fire not minding the pollutions effect on the air and the environment. This is peculiar with dry season period; in the raining season the solid wastes are dumped indiscriminately causing major environmental issues posing threats to the existence of human being.

Solid waste deposited on the main roads, gutters, streams and backyard of settlements results in floods, spread of different type of diseases (like jaundice, asthma, nauseas,) fire hazards, odour nuisance, atmosphere and water pollution, earthly nuisance and economic losses.

Solid waste disposal site is a dilemma faced by all the urban centres in Nigeria The increase in the volume and types of solid waste generated on daily basis in most cities is alarming. This arises from the increase in population and rapid urban growth resulting in solid wastes accumulation from human activities. This at the end leads to urban degradation.

Putting all this myriad problems into consideration, this paper is aimed at identifying the best site for solid waste disposal in Yola, Nigeria. The objective will be summarized thus:

- i. Acquisition of data of remotely sensed images and topographical map sheet covering Yola; as well as ground control points using ground survey method.
- ii. Multi-Criteria Analysis (MCA) of the acquired data with the view of obtaining the most suitable site for solid waste disposal in Yola.

GIS approach was used for the analysis of the acquired data with the view of obtaining the best site for the waste disposal. Geographic Information System (GIS) is a Computerised Information System for capturing, storing integrating, manipulating, analysing, checking and displaying data which are spatially referred to the earth. Nduwke K.N (2003). GIS handles both positional and attributes data as in maps and plans. Also Smart, N. U. (1998) simply defined GIS as "the management analysis and manipulation of spatially referenced information is a problem solving synthesis.

Mohammed A. S. (2004), uses spatial multiple criteria evaluation (SMCE) concepts and methods to support identification and selection of proper sites for waste disposal. The process makes use of a recently developed SMCE module, integrated into ITC's ILWIS software.

Nishanth, (2010) also determined a suitable site for urban solid waste disposal using GIS and remote sensing in Koltayan municipality, India. The multi criteria evaluation analysis method is used. The principal criteria that are used for spatial analysis are lithology, geomorphology, slope, drainage, population, distance from major roads, distance from major streams and distance from drainage. The criteria's are used in developing GIS database. The GIS software used for analysis is Arcgis 8.3. The database map is created and other thematic maps also created and weightage allocated to them based on the key parameters. Each theme is weighted. Various coverage's in these themes were assigned a suitability score and converted into a raster format using spatial analyst in the Arc map for the analysis. All the raster data sets for different layers were overlaid and the scores each composite class determined using raster calculator tool of spatial analyst extensive of Arc map. The final suitability classes are:-

- Highly suitable
- Moderately suitable
- Less suitable

Suleiman, I.A (2006) also in his work application of GIS system in site selection for solid waste disposal in Bauchi Metropolis uses the multi-criteria evaluation analysis using Integrated Land and Water Information System (ILWIS) software. The criteria he identified are mostly environmental factors and it was on this basis the most suitable site for waste disposal was determined in Bauchi.

As has been shown by the various authors reviewed a synthetic approach to site selection is provided by the techniques of multi-criteria evaluation (MCE) and these techniques can be incorporate with GIS. The purpose of MCE is to help decision makers to distinguish between several possible options where the preference for each of the options may depend upon several factors each of which might be regarded as having different members of the community. The approach does at least enable the decision makers to take account of different levels of perceived importance for different factors. As mentioned earlier overlaying of thematic layers in a GIS in order to identify regions that combine selected attributes from each of the layers is dated as back as 1969, it was the earliest types of analytical facility provided by GIS packages. So when working with a layer based GIS, the method entails creating a set of layers each of which represents one of the constraints on the solution to the problems. The selected layers may consist of regions of land. The layers are then super imposed to identify regions of space that satisfy all constraints.

The reviewed literature has shown that the practice of satisfactorily mapping using GIS is fast spreading not only in the developed countries but also in developing countries like Nigeria. Its use in Adamawa State is only Limited to the academia and recently in ministry of land and survey. It is for this reason that this paper intends to bridge the gap between theory and practice, by demonstrating how it can be used for Urban Planning and Management by identifying the most suitable site for solid waste disposal.

2.0 METHODOLOGY:

Overview:

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The method adopted in this paper involved the acquisition of data, data preparation and Multi-Criteria Analysis (MCA) of the prepared data with the aim of obtaining the most suitable site for solid waste disposal site in Yola. The feature data classes created in Arc Catalogue were carefully selected and digitized from the georeferenced image of the area concern. Elevation model of the area was generated by digitizing contour lines from the georeferenced topographical map. Using MCA in Arc GIS environment, the most suitable site for solid waste disposal was obtained.

