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A Geo-Spatial Approach for Solid Waste Dumpsites for Sustainable Development in Minna, Niger State, Nigeria

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Abstract: *Ineffective solid waste management constitutes a major environmental problem in urban areas, Minna, Nigeria inclusive. This study analysed the spatial patterns of waste dump sites and the health hazards associated with the observed patterns. Also, the study identified possible areas at risk of health hazards; suggests the most suitable location for dump sites and sorting centers for municipal solid wastes; and provides a framework for sustainable solid waste management in Minna, Niger State, Nigeria. The data used for this study were obtained from both primary and secondary sources. The primary source involved the use of GPS receiver to obtain the coordinates of dump sites and pictorial evidence were taken with a digital camera showing open dumps. Also, a set of 144 questionnaires were used to obtain information about people's perception of solid waste disposal and management. The secondary data used included the IKONOS image of Minna with 3.2m resolution in multispectral was obtained from Google earth in July 2010. The spatial analyses of the phenomena of interest were done on the basis of the 13 existing administrative districts in the town. Multi-stage sampling procedure was used to select respondents to the questionnaires used for the study. The Google earth satellite imagery was zoomed to a satisfactory resolution and the areas of interest were clipped using corel draw and then joined together through mosaicing. Thereafter, the required remote sensing, GIS and cartographic operations were performed. Results show that there were 31 major dumpsites in Minna which are situated within built-up areas mostly along major roads and watercourses. The proximity analysis based on the National Environmental Standards and Regulations Enforcement Agency (NESREA) used at distances 1000m, 500m and 250m showed that built-up areas, major roads, and watercourses fall within buffer range to dumpsites. The identified built-up areas within a distance of 1000m to dumpsites location showed that Bosso Estate, Myper, Dutsen kuran, Western by pass, Maitunbi, Tunga, Chanchanga, Shango, Kpakungun, Sokakahuta are at risk of possible environmental problems. Buffering analysis also revealed that Rivers Bako, Sauke and Gora were within a distance of 500m to dumpsites and is therefore at risk of pollution by the dumpsite constituents. In addition, 1000m buffering analysis showed that Paiko Road, Western by pass, Eastern by pass, and Zungeru Road are prone to littering by dumpsite constituents when aided by wind or human. These major roads are also liable to the risk of incinerator smoke which hampers the visibility of road users as shown by the query analysis. Furthermore, result showed that the most common waste generated in the study area is plastic (40.9%). It also revealed that 65.9% practice open dumps disposal system and only 59.1% of inhabitants disposes their waste daily. Malaria was reported by 86.4% of the respondents as the most important health problem in the town. Also, 61.4% of inhabitants depend on ground water as their means of water supply. The study also identified points free of intersection among dumpsites, built-up areas, watercourses and major roads at a distance of 3500m as most suitable sites for dumpsites and sorting centres. The study concludes that waste management with it attendant problems still constitute a major challenge in the study area and suggests the 3R's model as framework for effective solid waste management in the town.*

Key words: *Solid Waste, Municipal Solid Waste, Solid Waste Management, Dumpsite, Remote sensing, Goegraphic Information Systems (GIS).*

I. Introduction

Human activities create waste and it is the way these waste are handled, stored, collected and challenges faced by human beings in the urban areas nowadays is Solid Waste Management (SWM). Obviously, the way to limit the impact on our planet's ecosystem is by reducing the amount of solid waste generation (Wand-Yao et al., 2006). Waste can be defined as that which is cheaper to throw away than to utilize (Henstock, 1983). It does not mean that waste is totally valueless. Hence, Municipal Solid Waste (MSW) are commonly known as trash or garbage that consist of everyday item like food item, metal scrap, polythene, and paper among others (Cunningham and Saigo 1997).Waste management is an important objective of planning to

ensure that the future generations inherit an environment that is as pollution free as possible given the present scientific, economic, social and political constraints (United States Environmental Protection Agency, 2005).
Rapid population growth and urbanization results in increasing environmental concerns and MSW is of prime importance in such rising urban issues (Yedla, 2005). Saheed et al., (2008) reported that the generation of solid waste is directly proportional to population, industrialization, urbanization and the changing lifestyle, food, habits and living standards of the people. According to Karadimas and Loumos (2008), solid waste generation depends on the socio-economic profile of the urban residents. The generation being the non-point/area source, collection and disposal poses a serious problem to the local municipalities and other regulatory bodies. The per capita waste generation rate among developing countries was recorded as low as 300 g per person every day (Centre for Environmental Studies, 2000). This simply means a continuous generation of solid waste does not only degrades environment but also defines a huge loss of natural resources.

Municipal Solid Waste (MSW) management involves various steps, namely collection, transportation, processing and disposal. Land disposal is the most common method adopted. Again in urban areas, open dumping of landfill site is the most common form of MSW in populated cities (Bolton, 1995). In developed countries proper landfills exist along with proper construction and maintenance of the same (DOE/EIA, 1999). This issue has now received the attention of international and national policy making bodies and citizens. In the international level, the awareness regarding waste began in 1992 with the Rio Conference; here waste was made one of the priorities of Agenda 21. Here specific attention was given to the environmentally sound management of solid wastes. The Johannesburg World Summit on Sustainable development in 2002 focused on initiatives to accelerate the shift to sustainable consumption and production, and the reduction of resource degradation, pollution, and waste. The priority was given to waste minimization, recycle, and reuse followed by the safe disposal of waste to minimize pollution. On environmental degradation, Agenda 21 is a comprehensive plan of action to be taken globally, nationally and locally and was adopted by more than 178 Governments at the UN Conference in Rio de Janeiro).

