# EVALUATING THE SPATIAL DISTRIBUTION OF OPEN DUMPSITES AND THEIR EFFECTS ON THE RESIDENTS IN BOSSO-MINNA, NIGERIA

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Open dumpsites are the most prevailing form of waste disposal in most developing countries like Nigeria – which has been battling with indiscriminate dumping of waste for decades without much success. The failure of waste management system and Sanitary landfill in Nigeria has resulted to an uncontrollable spread of different kind of disease epidemics such as Malaria, Typhoid, Cholera, Dysentery and many others, posing threats to human health and causing the death of many people especially those residing within close proximity and as well as polluting the land, air and water bodies. The problem has been worsened due to lack of spatial data on the location of the dumpsite as well as identifying the households that are more vulnerable to the diseases associated with uncontrolled dumpsites. This study therefore seeks to evaluate the spatial distribution of open dumpsite in Bosso, Minna using Geographical Information System (GIS) and to investigate their likely effects on the residents. The methodology employed in the study involved the collection of waste dumpsites' coordinates using Global Positioning System (GPS) receivers and using Arc GIS 10.0 to digitize the built up areas from the acquired satellite images, creation of attribute tables, buffer analysis, overlay operations and production of maps. Residents living within 100m buffer zone were classified as highly vulnerable to disease spread, those farther away from dumpsites by 200m were classified as being moderately affected while those residents above 300m from dumpsites were classified as having very low vulnerability to disease spread. The research revealed that most of the open dumpsites were located within the high density areas which clearly demonstrated a true characteristics of high density areas and few of these sites are noticeable in the low and medium density areas. About 50% of the entire buildings fell within the 100 to 300m buffer zone generated. It is therefore recommended that immediate evacuation of these open dumpsites be effected and strategic location of waste transfer stations established by the Government and authority concern.

**Keywords**: Open Dumpsites, Waste management, Buffer, Spatial Analysis and GIS

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KASSAH et. al. (2016). **EVALUATING THE SPATIAL DISTRIBUTION OF OPEN DUMPSITES AND T HEIR EFFECTS ON THE RESIDENTS IN BOSSO-MINNA, NIGERIA** Sustainable Built Environment and Clim ate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SE TIC, 2016

# INTRODUCTION

Dumpsites can be described as refuse dumps situated either on land or on water where waste materials, such as solids, liquids, semisolids and gaseous are disposed (Abul, 2010). The siting, management and proper handling of dumpsites is essential to public and environmental health. The absence of these measures may cause the waste constituents to enter the environment thus affecting the livelihood of the surrounding communities (Sever, 1997; Daniel and Laura, 1999).

There are basically two options for waste disposal/dumpsites: operate a properly designed, constructed, and managed landfill or open dumpsites in which waste is burned in a controlled or an uncontrolled facility that converts waste to energy (United States Environmental Protection Agency, 2002). Open dumps are the most preferred method of disposing waste in most developing countries regardless of the fact that it is unhygienic and unsafe (Remigios, 2010) which are usually sited on low lying areas of an open land. There have been several occurrences of open and illegal dumping of refuse on the streets and other places that are not legally allocated for the purpose of waste disposal in Bosso, Minna-Niger State. Benedine, Robert & Abbas (2011) stated that open and illegal dumpsites are indiscriminately sited, irrespective of the presence of infrastructural facilities available in those locations. This could be as a result of attitudinal problem from the public especially in developing countries who prefer a place within the shortest distance and the institutional constraint from the government of Niger State that has no standing frame work to address this problem. This makes open dumping of waste the most prevailing form of waste disposal in developing countries especially Nigeria (Saidu, 2011). They are piled up by the road side, in the rivers, drainages and many open spaces in the cities thus posing threats to human health and environment (Cheeseman, Imam, Mohammed, and Wilson, 2007).

Open dumpsites are favourable harbours for mosquitoes, cockroaches, rodents, houseflies etc which serves as hosts or causative agents for malaria, typhoid fever diarrhea, Lassa fever etc. The people living close to open dumpsites are often subject to direct transfer of contamination from hand to mouth or through inhalation of dangerous volatile compounds and aerosols (Aderoju, Salman, Anjoye, Nwadike, Jantiku, Adebowale, Fagbemiro, Agu, 2014). Constant exposure to dumpsite lead to considerable public health consequences such as, cholera, Malaria, Typhoid, Dysentery/Diarrhea and many others, which degrades human health on daily basis (Su, 2005; Nubi, Ajao, and Nubi, 2008). The indiscriminate dumping of waste along the road side, open spaces, drainages and canals poses threats to human health and the environment in many countries (Oluwafemi, 2009; Joseph, Nagendran and Visvanathan nd). This is usually found in urban areas, where several developments have taken place and waste management practice is ineffective, and people suffer widespread of diseases which sometimes lead to premature death especially among children and women since their immune system may be unable to fight those diseases (Bartlett, 1999; Nwaka, 2005). Dumpsites irrespective of the type, (open or closed) should be sited at the outskirts of the city or community, because of the health effect on the residents, through the proliferation of flies, mosquitoes and rodents that transmits diseases which affects the human health (Abul, 2010).