Data / Equipments needed

Data used for this study include downloaded Google earth image of the study area (figure 1), Ground Control Points (GCP) as shown in table 1.0 and Topographical map sheets No. 196 N.E. showing Numan NE, 196 S.E showing Numan NS, 198N.W showing Girei NW and 198 SW showing Girei SW at scale of 1:50,000. Equipments used include Personal computer with Arc GIS 9.2 software and Ashtech Handheld Global Positioning System (GPS).

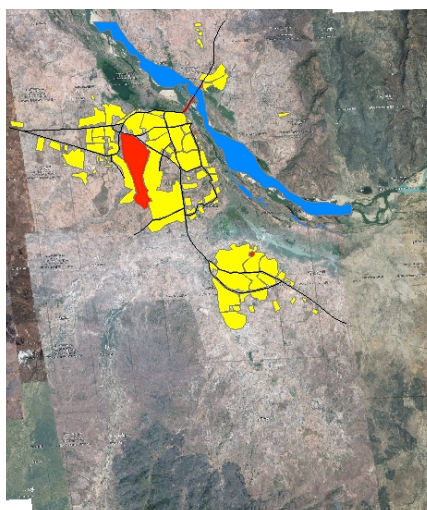


Figure 1: Satellite image of Yola

Data preparation:

Two types of data were used in this project. Graphics inform of maps and their related attributes inform of tables. Both data were created in Arc GIS environment. Creation of feature classes was done using Arc catalog software. New Personal Geodatabase was created and given a name Yola. From Personal Geodatabase, a feature dataset was created named Zumo. Projected coordinate system was selected as UTM WGS 1984 Zone 33N. Vertical controls system was Africa, Lagos 1955. From the feature datasets, feature data classes were created as contour, built-up area, soil, roads and river. For each of these data classes, the type of feature stored was selected e.g. line for road, contour and river, polygon for built-up area and soil.

Topographical map, soil map and the image acquired were registered before digitizing the themes in layers. Rectangular coordinate of the acquired GPS points was

used for the georeferencing. Table 1.0 shows the acquired ground control points. Root Mean Square of 0.268 was attained for the georeferencing of both the image and the topographical map as shown in figure 2.0

Table 1.0: Ground control points.

S/N	EASTINGS	NORTHINGS	DESCRIPTION
1	220576	1023171	Bajabure junction
2	220325	1022811	Mubi round about
3	219967	1022647	Airport junction
4	220428	1022314	Karewa junction
5	220925	1021919	Fufure junction
6	221433	1021580	Rumde Doma junction
7	219477	1023382	Damare Primary School

