View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by International Institute for Science, Technology and Education (IISTE): E-Journals

Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.5, No.17, 2015
www.iiste.org

Mapping and Identification of Suitable Dumping Sites for Solid Waste Management in Gwagwalada Area Council of the F.C.T. Nigeria

Muhammed M. Oyebode T.S Bello A. H Bako M. M.
Department of Geography, Federal University of Technology Minna, Nigeria

Abstract
Urban solid waste is one of the major threats to global environment in the world today. As global civilization keeps improving, there is increase in commercial, residential and infrastructural development due to the population growth which has a negative impact on the environment if not properly planned, monitored and maintained. One of the negative impacts is the problem of waste disposal which if not properly managed could lead to environmental problems and to avoid the negative repercussion of improper waste disposal, an area has to be put in place for solid waste disposal and management also referred to as dump site. Geographical Information System and Remote sensing Techniques were used in the process of site selection which is accurate, less expensive and less time consuming compared to the conventional method. The aim of this study was to identify a suitable sites for solid waste disposal in Gwagwalada town of the Federal Capital Territory (F.C.T), Abuja. An image of the study area was digitized to identify the different features on the ground and also the Digital Terrain Model (DTM) to show differencse in surface elevation. The Digital terrain model shows that the lowest elevation point is 176m while the highest point is 226m above the sea level. Three Data analysis types were used and this includes Buffering, Overlay and Query. The analysis was carried to ascertain that the proposed dump sites pose no threat to agriculture, life and property. The result of all analysis carried out shows that the location of the proposed dump sites is 184m in elevation and 1km off the exit route of Gwagwalada along the Gwagwalada-katse road. It is highly recommended that urban settings should have an open space for dump site on remote areas of little or no economic importance far from the residents and should be monitored properly. Concerned Environmental Maintenance Authorities can now used the knowledge of GIS and Remote Sensing Application in monitoring the environment and improve management.
Keywords: Solid Waste, Management, Dump Site, Mapping, Urban

Background

The growth in urban solid waste generation over the world is a consequence of urbanization, industrialization, and population growth, together with improved living standards has been widely reported. The Urban solid waste has also been recognized as one of the major problems confronting government and city planners in the world at large. This is defined as any solid material that is discarded by its owner, user or producer and also a left over arising from animal, plant and human activities that are normally discarded as useless and not having consumer value to the person abandoning them (Oyedele, 2009).

The growth in population, urbanization, industrialization and waste generation in the developing countries calls for proper solid waste management as it has become a necessity for environmental conservation and sustainability. For a sustainable solid waste management system techniques and policies such as waste recycling, re-use, waste reduction, thermal treatment, landfill sites e.t.c, must be put in place.

Urban solid waste management (USWM) is an "important entry point integrated urban management. It refer to the collection, transfer, treatment, recycling and disposal of solid waste in urban centres , More specifically, it refer to that part of the waste stream that is collected by, or on behalf of local authorities. The primary objective of waste management is to give adequate protection to the environment and general public from harmful effects of waste.

Landfill is usually the final function element of a solid waste management system. It has taken the bottom of the hierarchy of all option of waste disposal. Along with other waste disposal option such as recycling, incineration and composting, landfill is the most preferred option because of its easy mode of operation, low cost, less technological involvement and comfort of implementation. The successful siting of a sanitary landfill requires overcoming significant environmental and political obstacles. It depends on convincing decision-makers and the public that a sanitary landfill is needed and the site is the most suitable of the options available (or at least among the best).

However, despite the fact that solid waste landfills pose serious threat to the environment, the final destination of urban solid wastes in most of the countries in the world is dominated by land filling (Williams, 1998). A sanitary landfill site selection involves evaluation of various criteria using national or local land-use guidelines, environmental regulations, location restrictions, and so on. Social, environmental and technical criteria should be considered for potential landfill site selection.