Failing in a proper way of siting landfill in developing countries, leads to some negative effects such as fires due to landfill gases, rodents, insects, and birds due to organic food, bad odour and leachate that causes groundwater pollution. In this case, the landfill is indentified as unsanitary which poses the issue of public health hazard. Fly tip, fly dumping, midnight dumping, and illegal dumping are all different names for the same disposal method (Bellafante, 1991). Illegal dumping is a nuisance because of the physical dangers, aesthetic distaste, and costs associated with it and it may affect the health and safety of humans and wildlife. . Other problems may develop if harmful substances are dumped at the site, these substances may leach into the environment and contaminate the soil and groundwater.

Many cities have great concern for their already stressed water sources at this time, and adding pollution to the supply could be extremely harmful to residents that consume this water (Wolkomir, 1994). Domestic waste disposal management has received a lot of attention not only in Minna, Niger state but in Nigeria generally. The major problem caused by waste to the environment is the way waste is dumped openly without ways of disposal and treatment hence bringing about pollution characterized by various types of solid waste; organic and inorganic waste which when acted upon by rain water will dissolve to produce high toxic leachate which are normally high in heavy metals, ammonia, toxic organic compounds and pathogens. All these chemicals infiltrate and percolate into the ground to contaminate the ground water sources. Another issue is that in Niger State, the most dominating waste among all is plastics (PET bottles, nylons among others) which is non-biodegradable and hence causes blockages to drainage systems creating room for pathogens to breed (Aderoju, 2009).The pattern of disposal of municipal solid waste has lead to an increasing number of dumpsites which is an environmental issue in Minna town as at the present. Also, the decomposition of this organic waste produces aesthetic situation and also produces quantities of carbon dioxide and methane gases which are both green house gases which contribute to the ozone layer depletion and global warming as a whole. Some constituents of dump sites contribute majorly to most health related hazard which consequently lead to an abrupt of diseases and increasing mortality rate. This study is to address the environmental problem of municipal solid waste management in Minna by suggesting a framework to tackle this problem through an approach known as 3R's (Reduce, Recycle and Reuse).

This study is looking at the use of Geographical Information System as an effective tool to assess and manage dump sites in Minna town for a sustainable development. This approach will help identify the impact of the dump sites on the environment spatially and also help us in ways of monitoring possible environmental hazard problems for an effective and proper management of solid waste in dump sites for sustainable development. The study is aimed to provide a frame work for effective solid waste management for sustainable development in Niger State using geo-spatial techniques.

Objectives

The specific objectives of the study are to:

I. inventory and analyse the spatial patterns of waste dump sites in Minna:
II. analyze the health hazards associated with the exiting location patterns of dump sites;
III. identify and show possible areas at risk to health hazards;
IV. suggest the most suitable location for dump sites and sorting centers for municipal solid waste;
V. suggest a framework for sustainable solid waste management.

Justification of the Study

Uncontrolled open dumps are reservoirs of high public health hazards because of improper site management which directly endanger the health of the people living near to, or on the site. The public may be affected by the contamination of their drinking water, by soil contamination passed on to the aquatic and terrestrial food chain and through the spreading of diseases. People living near or on the site are often subject to direct transfer of contamination from hand to mouth and through inhalation of dangerous volatile compounds and aerosols. There is also a direct physical danger involved, deriving from possible waste landslides, collapsing landfills, explosions, fires and waste related transport accidents. Minna, the capital of Niger state has open dumps in its environment. Although the State's Government Environmental Board have been helping with the removal of some of these wastes but due to the exponential growth in population and urbanization in the town. Waste generation is inevitable and we need to find a way to curb this problem of solid waste in the environment because it contributes to global warming. Open dumping is the least financial cost solution for dealing with waste disposal, it is apparent that continued open dumping is not suitable for practical, social and environmental considerations.

Study Area

Minna, the capital of Niger State in the north central of Nigeria .As at 2009, Minna has an estimated population of 356,446 (NBS, 2010). Minna is an area located on latitude 9^0 33`N and $9^0$ 45`N and longitude 6^0 34`E and $6^0$ 42`E (see Figure 1.0). It is a local Gwari town and the word "Minna" in Gwari means to spread fire. The main agricultural products of the city are cotton, guinea corn, yam and ginger. It is connected to Abuja the Country's capital by road with a distance 150km. The city also has a small airport. The geological formations present in Minna are basement complex and sedimentary rocks. Minna experiences a distinct wet and dry season with annual rainfall varying from 1100mm to 1600mm. The rainy season starts from the month of April to October with peak in June and July or August and September in some years (Uthande, 2001). The mean monthly temperature is highest in March at 30.5^0C and the lowest in August at 25.1^0C. Fadama soil is the major type of soil in Bosso, this gives room for extensive farming operation in the area. Minna is somewhat zoned for different land use but in most of the zones, mixed uses exist. There are forms of residential, governmental, education, commercial and industrial There are prominent ridge in the area and these ridges extend to a distance of about 7km, the major rivers that made up the drainage of the rivers, Ekpa, Suka and Gora most these have extensive tributaries that covers most part of the areas and serve as a major source of water supply in Bosso and its environs zones.