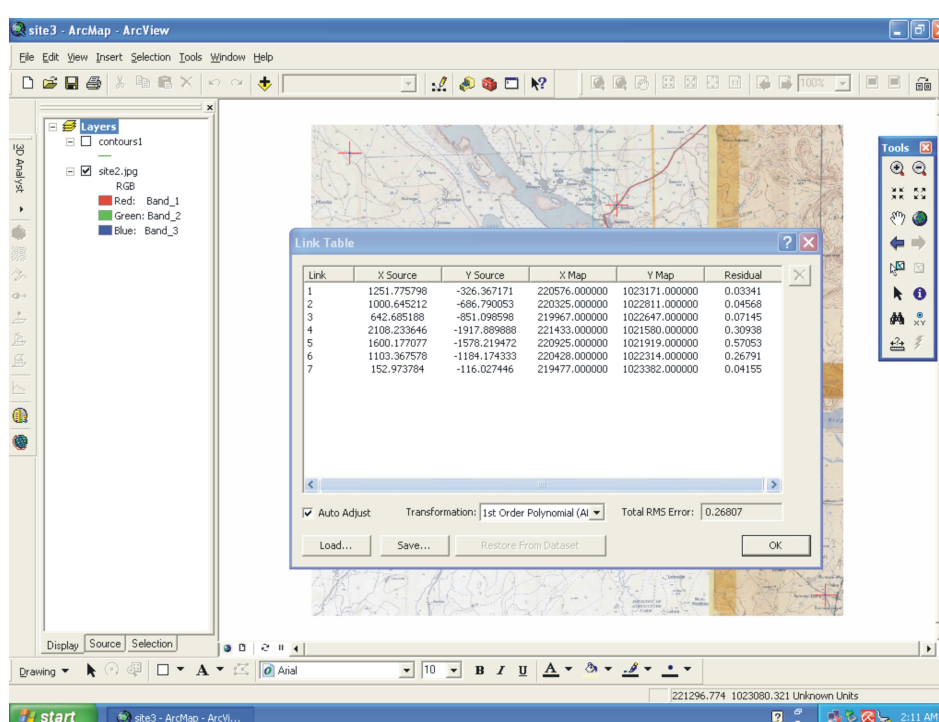
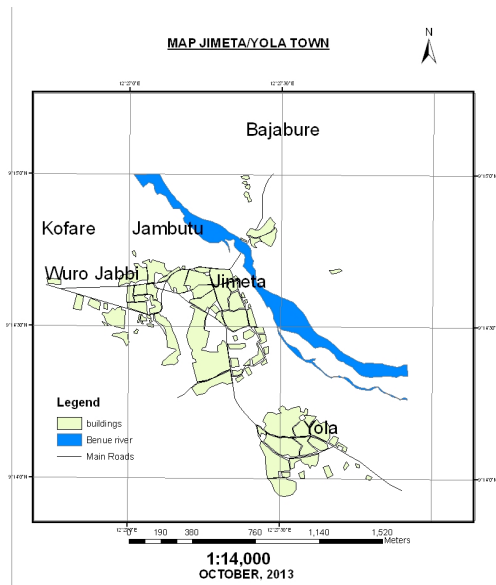
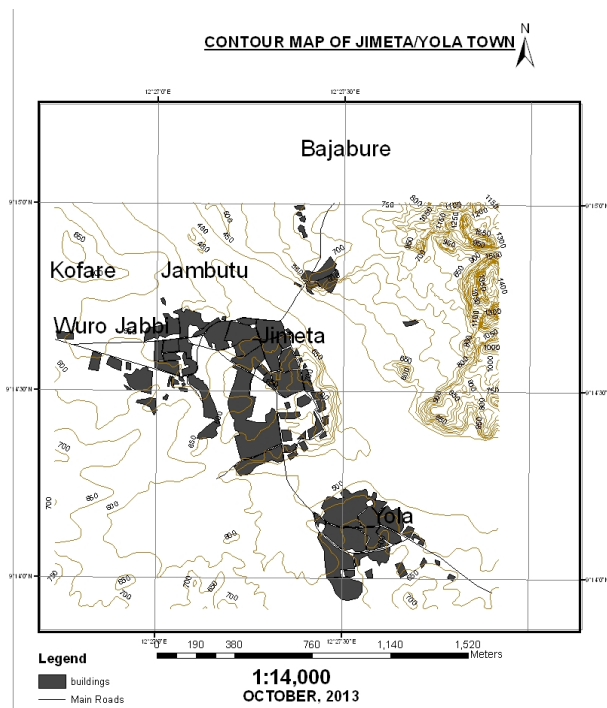


Figure 2.0: Georeferenced topographical map of the study area.

The themes created earlier (i.e roads, rivers and built-up area) were digitized from the downloaded image as a detail map. See figure 3.0.

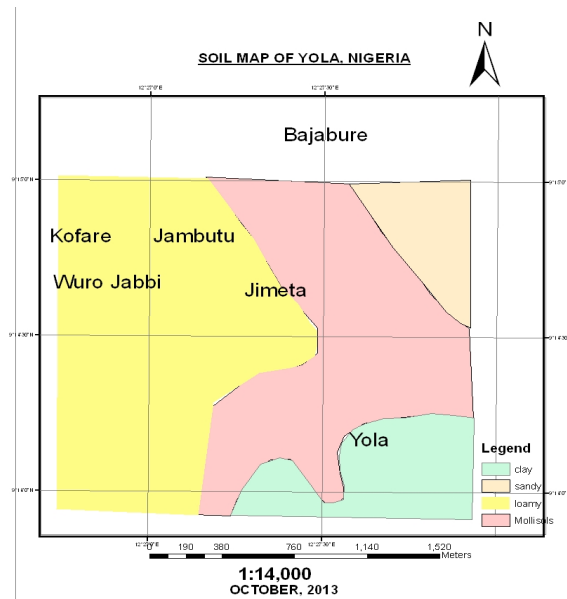


See figure 3.0: Detail map of the study area.
The elevation model was obtained from the contour lines in the topographical map.
See figure 4.0



See figure 4.0: Elevation model of the study area.

Soil type was obtained from the acquired soil map. See figure 5.0



See figure 5.0: Soil map of the study area.

3.0 Analysis and Results

The criteria adopted are based on physical nature of Yola and its socio economic level of people in that area. Soil type was obtained from the acquired soil map. The details about these criteria are:-

- The waste disposal site should be site on a good soil; loamy soil will be preferable because deposits will easily be decomposed into soil. Unlike sandy or clay soil.
- The waste disposal site should be located on a terrain with slope less than 20 degrees.
- The waste disposal site should be located not less than 10km from the city centre. This is considered neither too far nor too close to the selected area.
- The waste disposal site located in an area ranging from 5-10 hectares in size. Sites with limited area will not be encouraging since one will soon be faced with the troubles of selecting some other sites.
- The waste disposal site should not be less than 500 metres from any major road. This will reduce time, energy and material resources for transportation by making a reasonable distance from major road. Also deposits on roads will be avoided.
- The waste disposal site must not be within 300 metres from any river. This is because a site that is close to river will lead to water pollution.
- The disposal site should not be located near fast growing urban centre with high population or within a designed government approved layout.