Environmental hazards of varying magnitude dangerously threaten human and animal lives in most urban centers in Nigeria of which Gwagwalada is not an exception. Gwagwalada, the study area revealed, rapid urbanization, rural-urban migration, little or no town planning efforts coupled with attitudinal irresponsibility, lack of political will, ineptitude and graft have independently and collectively created environmental challenge in Nigeria. With human/solid waste decorating street corners and public space everywhere in Nigeria, the study teased out the institutional measures taken to confront waste management in Nigeria. Can Nigeria cope with the consequences of the avalanche of solid waste its citizens produce daily? What values of cleanliness abound amongst the people and why do we have solid waste all around? By adopting the sociological approach, the study answered these and many other questions using archival and survey research methods. As the study found, solid waste management has overwhelmed Nigerian government.

Study Area

Gwagwalada is one the five local government area council of the federal capital territory (FCT) of Nigeria together with Abaji, Kuje, Bwari andkwali which has the city of Abuja. It has an area of 1,043km and a population of 157,77 during the 2006 population census. It is located between latitude $8^0$55' and $9^0$00' North and longitude $7^0$00' and $7^0$05'E with elevation of 610ft.

The average annual temperature of the area ranges from 30- 37^{0}C, with highest temperature experienced in the month of March and with total average rainfall of approximately 1, 650mm per annum.

