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Geospatial Distribution of Waste Dumpsites for Sustainable Solid Waste Management In Abuja Municipal Area Council (AMAC), Federal Capital Territory, Nigeria

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Abstract:- This study examines the application of Geographic Information Systems (GIS) in determining the spatial location and distribution of solid waste dumpsites in Abuja Municipal Area Council (AMAC). This present study applied the Techniques of Geographic Information System (GIS) and Remote Sensing (RS) to dumpsites and selection in the emerging City of AMAC. Spatial data such as land use cover types; road, river and settlement of theCity were extracted from a geo-referenced high medium resolution satellite image through on-screen classification using remote sensing software. The existing dumpsites were geo-located and added as a layer to the map of AMAC. The land use cover, settlement, river and roads were buffered at 1000, 1000 and 2000 meters respectively using preset criteria such as distance of dumpsites from a settlement at 1000 m, surface water at 1000 m, roads at 2000 m and absence of important economic or Ecological features; to determine candidate dumpsites from the land-cover types.Majority of dumpsites do not meet criteria for location of dumpsite and many of them are cluster. For the purpose of this work, 6 standard dumpsites were selected for Abuja Municipal Area Council, which is 1000 meter away from settlement to avoid environmental challenge from dumpsite. Remote Sensing and Geographic Information System help in distributing facilities in a real world for spatial phenomena. Therefore, GIS play a significant role in Solid Waste Management System.

Keyword:- *Land use cover, dumpsite, buffer, remote sensing and GIS.*

I. INTRODUCTION

A. Background of study

Waste is any material discharged from human activities, which makes adverse impacts on human health and environment. Solid wastes are non-liquid and non-gaseous products such as those from households, municipal, supermarket, construction and industries (Ajay, 2019; Kapilan & Elangovan, 2018). Solid waste has become a global environmental and health issue in the contemporary world both in developing and developed countries (UNEP, 2005; United Nations, 2017). Such environmental challenges combined with social, economic and land availability issues raise concerns over land management and evaluation techniques (Coban, Ertis, &Cavdaroglu, 2018; Lein, 1990; Philippe &Culot, 2009).

According to Babayemi, &Dauda (2009) there are several factors influencing solid waste collection in Nigeria, some of which are the lack of advanced technology facilities for separation at its source, the strength of solid waste management policies and enforcement procedures, environmental education and awareness, and the economic status of individuals, among others.

Increasing population, rapid economic growth and rise in living standards have accelerated the process of solid waste generation throughout the world (Elmira et al., 2010; Hering, 2012).

Therefore, locating proper sites for dumping solid waste far from environmental resources, residential areas, water bodies, roads, faults and settlements is essential for the management of solid waste in a proper way. Solid wastes in urban areas mostly include wastes of plastics, glass, fabrics, metals, and kitchen waste which have complex composition and late degradable characteristics, creating more harm to the environment.

B. Statement

There are lots of implications when wastes are not properly handled and indiscriminately disposed of. The effects are negative and could be detrimental. It poses risk to our Environment, Health, Social and Infrastructure.

When wastes disposed of indiscriminately are not collected, it gives rise to unsanitary condition which poses environmental and health hazard risk. The condition create a breeding ground for diseases causing agent to thrives and outbreak of diseases like cholera, diarrhea, Malaria, Tetanus, Lassa fever, Typhoid and Yellow fever, Hookworm and other parasite infestation. Indiscriminate waste disposal promotes fecal contamination of the hands, food and water that can result to fecal-oral transmission diseases. Waste disposed of indiscriminately can also result to water pollution, land pollution, drainage blockage, flooding and infrastructural degradationhttps://nigerianobservernews.com/2017/06/indiscriminate-waste-disposal-its-implications-and-the-way-forward.