Multi Criteria Analysis (MCA) was adopted in buffering (of roads, river, and city centre); slope layer was created from the contours, soil selection from soil map. These themes were reclassified and overlaid using the analyst tool in the ArcGIS environment.

The buffered streams, roads, soil; built-up area and city centre was over laid. The result of this overlay will give a suitable site for solid waste disposal. This is presented in figure 6.0.

The suitable sites were shown in red, see figure 7.0. The site within Kofare is the most suitable area. It has an area of 15.22 hectares. The other moderately suitable site is on the southern part of Wuro Jabbe. It has an area of 5.21 hectares.

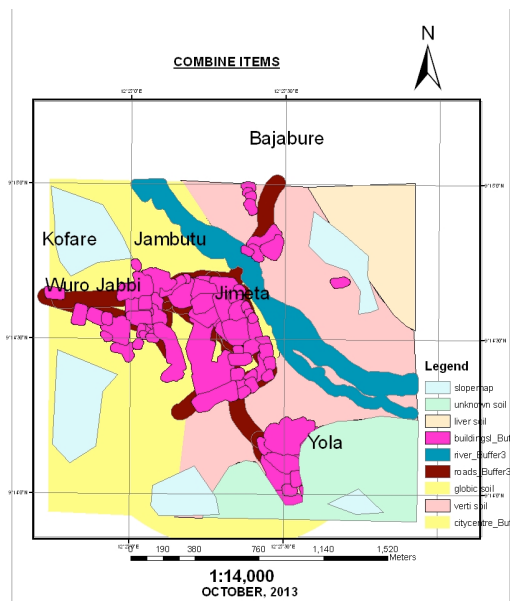


Figure 6.0: Analysed themes of the study area.

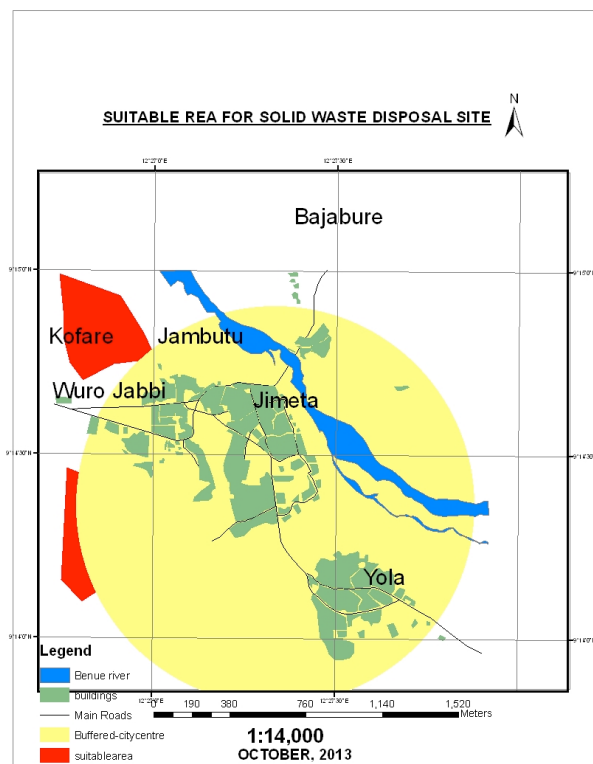


Figure 7.0. Suitable site for waste disposal in Yola, Nigeria, (in red).

4.0 Conclusion.

In this paper, Geographical information system (GIS) method was used to obtain the most suitable site for solid waste disposal in Yola, Nigeria. MCA was performed on the acquired data, and from the result, the site within Kofare is the most suitable site for the waste disposal.

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BIOGRAPHY

Surv. Isa Muhammad Zumo is a member of Nigerian Institution of Surveyors (NIS) and currently a lecturer in the department of Surveying and Geoinformatics, Federal Polytechnic, Damaturu. Nigeria.

Saidu Ahmad Vokna is a member of Nigerian Institution of Surveyors (NIS) and currently a Director in Ministry of Land and Survey, Adamawa state, Nigeria.

CONTACT

Isa, Muhammad Zumo

Department of Surveying and Geoinformatics, Federal Polytechnic, P.M.B. 1006, Damaturu, Yobe State, Nigeria.

Tel. +2348066011217

Email: isamzumo@gmail.com