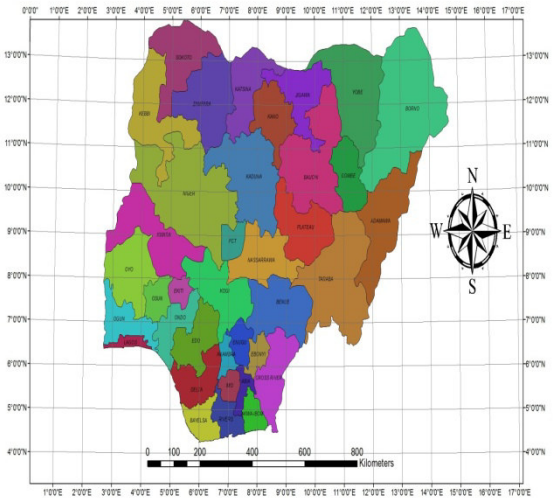

Figure 1:Administrative Map of Nigeria

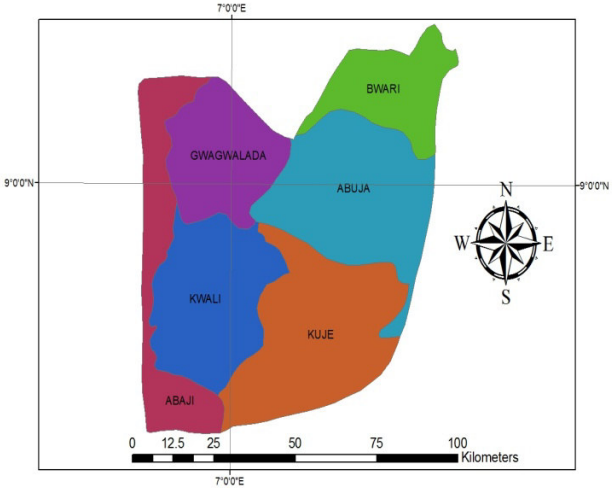

Figure 2:Map of the Federal Capital Territory

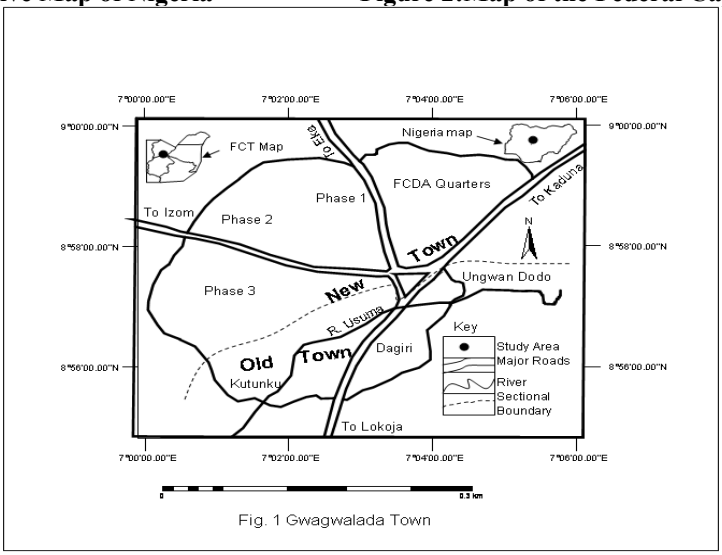

Figure 3: Gwagwalada Town

Data and Methods

The data used for this study originates from various sources. These are primary and secondary data, the

secondary data were gotten from ministry of land and housing, Abuja. An Ikonos satellite imagery of 2012 covering the study area of Gwagwalada metropolis was also downloaded from Global Land Cover Facility from the internet. A field survey was undertaken in order to ascertain the real names of features on the map in the field of the digitized copy.

GPS instrument were used to obtain point at different location in the study area so as to determine the variation of land height or elevation. The data also contain the geographical co-ordinates and elevations of each location in the study area. The map of study area, satellite image and soft copy of topographic map which were all properly georeferenced.

Table 1 Type and source of data

DATA	YEAR	SOURCE
Topography	1981	MINISTRY OF LAND AND HOUSING
Map of study area	2012	GEOGRAPHY DEPARTMENT, FUTMINNA
Image of study area	2012	GOOGLE EARTH

3.2 Digital Terrain Model (DTM) of the area.

The Digital Terrain models are data files that contain the elevation of terrain over a specified area or 3-D representation of a terrain surface created from terrain elevation data. The DTM of the study area was carried out in order to get the numerous spot heights or ground contour lines data of different location in the study area. The contour lines which were acquired through the use of GPS (i.e ground positioning system) in the cause of field work. It was then integrated into the topography map in a GIS (geographic information system) environment using the arc-view 10.0 software. On the opened arcmap window, the Google Earth Satellite Image was imported and Geo-referenced with the co-ordinates gotten from the use of GPS. The shape files of various features such as roads, rivers, settlement were created e.t.c. In the process of digitizing the satellite imagery a set of array data was generated which contains the co-ordinates and elevation of each features on the said image of the study area and the set of data was imported into the surfer 9 software which was used to generate the Digital Terrain Model as well as the contour map. This was done to achieve the suitable site for the proposed solid waste dump site.

3.3 Data Processing

The Google satellite image of 2012 was processed using Arcmap 10.0. During this process two steps were taken, the first step was imported into the Arc-map environment. The image was subset from the floating scene in order to emphasize the study area which later displayed as false-color composites Band as follows: Band 1, which represents Blue, band 2 for Green, and Band 3 for Red. This was enhanced using spectral reflectance characteristics in creating masks of known built-up areas and water body. Road network was also manually digitized using visual interpretations.

Buffering which is a spatial analysis known as proximity analysis, generating zones of a given distance around a Feature theme. It forms a polygon around a point, line or polygon theme by locating its boundaries at a specified distance. The built up areas, rivers, and main road in the study area were buffered at a radius of 1km respectively in order to come up with the most suitable dumping site.

Overlay

Map Overlay (an operation which is done by merging maps of the same location with different surface information about the location) was performed to identify areas that meet all set of criteria and to show areas that does meet the criteria. It helps in understanding the relationships between network analysis and specific geographic features in the study area metropolis map and other data (river, roads, settlements and Elevation map) were overlaid to derive possible sites that are suitable for dumping of solid waste.

Query

This commands is used to answer the question of 'what is and where is' in GIS. The land use was queried to get the open space while the elevation was queried to get suitable elevation. The land use map was queried because site location must fall outside the land use area so as to prevent resident from being infected with the stench from the waste.