Open dumpsites are a major problem to the environment especially to the air that we inhale. Dumpsites emit obnoxious odors and smoke that cause illness to people living in, around, or closer to them. Pollutant deposited on land can enter the body through contaminated crops, fruits,

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food products, animals and water. Dumpsite closer to residential areas can be a feeding place for dogs and cat apart from rat. These pet with rodents can bring diseases with them to nearby homes. Respiratory diseases, irritation of the eyes, nose and skin, gastrointestinal problems, allergies and psychological disorder have also been traced to unregulated dumpsite and indiscriminate waste disposal.

C. Justification

Remote sensing and GIS play a significant role in management of municipal solid waste. Remote sensing help to locate suitable sites for waste disposal using satellite imagery. The main advantage of satellite remote sensing is its repetitive and synoptic coverage which is useful for various studies in urban planning. Advancement in computer science has introduced GIS as innovative tools in waste disposal management. GIS has emerge as a key technology to manipulate and analyse Geographic data and powerful tool to collect, store, retrieve at will, display and transform spatial data from the real world.

The location of disposal sites must consider socio-economic, environmental and land use factors within the city and ensure human safety. Benefit of Geographic information system include; better information management, higher quality analysis, ability to carry out project efficiency and GIS optimize the travel time and cost function while enhancing the accuracy.

D. Aim and objectives

a) Aim:
The aim is to use Geospatial technique to distribution waste dumpsites for sustainable waste management in Abuja Municipal Area Council.

b) Objectives: The objectives are,

- Determination of current land use and land cover of Abuja Municipal Area Council (AMAC).
- Generation of dumpsites coordinate point from field survey
- Determination and validation of existing dumpsites in Abuja Municipal Area council
- Buffering of existing dumpsites away from settlement, road and river in Abuja Municipal Area Council.

II. STUDY AREA

A. Study Location

Abuja Municipal Area Council in Federal Capital Territory of Nigeria is geographically located at 8.923^0 N and 9.017^0 N of the Equator and 7.34^0 and 7.54^0 E in (figure 2). According to the 2006 population census the Federal Capital Territory (FCT) has total population of 1,402,201 (2006 population census) and land area of 1,769 square kilometres (km^2).