"Effect of Waste Management on Climate Change is a Fact, not a Myth" (Oresanya, 2010) which caused air pollution with impact on climate through methane emission in which dumpsites have

been identified as major sources (Aljaradin and Persson, 2012) especially the traditional open dumpsites which do not have a top cover or other preventive measures to reduce methane emission into the atmosphere. Therefore, dumpsites are regarded as the largest source of atmospheric methane in the world, leading to a global warming (Hansen, Nazarenko, Ruedy, Sato, Willis, Del Genio, Koch, Lacis, Lo, Menon, Novakov, Perlwitz, Russell, Schmidt, and Tausnev, 2005) which result in changing the temperature and rainfall patterns and which is expected to bring a variety of pressure upon plant and animal life.

There are a lot of reasons why open dumpsite is still been practiced in Bosso area of Minna despite the health implications This can be attributed to sheer ignorance of the health risks associated with dumping of waste in open areas, inadequate resources as well as lack of legal policies against indecent dumping of refuge. Others are lack of political will to protect and improve public health, high illiteracy rate and lack of collection centres/drums close to the residence especially in highly populated areas of Bosso-Minna. Waste management in Minna is considered to be unsuccessful, because it is affected by unfavourable economic, institutional, legislative, technical and operational constraints (Mohammed and Chukwuma, 2011). Although, Niger State government together with the Federal Government have attempted to implement some tactics to clean up the city but not much is seen to have been attained as most part of the state are surrounded by open refuse dumps. This has resulted to series of complaints by the residents of Minna on the dilapidating condition of their environment with the residents taking to the streets to complain about the level of garbage waste overflowing their roads, streets and drainages systems, stressing that it is becoming a threat to their health and entire well-being (Ebenezer, 2012).

Therefore, due to the health effects of open dumpsites, decision makers and professionals like town planners, engineers, environmentalists etc. require information about the locations (spatial distribution) of the dumpsites that will enable effective planning and identification of illegal dumpsite in Bosso-Minna. Evaluating the spatial distribution of the open dumpsites will help the agencies in locating the locations of the dumpsite which will help to determine if the site are to be evacuated. It will also help in identifying the residence that are at risk due to their proximity to these sites. The major problem is knowing where these dumpsites are located and their relationship/effect with the residence: how far is this dumpsite from the residential areas, and are these dumpsites approved by the authorities or not. Most times the reason why the government is ineffective in waste management is due to the lack of spatial data on the location of dumpsites which can easily be achieved with the use of Geographical Information System (GIS). GIS is a powerful tool which allows for integration of data from numerous sources and the performance of detailed analysis, taking into consideration the locations, social and economic variables (Parker and Campbell, 1998). GIS provides a powerful technology for the spatial analysis of environmental and health data, and the major areas of its application include assessment and mapping of environmental exposure, mapping of health outcome, and the analysis of spatial relationships between environment and health (Briggs and Elliott, 1994). It can also be used as a decision support tool to simplify the search for suitable sites selections for specific purpose because it is capable of extracting and classifying spatial features (Nakakawa and Ogao, 2007). Aderoju, et al. (2014) used Geo-Spatial approach to analyse the spatial patterns of waste dump sites and the health hazards associated with it as well as identifying possible areas at risk of health hazards in Minna, Niger State, Nigeria.

This research is aimed at using GIS based spatial analysis to evaluate the spatial distribution of open dumpsites in Bosso-Minna by creating data base of dumpsite within the study area which will help the waste management agencies to know the location of the dumpsite and plan for proper

management of dumpsites. This is important because it will help in analysing the health effect of these wastes on the residence within close proximity to the dumpsites.

# METHODOLOGY

## Study Area

The study area for this research work is Bosso Town-Minna in Bosso local Government Area of Niger State, Nigeria. Bosso town is the home of Federal University of Technology, Minna Bosso campus. According to 2006 population census in Nigeria, Bosso-Minna is said to have a population of 147, 359, (75,826 males and 71,533 females), while Niger state as a whole maintains a populations of 3,950,249 (National Population Commission, 2007). Niger State is blessed with cultural diversity with the major dominants of Bosso-Minna being Gbagyi and Nupe. Bosso-Minna is located on Latitude 6º 30'E and Longitude 9º 40'N and lies in the southern Guinea Savannah zone of Nigeria. It has a sub-humid, semi-arid tropical climate with mean annual precipitation of 1200 and 1300mm. About 90% of total annual rainfall occurs between the months of June and September (Saidu 2011). The temperature rarely falls below 22ºC but peaks at 40ºC and 30ºC in February/March and November/December respectively while wet season temperature average is about 29ºC" (Musa, Oladiran, Ezenwa, Ogbadoyi, and Akanya, 2011; Mohammed and Chukwuma, 2011).