In selecting a suitable site, the available facilities and resources around the proposed site were buffered, resources like the roads, built-up areas to ensure that the site do not have any negative effect on the residence (Javaheri *et al* 2006).

Satellite view of the study area

This section presents the satellite imagery showing the study area. The image shows the road network, rivers, built-up areas. It was snapped from the satellite imagery provided by the Google earth satellite imagery data base.

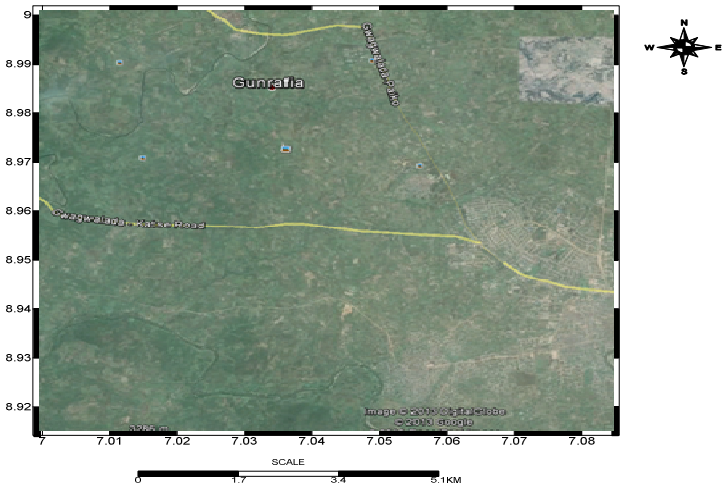

Figure 4: Satellite view of the study area (Ikonos, 2012)

RESULTS AND DISCUSSION

Digitized image of the study area

Figure 5 presents the digitized image of the study area which identifies the main features and resources. The digitized image shows the contour lines, built-up area, major roads, minor roads and the water body that are present in the study area. This image serves as guide for buffering analysis.

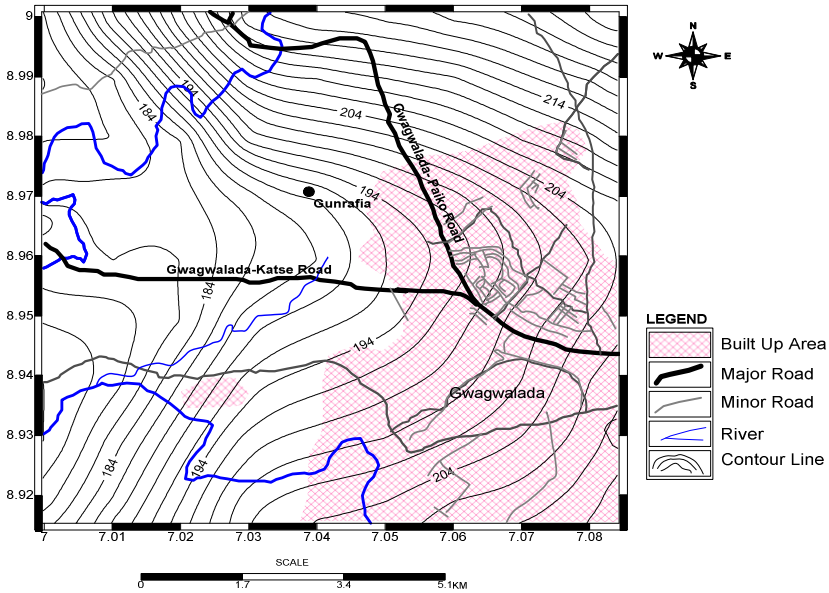

Figure 5: Digitized image of the Study Area

4.3: Digital Terrain Model (DTM)

The Digital Terrain Model of the study area was obtained so as to show the variation in the elevation or height which is one of the key factors considered when siting a municipal solid waste dump siteas presented in figure 6.