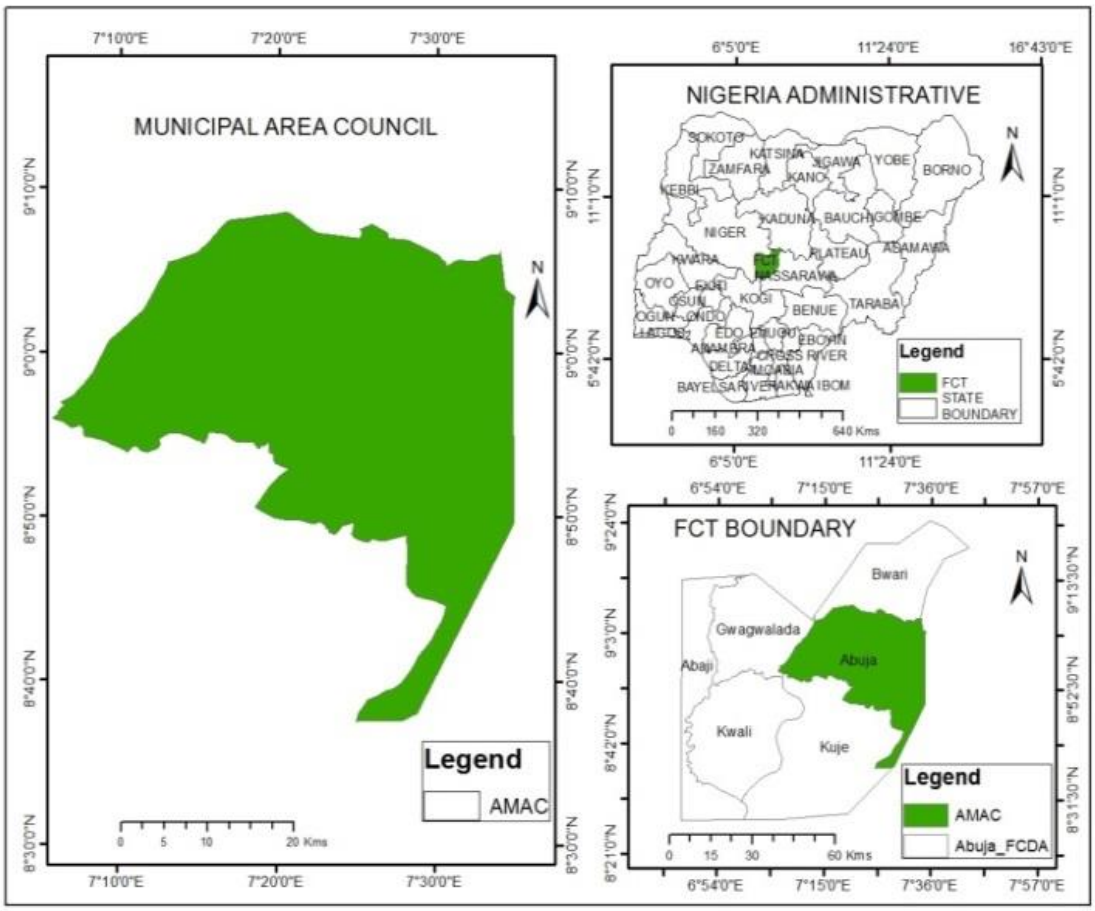

Fig. 1: Study Area Map

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B. Climate and Weather

The Abuja municipal Area Council (AMAC), experiences two climate seasons, wet and dry season with a brief of Harmattan, occasioned by the movement of the northeast trade wind, with the main features of dust and haze, intensified coldness, and dryness. Rainfall in the AMAC starts by March and end in October. Humidity in raining season is high and also temperature around this time is moderate. The dry season stars by November and end in April, humidity in this period is very low and the temperature is high due to free cloud cover Balogun (2001). The soil in Abuja Municipal Area Council is good for agriculture as it good for cash crop.

III. METHODOLOGY3.0

A. Data Acquisition and Source

S/N	Data	Type	Source
1	Landsat 8 (OLI)	Imagery (30 meter resolution)	Global Data
2	Coordinate points	GPS	Field survey
3	AMAC shape file	Administrative Map of AMAC	OSGOF
4	Road shape file	Raster file	GRID^3
5	River shape file	Raster file	GRID^3

Table 1: Data used for the project

B. Remote Sensing Image

In order to study current land use and land cover (LULC) of AMAC 2021 image. The Landsat data was acquired from the global land-cover website at the University of Maryland, USA (URL; http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp). The acquire images was the Operational land Imager (OLI) of 2021 as shown in Table 1. The satellite image was obtained on the 8th of November 2021 to follow weather consistence and climatic suitability of the work. Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) images consist of nine spectral bands with a spatial resolution of 30 meters for Bands 1 to 7 and 9. New band 1 (ultra-blue) is useful for coastal and aerosol studies. New band 9 is useful for cirrus cloud detection.Global Position System (GPS) device was used to determine the coordinates of existing dumpsites.

C. Site Selection Criteria

For the selection of the most suitable site for dumpsites, the following criteria were considered for the available datasets. The proximity analysis based on the National Environmental Standards and Regulations Enforcement Agency (NESREA):

- For built-up areas, dumpsite was placed at least 1000 meter away from all settlements for hygienic reasons.
- For Water body, dumpsite was placed at least 1000 meter away from water body to avoid hazardous emission from waste.
- For roads, dumpsite was placed at least 2000 meter away from an existing road so as to reduce transportation expenses.
- For elevation, dumpsite was placed on slopes with less than 9% inclination.