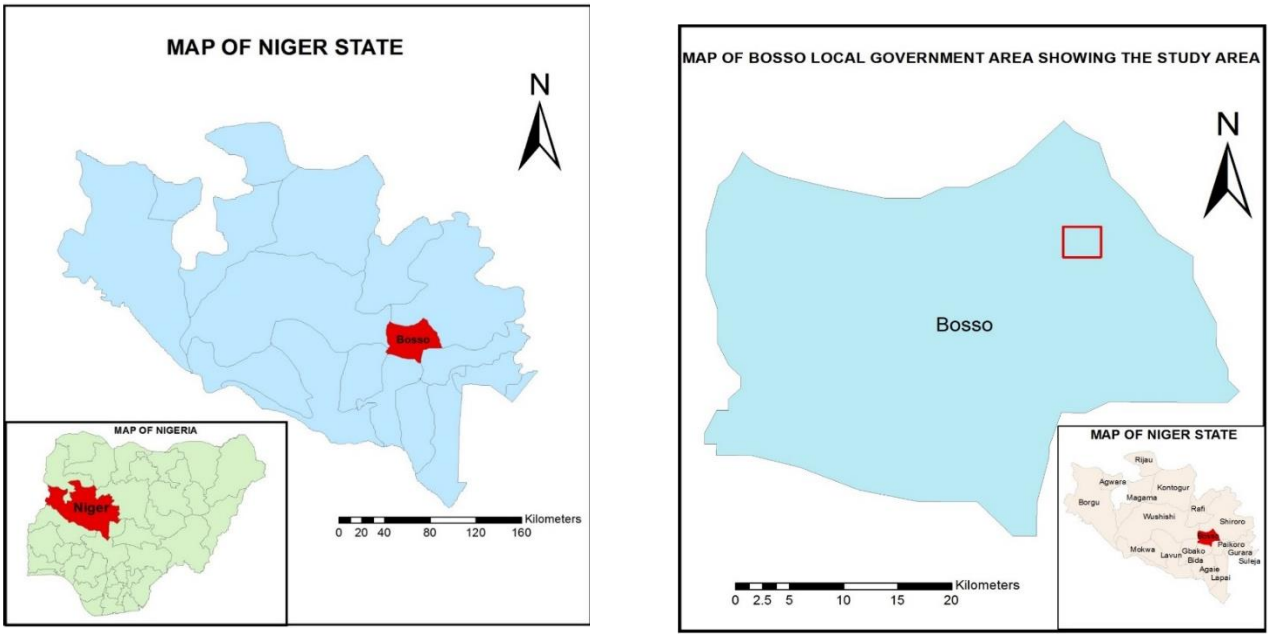



Figure 1: Map of Bosso Local Government Area Showing the Location of the Study Area in Red

# MATERIAL/DATA

Two types of data were used for this study; spatial and attribute data. The spatial data are the coordinates of the dump sites as well as the satellite image of minna. QuickBird satellite images of 0.6 metre resolution covering the study area was obtained from Niger State Geographical Information System (NIGNIS). The attribute data includes; name places of

open dumpsites, street name, description of waste etc. The satellite image was already georeferenced and projected to Universal Traverse Mercator (UTM) Zone 32N with Minna datum been the origin. The attribute data are textual data like names of road/streets, area etc. which were obtained in the field.

## METHODS

Database was created using ArcMap 10.1 software and shapefiles created for the following features such as buildings, rivers, road etc. From the satellite image, features such as roads, buildings, water carnal were digitized on screen. The area was divided into low and high density. The places that are well planned were regarded as low density while areas that are not well planned were digitized as cluster of buildings since it is not possible to digitise them as individual buildings. The coordinates of dumpsite were observed through ground surveying using Garmin 72H GPS hand held receiver.

## SPATIAL ANALYSIS AND QUERY

Buffering and proximity operation was carried out to determine the distances between dumpsite and the residential areas. Buffer rings were created in form of polygon around each dumpsite to show the proximity and disease prevalence. Three buffer rings were created using 100, 200 and 300metres respectively. More distances could have been used but the study area is not large enough hence the whole study area would have been covered if distance of 500metres and above were used, therefore covering the whole map and rendering it useless and also losing its meaning for the purpose for which it was created. Those houses that fall within 100m of dumpsites are classified as highly vulnerable to disease spread; within 100 to 200m as moderately vulnerable, while those within 200m to 300m from the dumpsites are less vulnerable to disease spread. The ArcGIS 10.1 software buffering operation was used in the determination of the the residential buildings that are prone to epidemics in the study area. Spatial query (selection by location) was used to select the buildings that falls within various buffers.