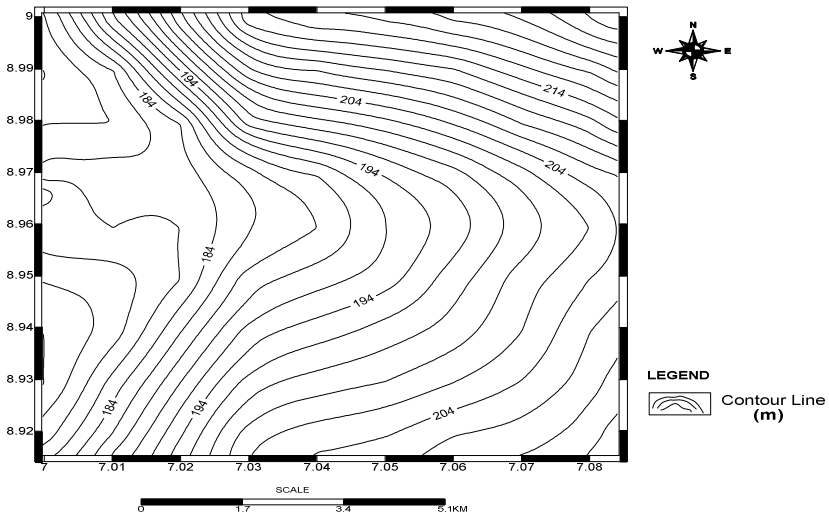

Figure 6: Contour line map of Study the area (at interval 2m)

Each contour line represents a particular height of the surface which is scaled in meter (m) with the interval of 2m and that explains the difference in elevation in the study area. Difference in surface elevation of the study area has to be considered when siting a dump site, this help to identify place which will meet up with the criteria for dump site selection since natural valley are best suitable for such project.

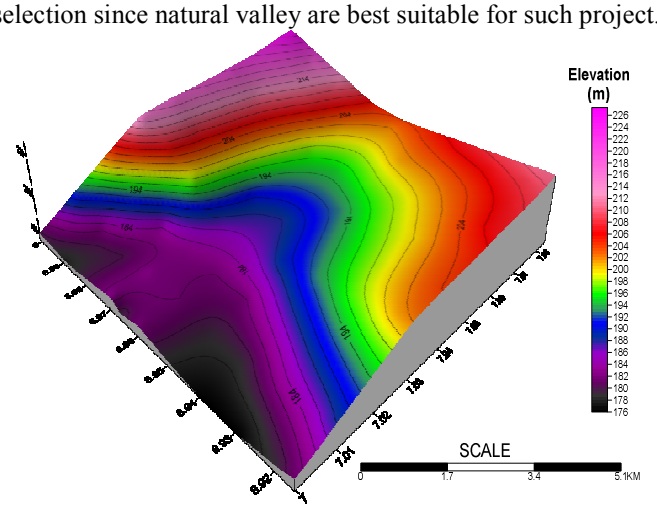

Figure 7: Digital Terrain Model (DTM)

Figure 7 on the other hand shows the elevation of the study area with highest point been 226 meters high and the lowest point been 176 meter as it is shown in the colour legend and corresponding values.

4.4 Buffering Analysis

The buffering analysis carried out are presented in figures 8, 9 and 10 showing settlements road and river buffered at 1 kilometer respectively which serves as one of the guide for selecting a suitable site for dumping site, this was to make sure that the site does not pose any negative effect on the inhabitant and the environment as a whole.