IV. RESULT AND DISCUSSION

A. Result

The tables 2 in this section displayed the results of the coordinate of Municipal Solid Waste dumpsites equally known as existing dumpsites in Abuja Municipal Area Council (AMAC).

During the field investigation, the coordinates of the existing dumpsites were obtained from the study area using a hand-held GPS device by a field measurement approach. The coordinates of the existing dumpsites collected during field investigation was tabulated into an excel sheet and then imported into the ArcGIS environment, then converted to shape file. The dumpsites shape file was overlaid on land use cover based on the adopted siting criteria.

S/No	Location	Latitude	Longitude
1	Lugbe Car wash	8.97352	7.36752
2	Lugbe POLICE Signboard	8.97482	7.370005
3	Chika 1	8.993023	7.403382
4	Chika 2	8.992845	7.409847
5	Chika 3	8.993815	7.404528
6	Aleita 1	8.98924	7.403012
7	Chika (Jadore)	8.987362	7.406105
8	Aleita 2	8.986178	7.397357
9	Piwoyi Central Dumpsite	8.996953	7.38829
10	Federal Mortgage Bank Estate	8.963567	7.386918
11	Progress Dynamic Academy Penthouse	8.965042	7.38066
12	Aiben Emerald Garden Trade Moore Estate	8.959137	7.361003
13	Phase 2 bridge Trade Moore Estate	8.957015	7.368128

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14	Ajuji hotel Apo	9.002023	7.473106
15	Behind zone E Apo 1	9.002121	7.45296
16	Behind zone E Apo 2	9.00134	7.47688
17	Apo settlement. High court	8.975974	7.500644
18	ORS Hotel Apo settlement.	8.976626	7.497941
19	Apo resettlement. Market	8.977583	7.503818
20	Guzape 1 (Asokoro)	9.01831	7.512792
21	Guzape 2 (Asokoro)	9.017635	7.5118
22	Guzape 3 (Asokoro)	9.016883	7.51132
23	Utako	9.064516	7.435675
24	Utako 2	9.061731	7.436493
25	Jabi	9.061701	7.418701
26	Jabi 2	9.062105	7.418318
27	UTC Area 10	9.035216	7.45826
28	Area 2 Dumpsite	9.035921	7.477784
29	Garki New Market	9.026657	7.491566
30	Area 1 Secretariat	9.026043	7.470263
31	Area 1 Durumi	9.019095	7.468173
32	Durumi 1	9.018203	7.468571
33	Durumi 1 new market	9.014735	7.468609
34	Gaduwa junction	9.003276	7.464111
35	Durumi 3 Central dumpsite	8.994915	7.462317
36	Durumi 2 (new site)	9.009072	7.462671
37	Court	9.282885	7.385489
38	Area Council	9.287262	7.3773
39	Stadium	9.283265	7.380225

Table 2: Coordinate points of existing dumpsites

Land use/land cover in the study area is dominated by urban activities, such as residential, institutions,commercial and industrial area, with few areas (mostly undeveloped) devoted farming activities. Inaddition to the major urban land uses mentioned above, other land uses/coverare forest and rock outcrop study area. Therefore, Abuja Municipal Area Council needs to be properly plan to avoid environmental challenge.As we can see in figure 2 the dumpsites are cluster, there is no proper arrangement; most of the dumpsites are not met criteria for siting of dumpsite.