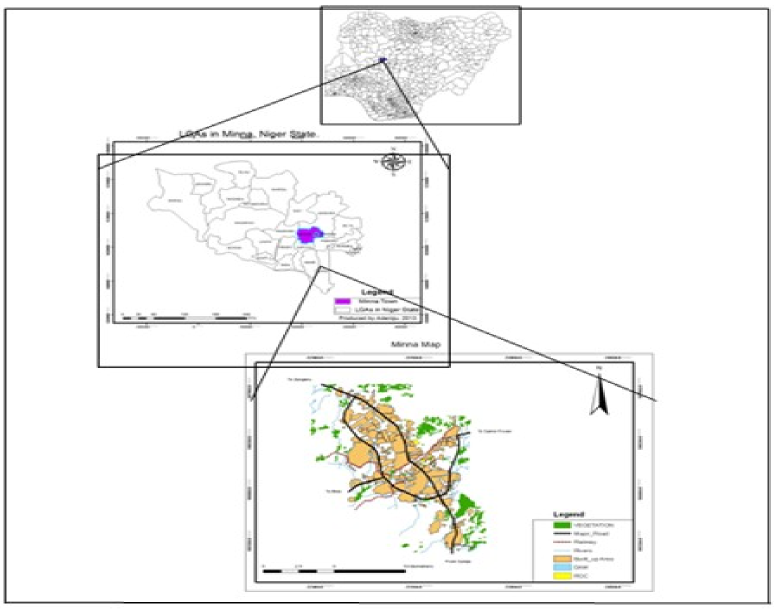


Fig 1.0: Study Area, Minna

II. Methodology

The research instruments; data type and sources; data collection procedures; data preparation and analytical techniques used in the study was discussed in this paper. The table 1.0 shows the data used, data type, data sources and also devices used for this research.

Data Acquisition and Data Source

Data List	Data Type	Data	Data Source
IKONOS 3.2m multispectral	Secondary	Satellite Imagery	Google earth
GPS Points	Primary	Dumpsites coordinate	Field Survey
Administered questionnaire	Primary	Respondent data for analysis	Field Survey
Sony Digital Camera	Primary	Dumpsite pictures	Field Survey

Table 1.0: Data Acquisition and Data Source

Data Processing and Georeferencing

Area of interest was extracted from Google earth and it was then Mosaic using ArcMap 9.3 software. Georeferencing of the satellite image was done and rectified with total root mean square error of 0.067. Data set projection was done in World Geodetic Survey (WGS), 1984, Universal Transverse Mercator (UTM) Zone 32N. Database creation using the personal Geodatabase of the ArcMap 9.3 software and also shapefiles were also created for the following features; roads, rivers, waterbody, rock outcrop, vegetation, railways and dam. On-screen digitizing was done for all the created shapefiles from the imagery. Existing dumpsites coordinates taken during the field survey was also plotted and then converted to shapefile.

Geospatial Analysis

The basic spatial analysis employed during this work was buffering operation and proximity analysis was also demonstrated in the ArcGIS environment. Buffers of specific distance was created around the dumpsites so as to determine the proximity level of the dumpsites to the roads, rivers and the built-up areas. Proximity analysis was performed via query to know the proximity level of features to dumpsites.

Questionnaires and Statistical Analysis

The primary data collected through questionnaire was used to know the perception of people about solid waste management in their environment .200 questionnaires were issued out but just 144 was recovered due to time constraints. The questionnaires were administered using a Multi-stage sampling technique. Stratified sampling was used and the study area was divided into strata (districts) and each stratum was used as area of interest in which questionnaires were administered. Secondly, Systematic sampling was used in each stratum, oppositional streets were selected and houses at every seven house interval were interviewed. Usually the head of the house hold or the woman of the house helped in responding to the questions. The response was analyzed using software Statistical Package for Social Scientist (SPSS) and Microsoft Excel.

Site Selection and Sorting Centre Criteria

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

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

The criterion for used for identifying dumpsites before coordinates were picked was based on size and height. It must be about $20m^2$ and 1m height (Aderoju, 2009). The validation of dumpsites sizes was done by measuring with measuring tape and a meter rule. .

Framework for Sustainable Solid Waste Management.

The Strategy of the Integrated Waste Management to be adopted for a Municipal Solid Waste (MSW) to attain a sustainable development of Minna town is the 3R's (Reduce, Recycle and Reuse). This strategy can also be referred to as Waste to Wealth approach.

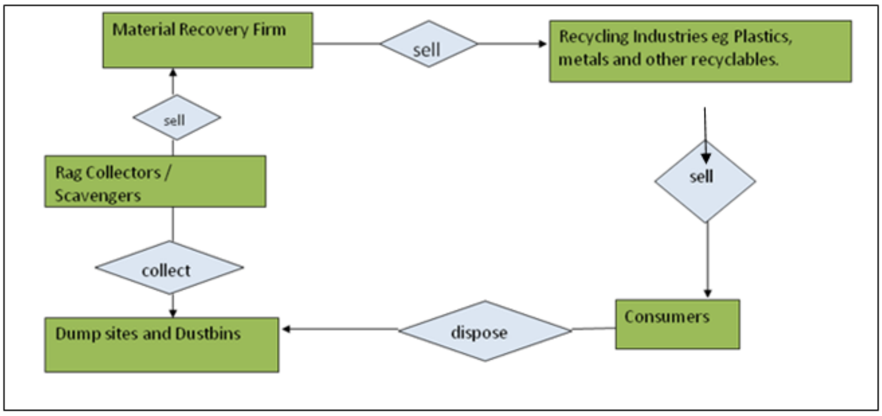


Fig 3.0: Waste to Wealth

The figure 3.0 explains the waste to wealth flowchart as follows;

Scavenger collects valuable wastes from dumpsites and landfills and sells them to dealer usually referred to as Material recovery firm or Kawadies in India. The dealer take these purchased solid wastes to their junk yard for sorting. Sorted solid wastes are gathered to large heap that is more than truck full and then sold to relevant recycling industries. Recycling industries manufactures new products from recovered materials and sell to the consumers. The consumer utilizes the new products and generates waste and then disposed off into dustbins and dump sites. Some scavengers sell food scrap to farmers which serve as fertilizer for a better production of agricultural produce.