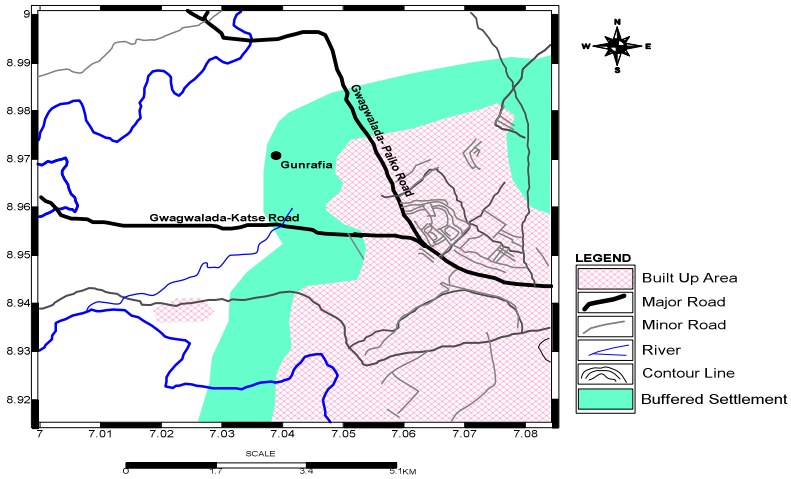

Figure 8: Built-up Area Buffered at 1km

Figure 8 presents the settlements buffered at 1km distance. This was done to checkmate the possible distance between the proposed dump site and the settlements. This was to make sure that the site poses no threat to human health since dump site harbor pests and could possibly lead to air pollution from the stench or unpleasant smell which might arises from the site which can also lead disease outbreak

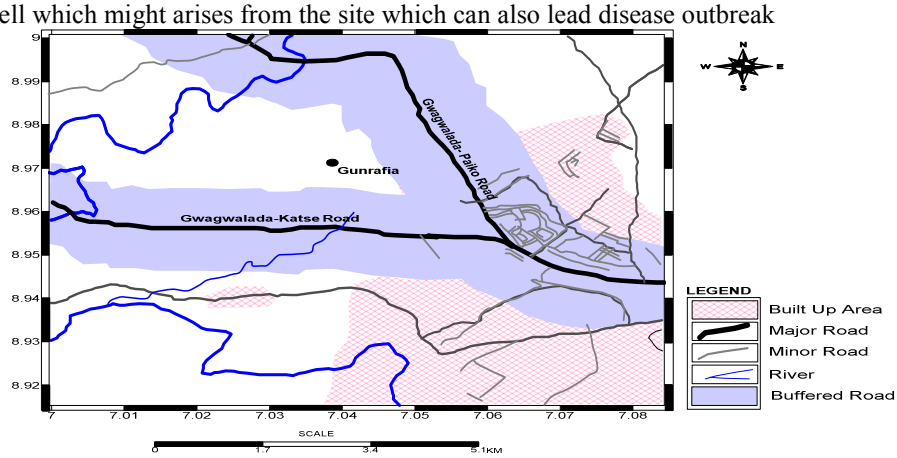

Figure 9: Main Roads Buffered at 1km

The main roads are buffered at 1km to be able to know the main entrance and exit routes to the study area which help in finding the best site for the proposed dump site as shown in figure 9.