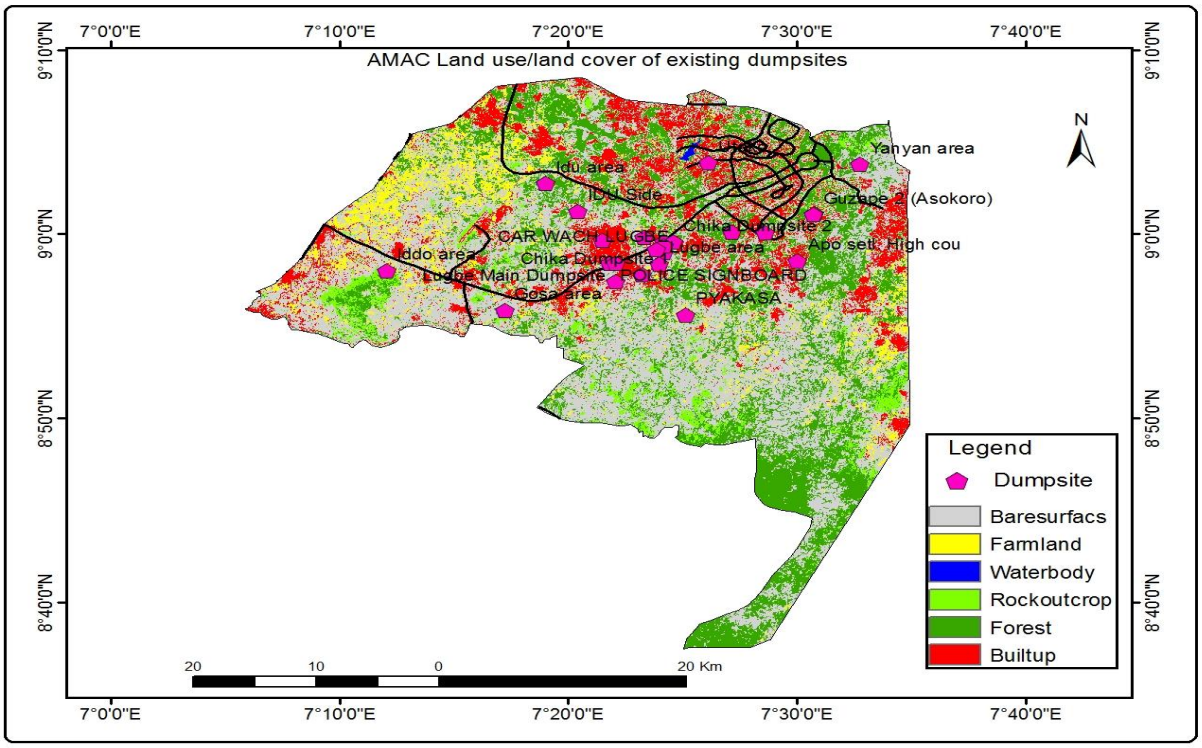

Fig. 2: LU/LC with existing dumpsites

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Figure 3 shows the Abuja Municipal Area Council road buffer of 2000 meter from dumpsites. From the result, majority of the dumpsites are located within the range of set buffer and some that are not include; Pyakasa, Apo settlement, High court, etc.