III. Results And Analysis

This is a table 2.0 showing the location of dumpsites in Minna and maps showing the location with related features. The table and the maps are displayed below;

S/N	DISTRICT	EASTINGS (m)	NORTHINGS (m)	ELEVATION(m)
1	Chanchaga 01	233230	1054290	229
2	Chanchaga 02	250802.21	1054170.34	236.2
3	Chanchaga 03	233227.92	1054289.75	226.3
4	Tugangoro 01	234341.87	1056494.95	236.9
5	Tugangoro 02	233243.48	1056502.66	232
6	Shango 01	233259.08	1058715.08	251.6
7	Shango 02	233260.75	1058723.34	253.5
8	Tunga 01	231086.06	1062050.56	274.8
9	Tunga 02	231070.28	1059837.61	283.5
10	Tunga 03	231086.06	1062050.56	263.1
11	Tunga 04	231205.4	1078647.73	278.5
12	Dutsenkura 01	227800.3	1065391.51	263
1	Dutsenkura 02	227815.3	1065533.71	263.1
3	Dutsenkura 03	215825.3	1065393.50	260.3
14	Dutsenkura 04	217815.3	1065293.71	272.3
15	Dutsenkura 05	227815.3	1065393.71	277.4
16	Bosso Estate 01	225618.95	106509.68	282.2
17	Bosso Estate 02	225635.13	1067622.72	267.7
18	Tudun Fulani	227938.11	1067606.71	269
19	Bosso Newyork	227831.35	1067606.71	294
20	Myper	227815.35	1065393.71	274.6
21	Maitunbi 01	233406.06	1065354.32	303.1
22	Maitunbi 02	234404.19	1065346.54	300
23	Maitunbi 03	233290.37	1063141.41	311.2
24	Maitunbi 04	233198.21	1064247.87	301
25	Kpakungu 01	225578.64	1059877.11	293.1
26	Kpakungu 02	227775.32	1059861.22	125.5
27	Kpakungu 03	228873.65	1059853.32	231.2
28	Sokakahuta	231062.41	1058731.14	244.2
29	Easterb by Pass 01	233282.87	1066034.95	271.6
30	Eastern by Pass 02	233282.53	1062034.95	272