## RESULTS PRESENTATION

Table 1: Numbers of Dumpsites in Each Location

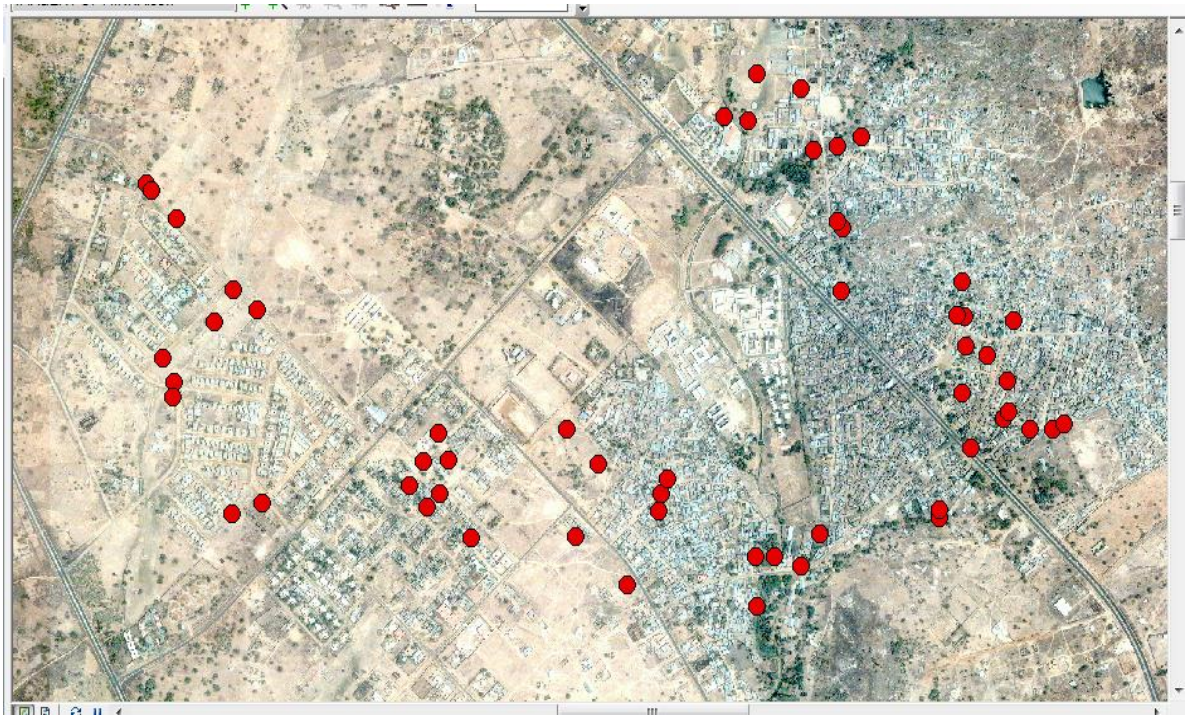
| Location of Dumpsites | No. of Dumpsites | Percentage Dumpsites |
|---|---|---|
| Bosso Estate | 12 | 21.4 |
| Bosso Lowcost | 8 | 14.2 |
| Front of School | 24 | 42.9 |
| Awwal Ibrahim | 12 | 21.4 |
| FUT Bosso Campus | 0 | 0 |
| **TOTAL** | 56 | 100 |

Source: Authors' field work 2016.

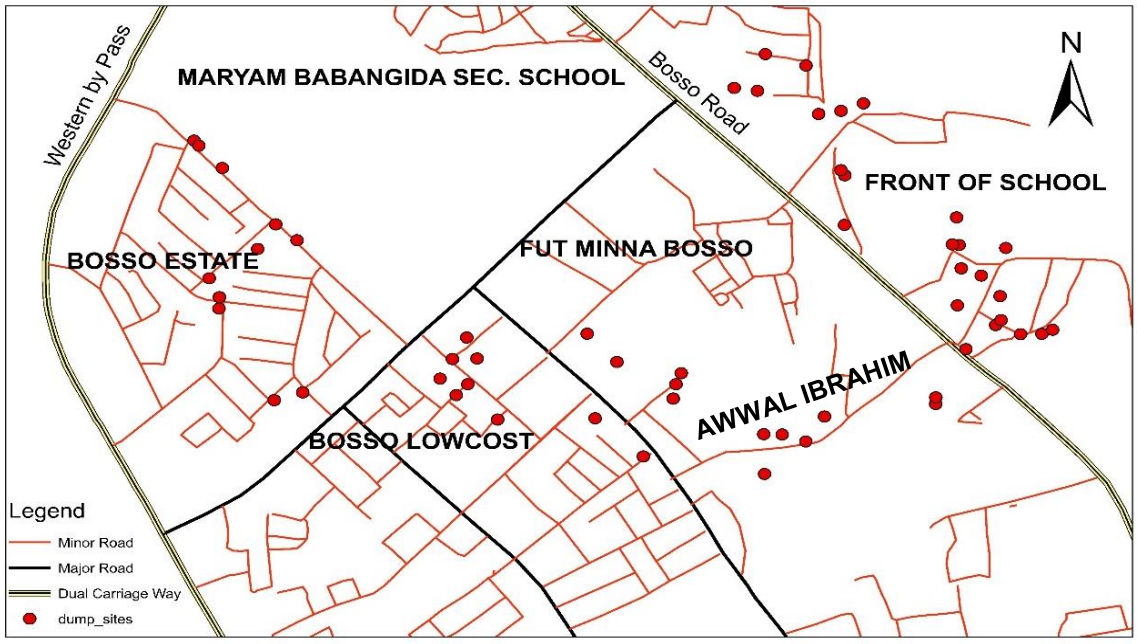
Table 2: Number of Low density Houses vulnerable to deseases due to proximity to the dumpsite

| **Buffer in Meters** | **Number of Houses** | **Vulnerability** | Percentage |
|---|---|---|---|
| Within 100 | 240 | High | 13.4 |
| Within 100 to 200 | 475 | Meduim | 26.6 |
| Within 200 to 300 | 369 | Low | 20.6 |
| Not Within the buffer | 703 | Not vulnerable | 39 |
| Total | 1787 | | 100 |

Source: Authors' field work 2016.



**A**




**B**

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Figure 2: (A): Spatial Distribution of Dumpsites in relation to satellite images. And (B) in relation to the digitize image.

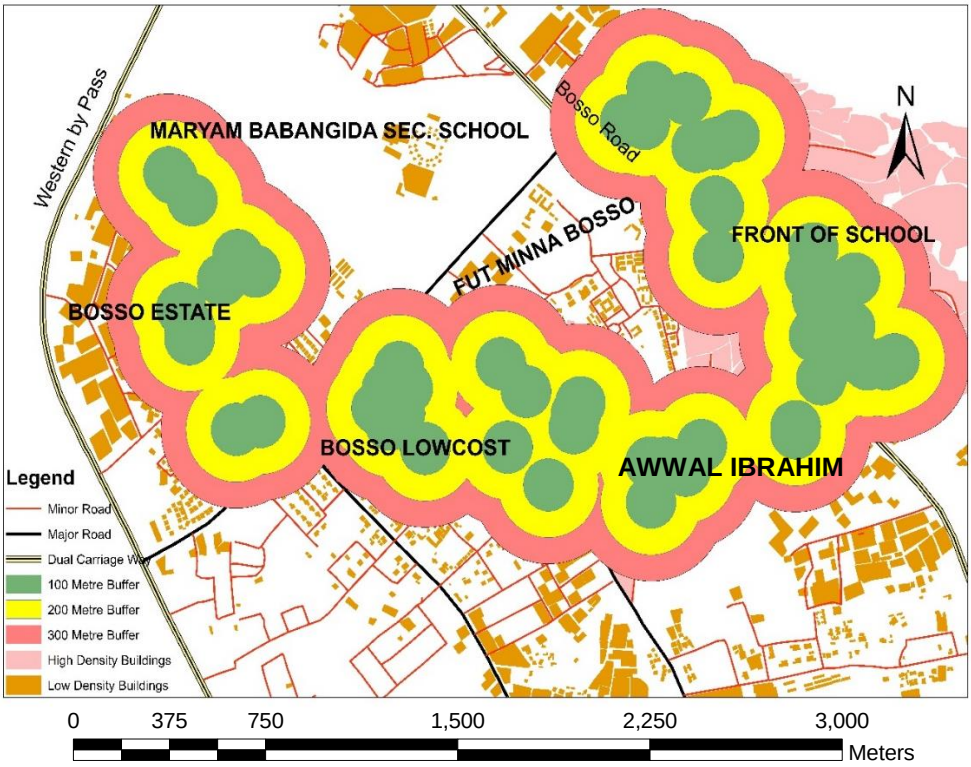


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Figure 3: Overlay of buffers rings on Low and high density buildings.