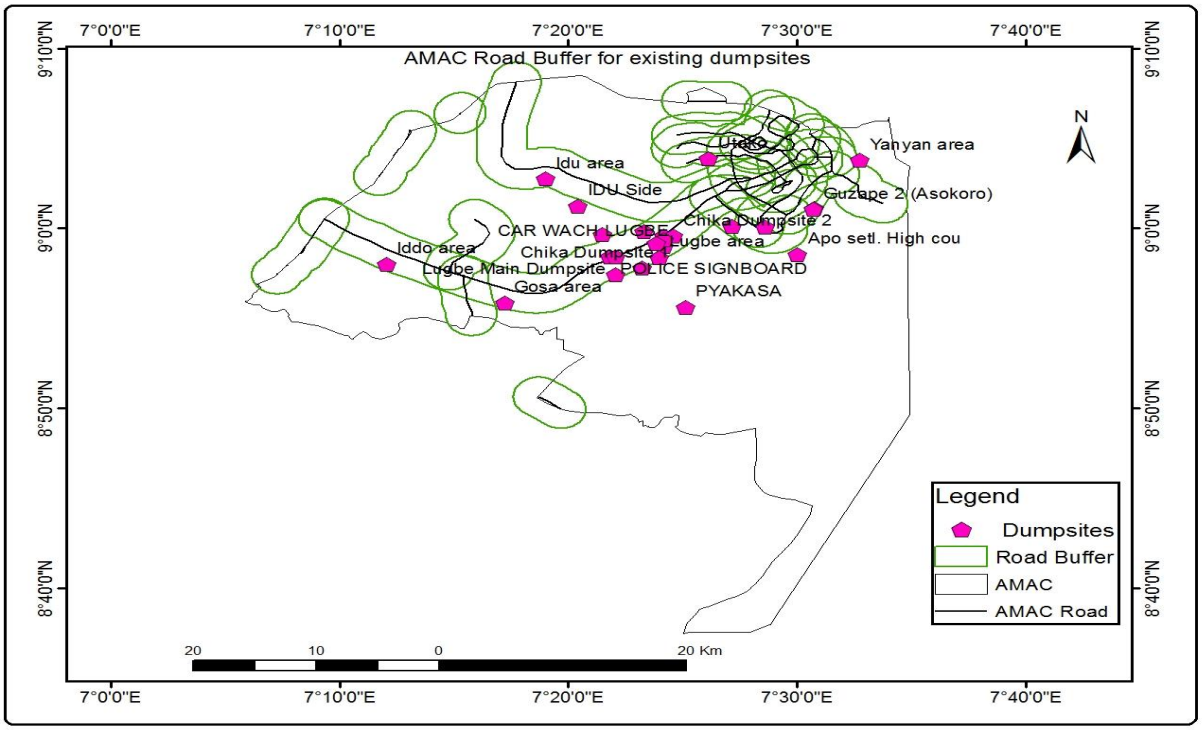

Fig. 3: AMAC Road buffer with existing dumpsites

Figure 4 shows Abuja Municipal Area Council river buffer of 1000 meter away from dumpsites. Result showed that Gosa dumpsite, Idu side dumpsite and Jabi dumpsite are too close to the water body. Therefore, the all other dumpsites are very okay with the standard.

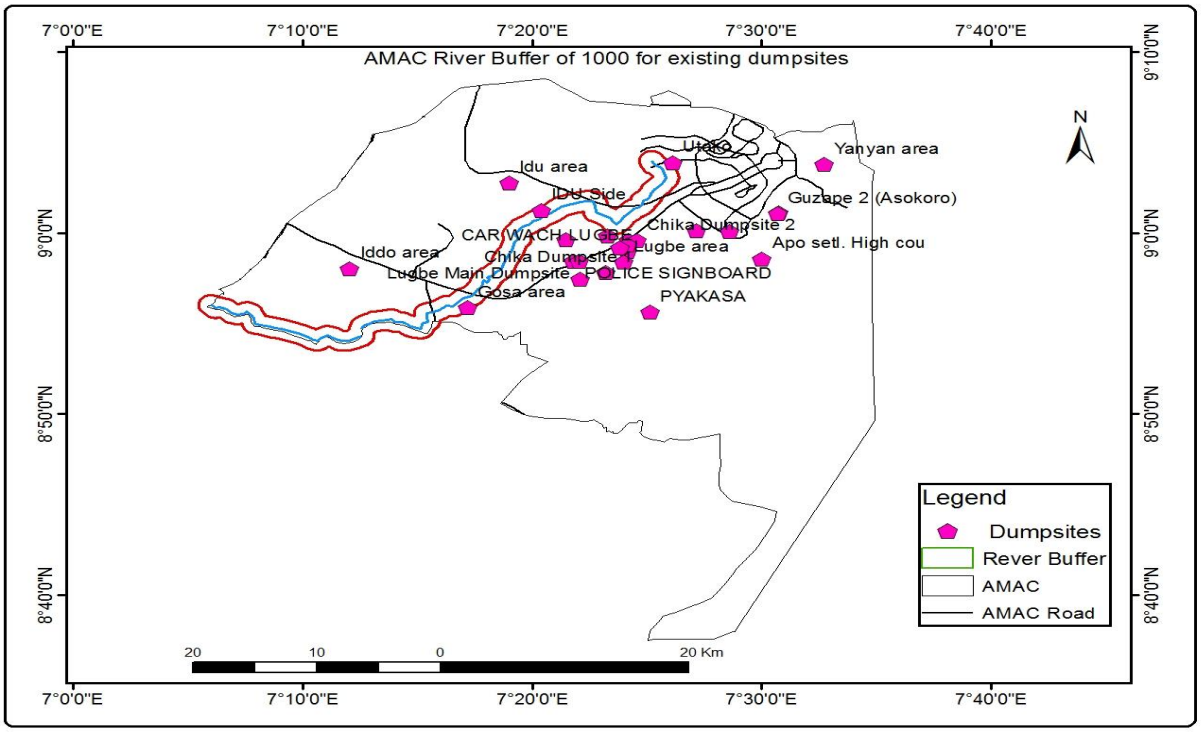

Fig. 4: AMAC River buffer of 1000 meter from water body

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Figure 5shows Abuja Municipal Area Council student dumpsites, buffer 1000 meter away from settlement. These dumpsites location are selected to avoid environmental hazard from the community. When dumpsite is located close to resident, people living around here are continue to perceive offensive odour from dumpsite and this can lead to outbreak of disease. That is way 1000 meter away was considered above any other factor for the selection of new dumpsites in Abuja Municipal Area Council.

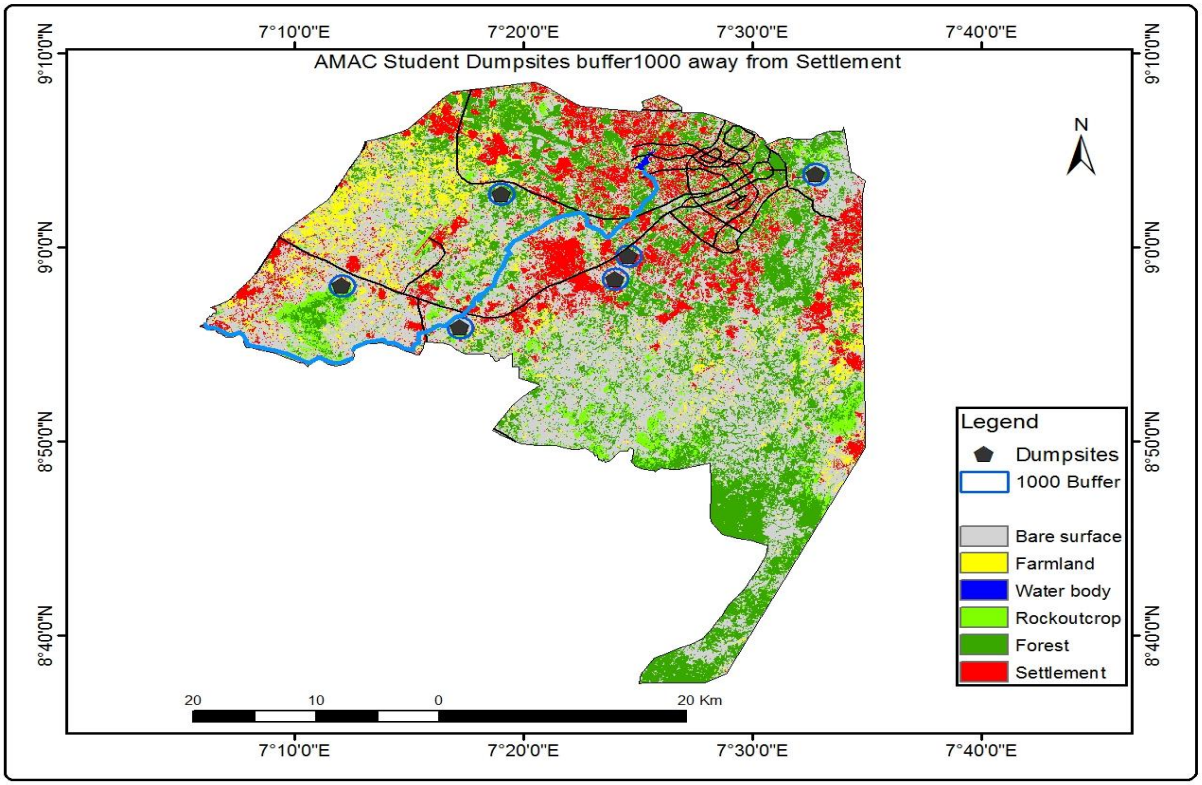

Fig. 5: Student dumpsites selection for Abuja Municipal Area Council

B. Over View of Solid Wastes Disposal in Abuja Municipal area Council (AMAC)

Municipal solid wastes which include plastics, other biodegradable and non-biodegradable wastes are indiscriminately disposed of in AMAC. Plates 1, 2, 3 and 4 showed the way people indiscriminately dispose waste in an open space which, cause the defacing of the aesthetics of the urban centres and the health threats to the inhabitants who are exposed. The open dumpsites were seen sited at busy streets and junctions, close to residential areas, close to water bodies and in open fields, etc.

Plate 1: Open dumpsite around the big estate (Source: Fieldwork, 2022)

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Plate 2: Open dumpsite around the big estate (Source: Fieldwork, 2022)

Plate 3: Open dumpsite around the street (Source: Fieldwork, 2022)

Plate 4: Open dumpsite around the street (Source: Fieldwork, 2022)

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C. Discussion

The Spatial Distribution of both authorized andunauthorizeddumpsites is shown in figure 2, the illegal dumpsites are more concentrated in the low-medium density populated part of The Abuja Municipal Area Council. The unauthorized solid waste dumpsites can also be found along water body. From the analysis in the study area, there is more unauthorized dumpsite than authorized dumpsite. The unauthorizeddumpsites are cluster around Lugbe, Piwoyi etc.Findings in the study further show that authorized dumpsite is situated in the study area as well, but the only well-known is Goza dumpsite close to Idu area. This Goza dumpsite need to be relocated because development has reached this place, in fact there is two big estates in front of the dumpsite.

Some dumpsites are very close to water body according to 1000 meter buffer away from the water body, which is unfit for consumption for people around here. In the same vein, many of the dumpsites are close to the settlement that can pose environmental hazard to people living around these places. Apart from other things, either authorized or no authorized majority of the dumpsites do not meet the criteria of 1000 metre buffer from the road they are very far from the road.

The locations of the dumpsites show serious negative implications on infrastructural facilities in the area. Some dumpsites were on drainages thereby obstructing the free flow of water and this could eventually lead to flooding and erosion during the rainy seasons. A good number of the dumps were very close to buildings 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 are part of the highest killer diseases in Nigeria. In some cases, they pollute surface and ground water, hence, exposing inhabitantsof the area to the consumption of contaminated water and food which is inimical to their health. The people in these areas were also exposed to offensive odour and polluted air.

V. CONCLUSION

It was concluded that the use of Geographic Information System in analyzing a spatial analysis especially when representingthe real world phenomenon, helps in the integrating and simplifying the interpretation of a distribution of afacilities especially the visual analysis and interpretations. GIS play a significant role in Solid WasteManagement System; it helps the Managers in database creation and the stakeholders to know the exact areaswhere there is need more attention rather than concentrating on a particular area.This paper attempted to analyze the distributions of sustainable dumpsites in Abuja Municipal Area Council. To improve on existing dumpsite a comprehensive assessment approach is essential to the established performance of the present strategy, to provide information to management for discourse that's why Geographic Information system is employed in showing the spatial distribution of both legal and illegal dumpsites within the study area.

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