Table 2.0: Districts Locations

1. Spatial patterns of dumpsites

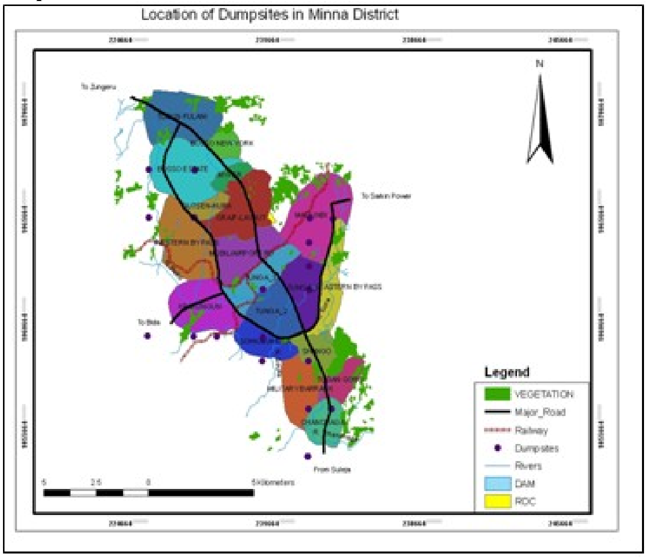


Fig 4: Dumpsites Locations in Minna Districts

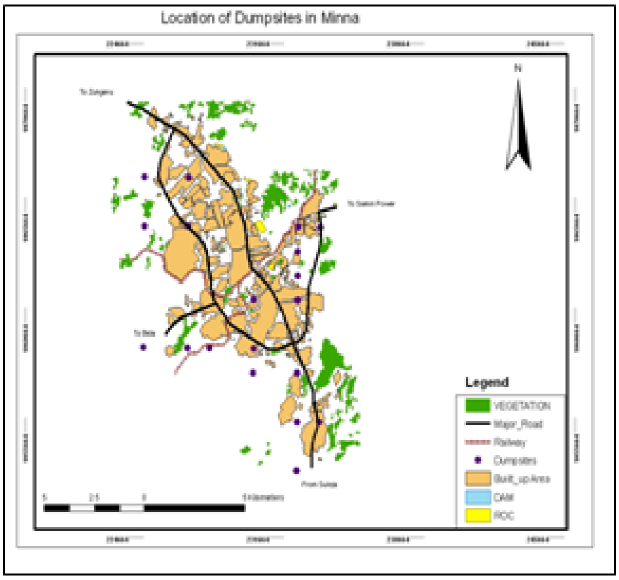


Fig 5: Dumpsites Locations in Minna

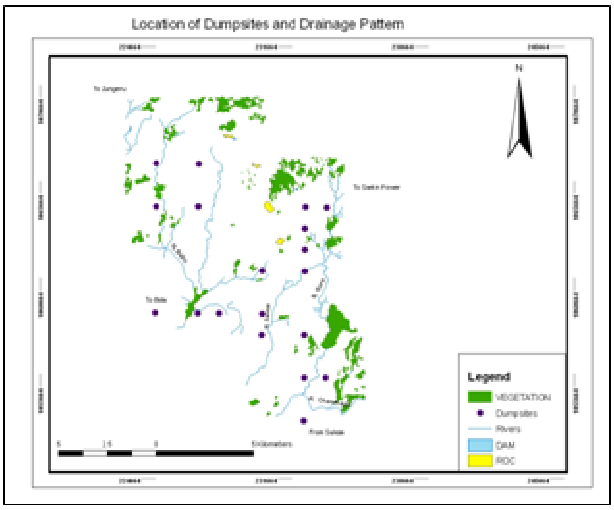


Fig 6: Dumpsites Locations in Drainage ways

The figures 4, 5 and 6 showed the spatial distribution of dumpsites location in Minna, Niger State. The figure 4 simply shows the dumpsites in different district in Minna. The figures 5 and 6 show the spatial distribution of dumpsites within settlements and also rivers in Minna.

2. Buffering Analysis.

The buffering of 1000m, 500m and 250m was done around the dumpsites in Minna town so that we can run a proximity analysis to dumpsites.

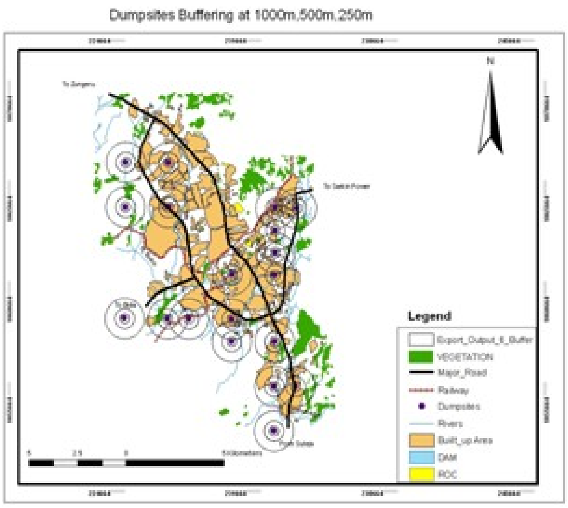


Fig 7: Dumpsite buffer @ 1000m, 500m and 250m

3. Proximity Analysis

Query analysis was done to check the proximity of features to the dumpsites. The Query results are shown respectively.

Select by Location "Built up Areas that falls within 1000m buffer of the dumpsites"

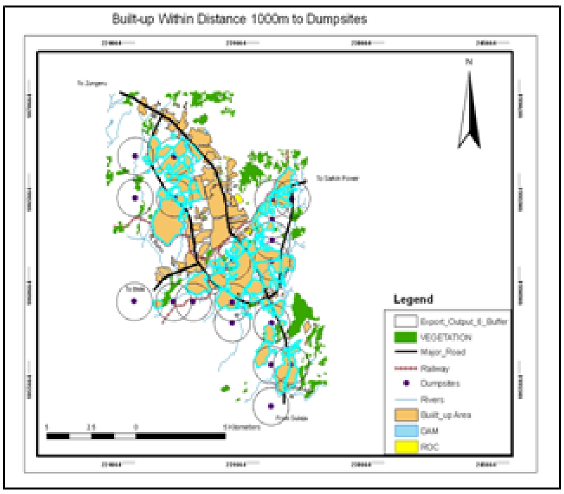


Fig 8: Built-up within distance 1000m to dumpsites

From figure 7 below, it was seen that the built-up areas displayed in green colour falls within the 1000m buffer. With this result, it is seen that dumpsites are sources of pollution and at the same time ignite diseases around built-up areas. Hence the proximity of built-up to dumpsites also contributes to the creation of breeding grounds for pathogenic organisms and emanating foul smell.

Select by Location " Rivers that falls within a distance 500m buffer of the dumpsites"

From figure 9, it was seen that Rivers displayed in green colour falls within 500m buffer of the dumpsite. This implies that such Rivers are more vulnerable of pollution from dumpsites compared to those at further away.

Selection by location “Roads that fall within a distance of 1000m around dumpsites”
From figure 10 below, it was seen that the roads displayed in blue falls within the 1000m buffer. The problem of poor air quality emanating from the dumpsites to the users of the roads that falls within buffer zone. It is seen that dumpsites are source of littering of the road with the aid of devil’s wind and the emission of smoke from refuse burnt in the dumpsites and as such leads to the obstruction of motorist visibility and prolongs traffic.

4. Statistical Analysis

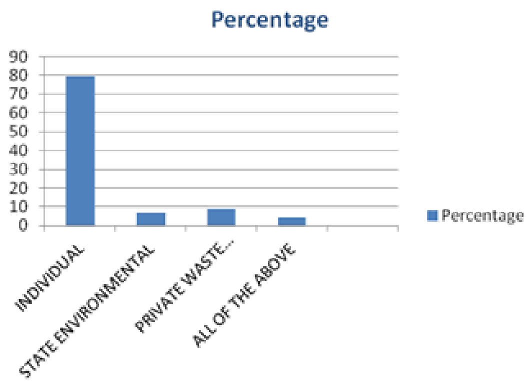
There were 200 questionnaires distributed and only 144 questionnaires was recovered and analyzed using SPSS. The results of the analysis are displayed below;

DISTRICTS	FREQUENCY	PERCENTAGE (%)
BOSSO ESTATE	13	9
CHANCHAG	13	9
EASTERN BY PASS	10	7
KPAKUNGN	16	11
MAITUNBI	16	11
MYPER	10	7
SHANGO	10	7
SOKAKHUT	10	7
TUDUN FULANI	10	7
DUTSEN KURA	7	5
TUGANGORO	3	2
TUNGA	16	11
WESTERN BY PASS	10	7
Total	144	100.0

Table 3: The respondents in each location

CLEANING RESPONSIBILITY	FREQUENCY	PERCENTAGE (%)
INDIVIDUAL	115	79.5
STATE ENVIRONMENTAL	10	6.8
PRIVATE WASTE MANAGERS	13	9.1
ALL OF THE ABOVE	6	4.5
TOTAL	144	100.0

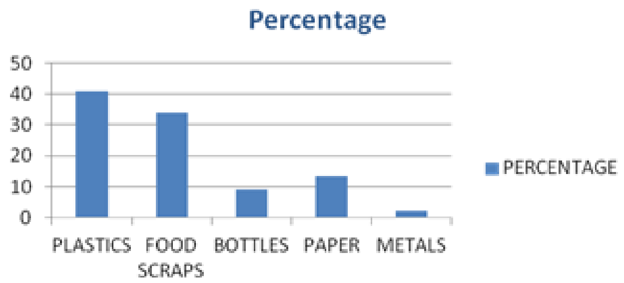
Table 4.0: The responsibility for cleaning the environment



The bar chart shows that in Minna 79.5% of the surroundings cleaning are done by individual, 6.8% is by State Environmental, 9.1% by private waste managers while 4.5% makes use of all.

WASTE CLASS	FREQUENCY	PERCENTAGE(%)
PLASTICS	59	40.9
FOOD SCRAPS	49	34.1
BOTTLES	13	9.1
PAPER	20	13.6
METALS	3	2.3
TOTAL	144	100.0

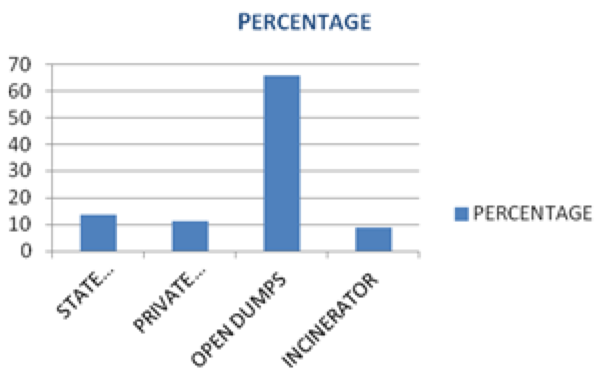
Table 5.0: The class of Municipal Solid Waste generated in Minna



The Bar chart shows that in Minna town 40.9% of the wastes generated are plastics, 34.1% are food scraps, 13.6% are paper, and 2.3% are metals.

Disposal Methods	Frequency	Percentage (%)
PRIVATE MANAGERS	16	11.4
OPEN DUMPS	95	65.9
INCINERATOR	13	9.1
STATE ENVIRONMENTALS	20	13.6
Total	144	100.0

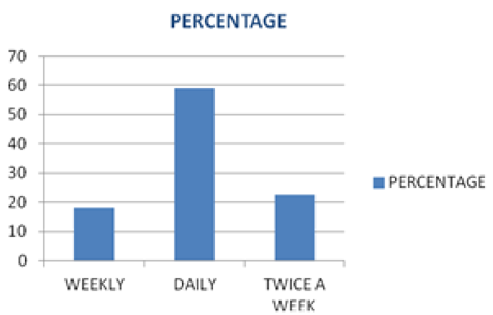
Table 6: The Disposal methods in Minna



The bar chart shows that the disposal method practiced in Minna is 65.9% Open dumps, 13.6% uses the State Environmental Service, 11.4% uses private managers, and 9.1% uses incinerator.

DISPOSAL FREQUENCY	FREQUENCY	PERCENTAGE (%)
WEEKLY	26	18.2
DAILY	85	59.1
ONCE A WEEK	33	22.7
TOTAL	144	100

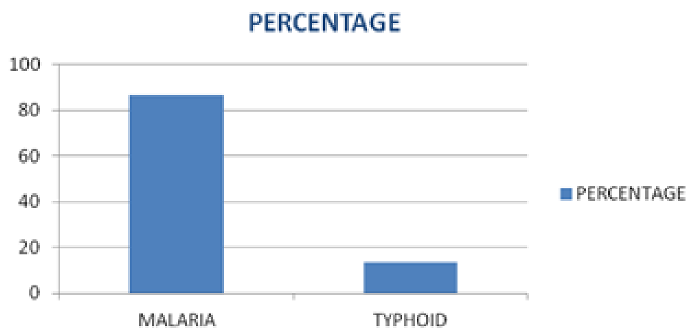
Table 7: The disposal frequency in Minna



The bar chart shows that 59.1% disposes their waste daily, 22.7% twice a day, and 18.2% weekly.