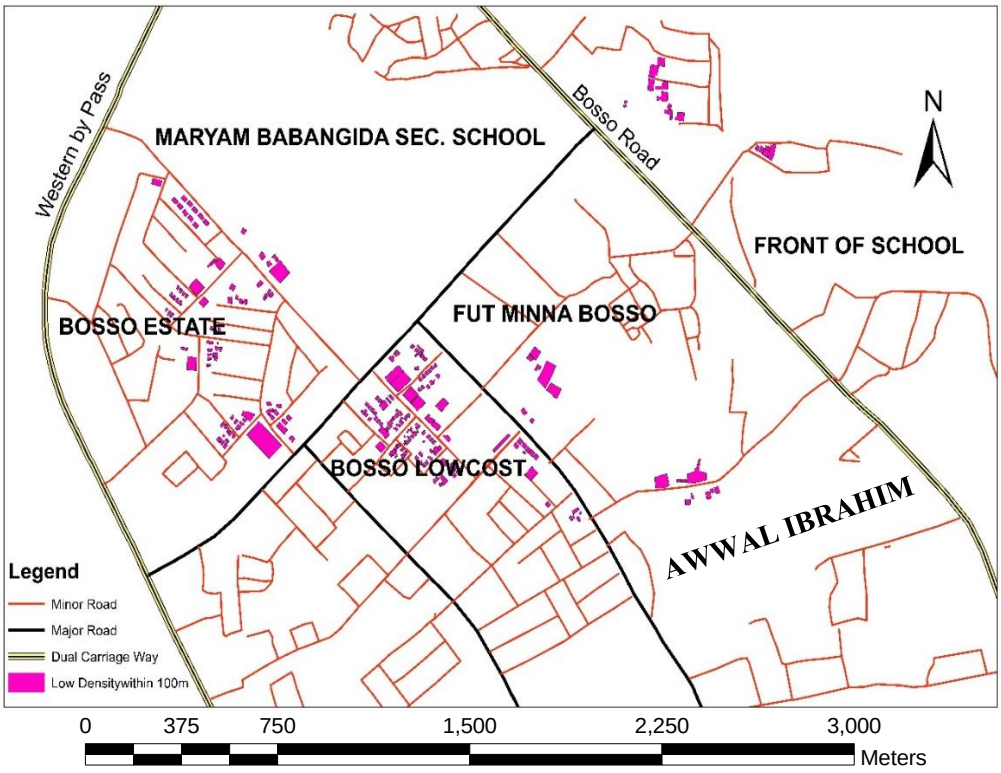


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Figure 4: High vulnerability to disease spread buildings within 100metres buffer

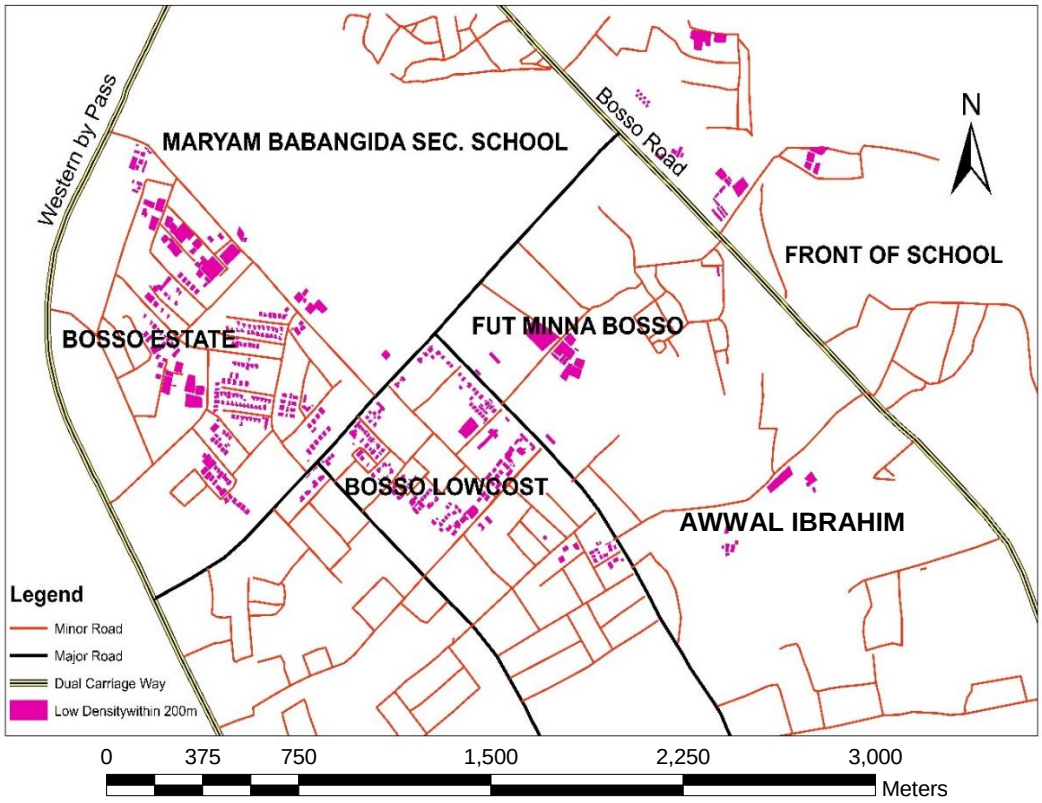


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Figure 5: Moderately vulnerable to disease spread buildings within 100 to 200 metres buffer

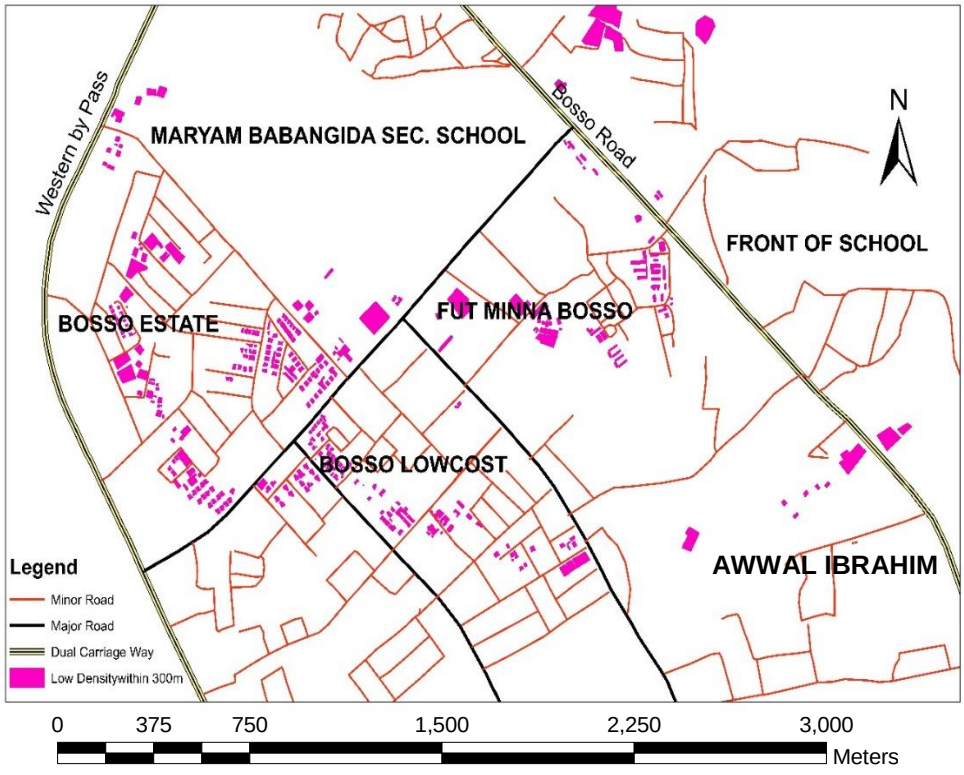


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Figure 6: Low vulnerable to disease spread buildings within 200 to 300 metres buffer

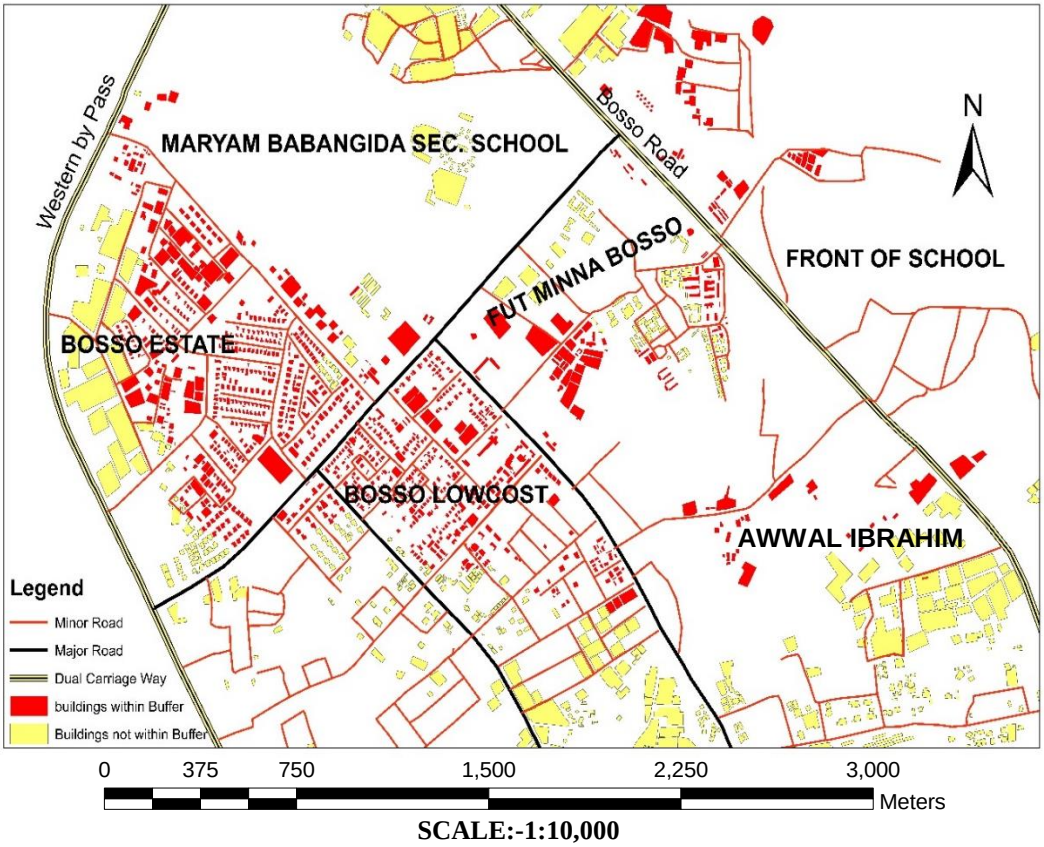


Figure 7: Building within area vulnerable to disease spread in red and building outside areas vulnerable to disease spread in yellow.

## DISCUSSION OF RESULTS

The study area for this research work has been subdivided into five segments namely: Bosso Estate, Bosso Lowcost, Front of FUT Bosso campus, Awwal Ibrahim and FUT Bosso campus. A total of 56 dumpsites were located and mapped I the study area as shown in table 1. Front of FUT Bosso campus has the highest number of dumpsites as 24 points while non was recorded in FUT Bosso campus. Bosso Estate and Awwal Ibrahim areas had 12 points each and 9 points were located in Bosso Lowcost. From the satellite image it can be seen that Front of FUT Bosso campus and Awwal Ibrahim are areas of high density buildings with 42.9% and 21.4% of dumpsites respectively.

Table 2 shows the number of low density houses that are vulnerable to diseases as a result of proximity to dumpsites. It was not possible to count the houses in high density areas, therefore, they were digitized as clusters of buildings. As a result, carrying out spatial query of the houses in high density areas was not possible but the result of buffer analysis in Fig 3 clearly pointed out that the high density areas are mostly affected. This is because more than half of the total number of dumpsite exists in the high density region of the study area.

Also, It can be observed from Table 2 that about 61% of the total number of low density houses are within the vulnerable zone. 13.4% with about 240 houses in the high vulnerable zone, 26.6% with 475 houses in the medium zone and 20.6% with 369 houses in the low vulnerable zone. This work also revealed that 703 houses in the low density area are not vulnerable to diseases due to their

proximity to dumpsites. That is, they are beyond 300m in all directions to any dumpsites within the study area.

From Figure 2, it was observed that open dumpsites are mostly found within the high density residential area which includes Bosso market, Mypa junction and London street area with a few spread across the medium and low density residential areas namely Bosso estate and Bosso Low-cost. This portrays a true reflection of the characteristics of such settlements. Also it can be seen that the Federal University of Technology, Minna (Bosso campus) and Maryam Babangida Secondary School are free from this menace. This implies that no dumpsite is cited within the school environment. The location of these dumpsites within the Bosso estate and Bosso low-cost residential areas are mostly along the existing streets. This could be as a result of the existence of an approved layout design prior to the construction of the estate and also because they are low density residential areas while from Bosso campus towards the north, east and south axis, It was noted that the dumpsites does not follow any definite or specific pattern. Their locations are based on any available space, probably because these areas lacked proper planning standards as shown in Figures 2 and 3. Figure 3 is an overlay of buffer operation around the dumpsites which shows the extent to which the residential buildings are affected with respect to the spatial distribution of open dumpsites. The result shows that the high density area (buildings) is mostly affected. Spatial query operation on low and medium density residential buildings was performed as shown in Figures 4, 5 and 6 but the query was not possible for high density because the buildings were digitized as blocks. The residential buildings with 100m buffer zone indicates highly vulnerable, the 200m buffer zone and 300m buffer zone are termed moderately and low vulnerable respectively to the spread of diseases such as cholera, typhoid fever, diarrhoea and malaria as a result of proximity to dumpsites. From recent disease outbreak on Lassa fever in Nigeria, open waste dumps in residential areas are also convenient places for the breeding and survival of rodents (Niger State Ministry of Health & Health Services, 2016) especially the Lassa fever proliferating Multi-mamatte rats. In figure 7, the research reveals that over 50% of the residential buildings in the study falls within the 100m, 200m and 300m buffer zone which represents high, moderate and low vulnerability respectively. The central and north eastern region of the study area are mostly affected from the buffer operation while the extreme areas are spotted as safe zones in the study area. This indicates that the existence of open dumpsite around the central and the north east regions is on the high side which was also observed to be increasing sporadically so much that if nothing is done to curb the incessant increase urgently, more than 50% of the areas denoted as safe regions will be affected very soon. This is because major cities and urban centres in the world today are faced with a global challenge (population pressure) and Bosso-Minna is not an exception. Therefore, it is a clear warning to the residents and the government of Niger state together with other relevant authorities to look critically into some of these health related issues that could serve as windows to the breakdown of epidemics since the environment is gradually getting affected.

## CONCLUSION

This research was carried out by evaluating the spatial distribution of open dumpsites and their effect on the residents in Bosso-Minna, Niger State, Nigeria. The research looks at the distributions of open dumpsites within urban areas of Bosso-Minna where population pressure is high. The spatial analysis carried out, based on the buffer zones generated shows the proximity of the buildings in Bosso-Minna and how likely they are to be exposed to epidemics related to dumpsites such as Cholera, Malaria, Typhoid, Dysentery and many others. The central and north east zones are the most affected areas while the extremes are still safe as at the time of this research work.

The research proceeds to discuss the usefulness of GIS as an indispensable tool for proper decision making, planning and implementation of policies by the Government or relevant authorities.

# RECOMMENDATIONS

## 1. Awareness campaign on the effect of open dumpsites

As stated in this research, one of the reasons of dumping refuse or waste in open areas in Bosso-Minna might be their Ignorance of the health risk associated with open dumpsites and illiteracy rate. Therefore, in recognition of this problem, it is very important for the residents of Bosso-Minna to be educated on this issue in order to be able to combat the and eradicate the epidemics that is posing great threats to the human health and the environment. This can be achieved by creating an awareness programme for the people, enlighten them of the effects and how it can be eradicated.

## 2. Sanitary landfill site selection

As it has been discovered and discussed in this research, open dumpsites are the common methods of waste disposal in Nigeria from which Bosso-Minna is not exempted. This study suggest sthat a suitable landfill site for waste disposal in an environmentally friendly area be created, considering the factors and constraints for this selection.

## 3. Evacuation of the existing open waste dumps

This research also recommends that, the Government through relevant authorities should immediately clear all the open dumpsites in the locality and replace them with waste transfer containers like open drums or trailers in strategic locations considering also the walking distance of users.

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