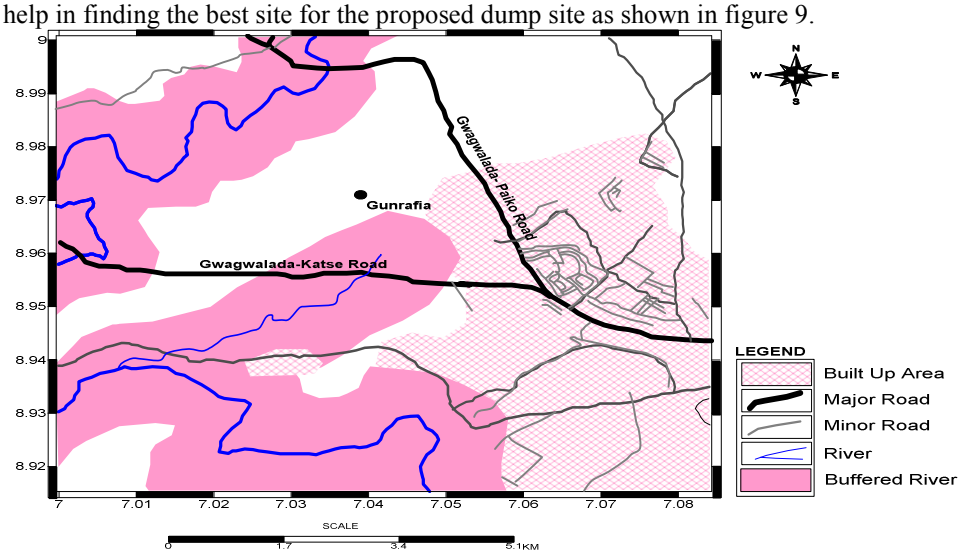

Figure 10: Rivers Buffered at 1km

Figure 10 shows that the rivers and other flowing surface water bodies were buffered at 1km in order to check for the possibility of contamination of the surface water which might result from leaching from the dump site. Since the dump site cannot be covered from the likes of rainfall and other decomposable materials it means

the problem of leaching must be checked which is done by buffering the nearby water bodies in order to avoid the problem of possible contamination by the leachate from the land fill site.

Overlaying and Selection of site

Figure 11 presents the overlayed buffered maps and shows the most suitable area for dumping solid waste which meet up with all set of criteria mentioned for site selection.. This was done by merging maps of the same location with different surface information about the location e.g rivers, main roads, minor ,roads, built-up area e.t.c. It helps in understanding the relationships between network analysis and specific geographic features in Gwagwalada metropolis map and other data were overlaid to derive possible sites that is suitable for dumping of solid waste at the minimum cost.

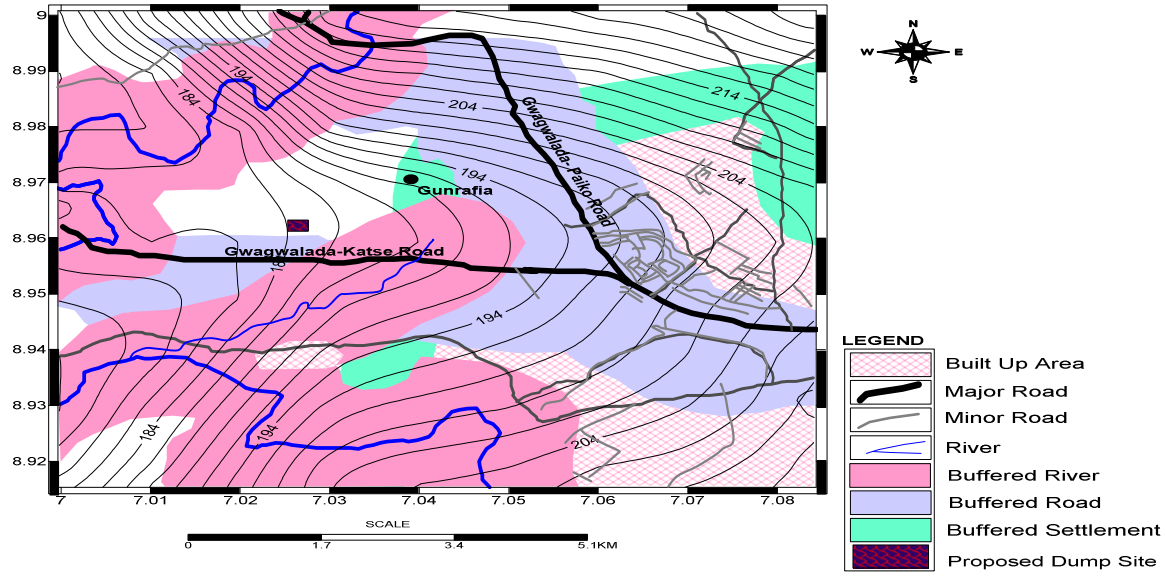

Figure 11: Established Suitable Area for Urban Dump Waste Site

Gwagwalada has a relatively high population due to the presence of institutions and administrative offices and if the dump site is not kept away from the built-up areas, it may be of great threat to human health. Waste breeds insects, causes leaching of chemicals into the ground water or could possibly contaminate the surface flowing water thereby leading to the problem of alternative water supply, it could also lead to disease out-break as well as causing problems for economic activities. Therefore, in selecting an urban waste dump site, all the criteria for such project must be properly implemented.