PROMINENT DISEASE	FREQUENCY	PERCENTAGE (%)
MALARIA	124	86.4
TYPHOID	20	13.6
TOTAL	144	100

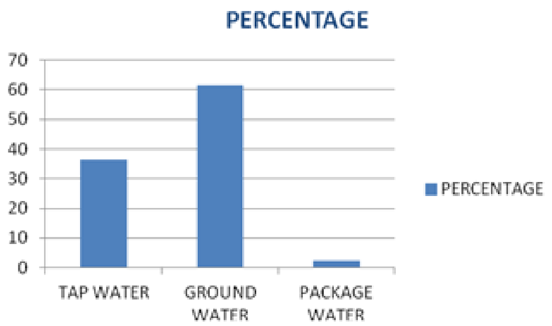
Table 8: Prominent disease in Minna



The Bar chart shows the diseases in Minna town is believed to 86.4% for Malaria fever, 13.6% for Typhoid fever.

WATER SOURCE	FREQUENCY	PERCENTAGE (%)
TAP WATER	53	36.4
GROUND WATER	88	61.4
PACKAGE WATER	3	2.3
TOTAL	144	100

Table 9: Water source type in Minna



The Bar chart shows that 36.4% uses tap water for consumption, 61.4% for ground water, and 2.3% for package water as water source type in Minna.

5. Site Selection for Dumpsites and Sorting centres.

For site selection, multiple rings buffer was created for the following feature of interest which is Major road, built-up, River.

The created multiple rings buffer was at specified distance as below;

- Built-up area at distance 1000m
- River at distance 500m
- Major road at distance 3500m such that it covers the entire study area.

Secondly, query by intersect was done in ArcMap using the ArcTool box. All the features of interest were selected with specified distance. This was done repeatedly at distances 2500m, 3000m and 3500m. The criterion is that until no sign of intersection among selected features, hence the remaining parts are the possible site for dumpsite location.

At distance 3500m, it was observed that no intersection occurred which signifies that the remaining area between 3000m and 3500m are the possible site for dumpsites.

For sorting centers, the criterion was that it should not be more than 50m away from selected dumpsite or landfill based on the concept of nearness to raw materials. The query of intersection was done at distance 3450m and the criterion for intersection was equally met.

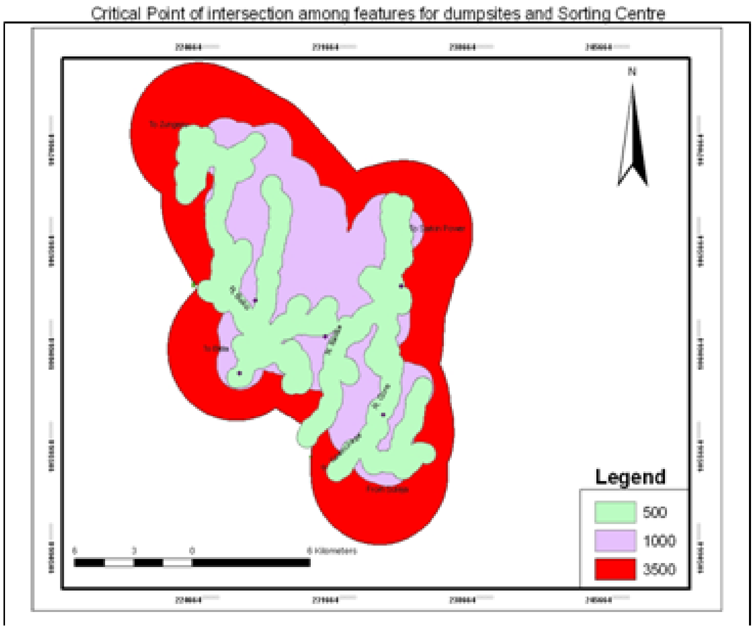


Figure 11: Critical points of intersection among features for Dumpsites and Sorting

This map shows critical point of intersection at distance 3000m after query by intersect. This simply implies that it is not suitable for dumpsites and sorting centres.

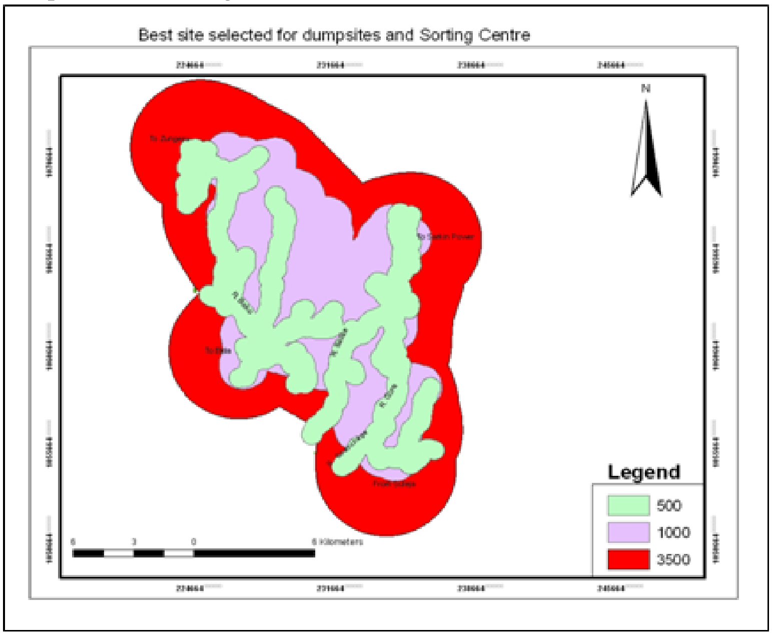


Figure 12: Best site selected for Dumpsites and Sorting

The most suitable site selected for both dumpsites and sorting centres are marked in red. This is because there is no more critical point of intersection at distance 3500m. It was observed that there was no critical point displayed at distance 3500m.

IV. Discussion

The Map of Minna showing dumpsites was buffered at 250m, 500m, and 1000m respectively. The features of interest for possible site selection for both dumpsites and sorting centres are built-up areas, rivers/watercourses and roads. The problem of pollution, littering, diseases occurrence, green house gas emission are based on the increasing rate of dumpsites and if not checked it will continue to degrade the environment.

The query for built-up areas within a distance 1000m dumpsite location showed that Bosso estate, Myper, Dutsen kuran, western by pass, Maitunbi, Tunga, Chanchanga, Shango, Kpakungun, Sokakahuta are at

risk to possible environmental problems listed above. The query for river within a distance 500m buffer to dumpsites location showed that River Bako, River Sauke and River Gora are at risk to pollution by dumpsite constituents. The query for road within a distance of 1000m buffer dumpsite location showed that Paiko road, Western by pass, Eastern by pass, Zungeru road are at risk to incinerator smoke, littering of dumpsite constituents aided by wind or human.
From the analysis of the administered questionnaires which was done in SPSS it was observed that;

Plastics are the most dominating solid waste generated in the entire house hold of Minna town of about 40.9%, then food scrap of about 34.1%, and the least generated are about 2.3%. This most common of all the disposal methods of municipal solid waste is the open dumps which was observed to be 65.9% among other means of waste disposal methods and the least used was incinerator method which is the act of burning refuse. It was observed that the rate of disposal differs in Minna, 59.1% disposes the waste daily, 22.7% disposes their waste twice a week, and while 18.2 % disposes theirs weekly. The most prominent diseases among others were malaria with 86.4%, while Typhoid scored 13.6% and cholera was always on rare cases. Blockage in drainage systems by dumping waste into drainage ways, transportation of nylons by wind into drainage ways brings about breeding grounds for mosquitoes .This make malaria the most prominent disease among the listed diseases. It was also observed that open dumps has the potential of polluting ground water because during rainy season where water infiltrate and percolate into the ground and with potential dumpsites at a higher elevation to a ground water source. The polluted water from the dumpsite percolates into the ground and floor horizontally by gravity to recharge close ground water source.

The selection of the most suitable location for dumpsites and sorting centres was necessary for proper clean up of the Minna environment. This simply helped to identify the critical points where features of interest intersect one another. The features of interest were built-up areas, major roads, rivers or watercourses, and dumpsites. This was repeated by varying distances (2000m, 2500m, 3000m, and 3500m) such there was no critical point left. It was observed that at 3500m there was no critical point displayed which simply implied that the remaining part outside the critical zone was selected for dumpsites and sorting centres. Sorting centres was assumed to be at 50m away from selected site for dumps which is still outside the critical region.

V. Conclusion

The study showed that improper disposal of solid waste poses potential risk to health. The open dump solid waste disposal practice in Minna is not in accordance with the best principles of public health and environmental protection. It was deduced from the analysis of the questionnaires that the majority of the household in Minna practice the open dump disposal method and that waste constituents are majorly plastics and food scraps. The issue of malaria fever being the most prominent disease in Minna has been linked to the blockages in drainage ways which is usually as a result of indiscriminate dumps in the drainage ways which eventually creates breeding ground for mosquitoes to multiply. Drainage blockage are usually caused by plastics and being the most dominant waste generated in Minna and it is non-biodegradable, the possibility of more mosquitoes and higher cases of malaria is unquestionable.

The upsurge in which urbanization have taken almost every district have dumpsites located within the vicinity of their residential areas and the Niger State Environmental have done little on the aspect of solid waste management.

The use of Geospatial technology helped in providing an information system of dumpsites in various districts of Minna that enables monitoring and management of the dumpsites so as to prevent environmental hazards which might cause disease outbreak. Geospatial technology has also helped the location of the most suitable place for dumpsites and sorting centres for waste constituents for recycling so that an environmentally sound environment can be maintained in Minna.

In pursuit of a cleaner and healthier environment, jobs are automatically created, time and time, energy and land are saved, money is made and natural resources will be preserved for the future generation is the concept of (Reduce , Recycle and Reuse) is adopted.

VI. Recommendation

There should be a proper framework for municipal waste management in Minna such that there will increase coverage and efficiency of solid waste services, community-based and private sector involvement for a proper and sustainable waste management program. There should be proper awareness creation about the concept of (Reduce, Recycle and Reuse) through media, symposia and workshop, and should be introduced as an institutional curricula such that people be enlightened on the advantages and benefit they will rip. With the economic viability concealed that reduce, recycling and reuse has multiple benefit for any sustainable economy, the state government can explore this possibility being another source of revenue as well as another means of creating jobs for the inhabitants of the state. The use of geospatial technology should be encouraged by the state government in all arm of its ministry most especially the state environmental ministry for proper monitoring and management of its environment. The need for strict regulations and policies guiding solid waste management such that defaulters are made to pay fine based on the extent of pollution. The use of polluter's pay principle can be applied and it should be carried out by transparent and honest people of high integrity in relevant agencies at regular interval.

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