The proposed location of the dump site was found to be off the exit route from Gwagwalada along the Gwagwalada-Katse road and it is 1km with an elevation of 184m while the highest elevation in the study area is 226m high as shown in figure 11. This location has met up with all aforementioned criteria for dump selection where both human health, economic, social and Agricultural activities are not in any way threatened by the proposed dump site.

Conclusion

Sustainable solid waste management practice has the potential to reverse the trend of indiscriminate waste disposal. They can help to improve local livelihoods, reduce spread of diseases and restore natural ecosystems. The findings have shown the ability of using geospatial techniques as a veritable tool for selecting a suitable site for dumping of solid waste. The selected site has easy accessibility and the disposal of solid waste can be managed effectively.

REFERENCES

Adelaide, A. (1995). Waste management and sanitation at James town and Accra Central. A dissertation submitted to the department of sociology, university of Ghana, Legion.

Arinola, A.G, & Arinola, A.M. (1995). Solid waste in urban and rural areas of Ibadan Nigeria: Composition, treatment and public health concerns. Compost science and Utilization, 3(3), pp.80-83.

Atkinson, S.F. (1995). A geographical information system approach to sanitary landfill siting Procedures: A case study Environmental professional, 17(1), 20-26.

Ayininuola, G.M & Muibi, M.A. (2008). An engineering approach to solid waste collection System: Ibadan North as case study. Waste Management, 28 (9), 1681-1687

Banar, M, Kose, B, Ozkan, A. & Acar, I. (2007). Choosing a municipal landfill site by analytical network

process. Environmental Geology52, 747-751. Available from http// *www.springerlink.com/content/565568408 rp42105/* (Accessed January 5)

Beukering PV, Sehker M, Gerlagh R, & Kumar. V(1999). Analytical urban solid waste in Development Countries: Aperpective on Bangalore. Collaborative Research in the Economic of Environmental and development (CREED) and Environmental Economic Programme (IIED), Working Paper No. 24, March 1999, P.24.ISBN 1357924X (ISSBN). Available of the website: http://*www.iied.org/eep/pubs/creed*. (Retrieved, February 20th 2004).

Chang, Ni-Bin., Lu, H.Y., & Wei, Y.L. (1997). GIS technology for vehicle routing and Scheduling in solid waste collection systems. Journal of Enviromental engineering, 123 (9), 901-910.

Doan,P.L. (1998). Institutionalizing hoiuehold waste collection: the urban environmental management project in cote d'Ivoire. Habitat International, 22(1), 27-39.

Dolk, M. (1997), Resident near waste landfill sites and risk of non-chromosal congenital malformations. EUROHAZCON: Collaboration study group, New York.

Javaheri, H, (2006), Site Selection of municipal Solid Waste Landfills using Analytical Hierarchical Process Methods In A Geographical Information Technology Environment In Giroft. Iran Journal of Environmental Health science Engineering. 3, 177-184.

Juang, Jerry. Y.C(2009), Solid Waste Disposal. Microsoft Encarta.

Kaoa, J.J, Hunge-Ye L, & Wei-Y C. (1997). Network geographic information for landfill Sitting. Waste Management and Research, 15, 239-253

Programme Available from the website: *www.waste.nl* (Retrieved February 18, 2004).

Maggi, J.Y & Chup, C.D. The effect of Abattoir Waste on Water Quality in Gwagwalada, from *http://dx.doc:org/1/10.431/eyesm.v5145/4*.

Sunday, I, Olarewaju.O. I & Abaje I.B. Mapping flood Vulnerable Areas in a Developing Urban centre of Nigeria.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar