

# A Geospatial Approach to Crime Mapping and Analysis in Lokoja Metropolis, Nigeria

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**Abstract:** *The rate of crime incidents is increasing in all developing cities due to urbanization, increase rate of poverty, challenges of insecurity, change of technology, materialistic way of life and also due to poor socio, political, economic and environmental conditions. This project looks at the possibility of utilizing maps generated using GIS for effective management of crime in Lokoja, Nigeria. This option was explored by showing the procedural method of creating digital maps showing crime locations, crime geo-spatial database, and spatial analysis such as query using ArcGIS software and creating graphs using Microsoft Excel. This was done by using secondary data mainly crime incidence reports gotten from Nigeria Police Force (NPF), and primary data - the coordinates of the crime locations acquired using handheld GPS device, acquired imagery of Lokoja and Lokoja street map in creating a geodatabase with all spatial and non-spatial data, creating hotspot map based on temporal and spatial analysis. The result of query analysis shows crime hotspots, crime pattern over the period of three year and frequency of occurrence of crime in relation to various months of the year, areas requiring constant police patrol. The project proves that GIS and maps generated can give a better synoptic perspective to crime study, analysis and proactive decision making and prevention of crime. The study finally recommends that a digital database for crime be maintained in all crime fighting institution for effective crime monitoring, prevention and management*

**Keywords:** Crime, GIS, Geospatial, Database, Spatial analysis

## 1.0 INTRODUCTION

Crime mapping and geospatial analysis plays a pivotal role in defining new forms of representation and visualization to better understand crime and to respond adequately to the problems associated with it. Michalowski (1985) defines crime as an intentional act or violation of the criminal law committed without defence or justification against the state as a felony or misdemeanour, it also involve any behaviour that violate criminal law. Criminal activities in the form of theft, assault, homicide, rape etc. is something that takes place every day in almost all part of the world.

To combat crime according to Waugh and Openshaw (1994), Geographic Information Systems (GIS) has demonstrated to be a proper tool for assisting crime officers to determine the potential crime sites. It examines complex seemingly unrelated criteria and display them all in a graphical layered, spatial interface or map. Therefore, GIS with its ability for multifunctional operations can help identify high risk or potentially violent areas and also pin-point crime-prone locations in a geographical area. Cities in Nigeria are nodes of political activities and are also centres and melting pots of culture, religion, sports etc. However, violence and other crimes have emerged from these melting pots and the challenge is how to contain it before it consumes the cities (Mamman, 2004). In the 80s, the rate of crime occurrence grew sharply to nearly epidemic proportions, particularly in major cities of Nigeria such as Ikeja, Port Harcourt, Kano, Kaduna, Lokoja etc.

This was due to population explosion, economic inequality and deprivation, social disorganization, inadequate government service and law enforcement incapability, unemployment, socio-political conditions etc. (Murray *et al.* 2001).

Over time, the traditional and longstanding system of intelligence and criminal record maintenance has failed to live up to the requirements of the existing crime scenario. Manual processes do not provide accurate, reliable and comprehensive, real-time crime data and does not help in trend prediction and decision support (Fajemirokun *et al.*, 2016).

The solution to this problem lies in the effective use of GIS to carry out mapping of crime, analyse and make informed decisions for effective crime monitoring, prevention and management. A lot of researches have been carried out on integrating GIS application to crime.

However, such research efforts have been greatly limited in many developing countries such as Nigeria largely due to technological backwardness. (Olajuyigbe *et al.* 2016).

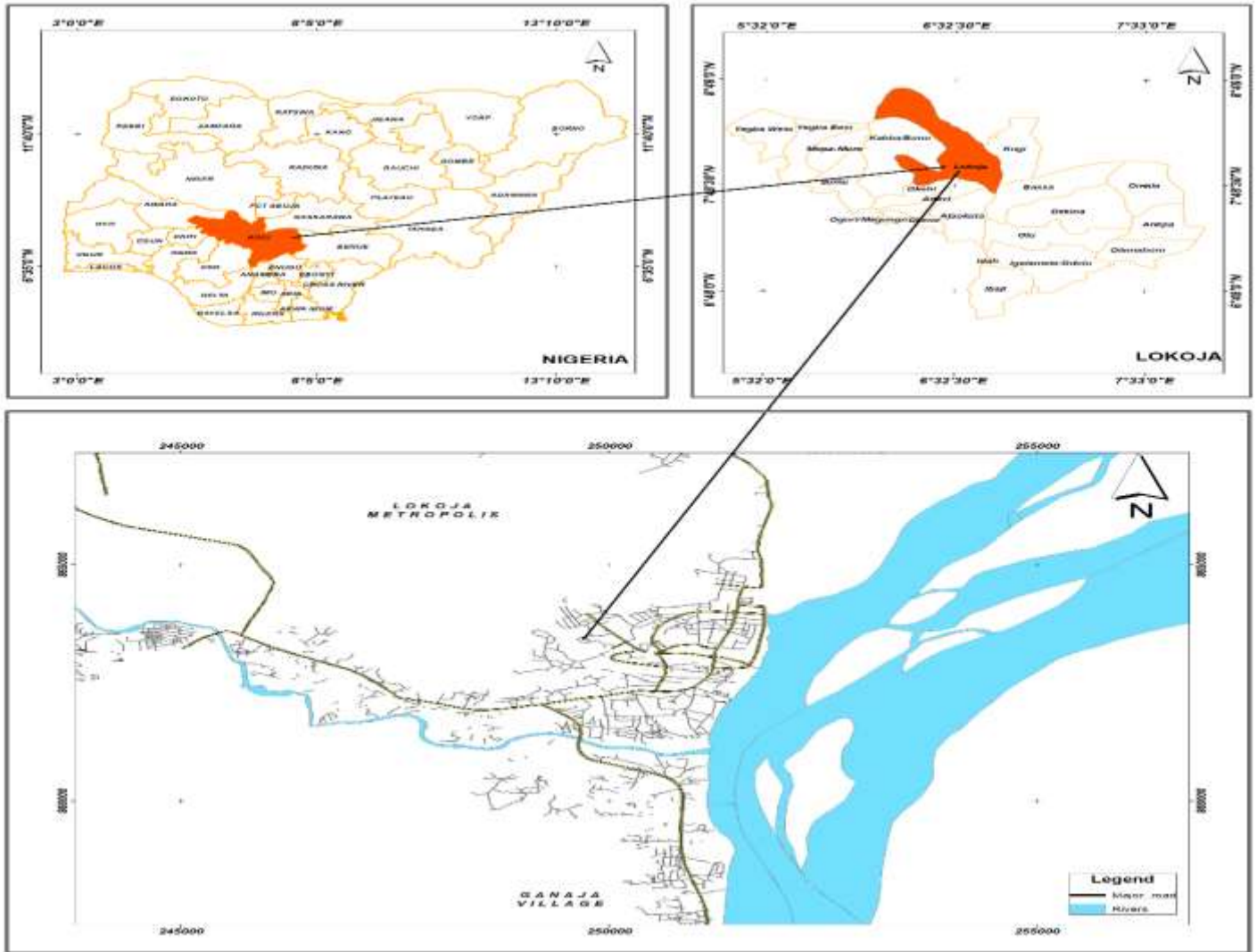
This paper explores a GIS-based qualitative analysis of the crime scenario in Lokoja metropolis of Kogi State, Nigeria. The study also seeks to underscore the changes in the pattern of crime over the years, considering that Lokoja is an emerging city and a nodal town connecting East and Western part of the country to the North. This geographical location and variation in the composition of the people has made the town volatile and prone to security issues.

## 2.0 Study Area

**Table 1:** Summary of the Study Area

S/No.	Item	Minimum	Maximum
1.	Location	07° 03'00"N	07°05'05"N
		06°03'00"E	06°05'00"E
2.	Elevation	53m	411.480m
3.	Rainfall	804.5mm	1767.1mm
4.	Relative humidity	30%	70%
5.	Temperature	27°C (Average annual)	
6.	Population	Over 100,000	
7.	Tribes	Igala, Ebira, Bassa-nge (Nupe), Hausa, Yoruba etc	

Source: Author's Lab Work (2022)



**Figure 1:** The Study Area

**Source:** Author's Lab Work (2022)

### 3.0 Materials and Methods

#### 3.1 Data Acquisition

The research used two types of data: Primary and Secondary data. The primary data used in this research include data acquired from field survey to identify the approximate location of recorded crime incidence, while the secondary data used in this research include Police records of crime in Lokoja metropolis from (2015 to 2017), Lokoja street guide Map, Quickbird imagery of the study area.

**Table 2:** Summary of Datasets Used in the Study

S/N	Data	Scale/ Resolution	Source	Purpose
1	Street guide map of Lokoja (2016)	Shapefile in soft copy format	Ministry of Lands, Housing & Urban Planning, Lokoja	To serve as base map and to aid address geocoding.

2	Coordinates data (2018)	3m accuracy	Field work Hand-held GPS device	To establish the spatial distribution of recorded crime and for updating the street guide map.
3	High Resolution Satellite Imagery- QuickBird (2017)	0.6m spatial resolution	Edges Environmental services Ltd., Abuja.	Locational characteristics
4	Police Crime Record, (2015 – 2017)		NPF Divisional Headquarters, Lokoja.	To enumerate the crimes committed and their locations within Lokoja.

Source: Author’s Lab Work (2022)

### 3.1.1 Acquisition of Crime Incidence Data

This data was obtained from the Nigeria Police Force (NPF), Lokoja divisional headquarters. The data included crime incidences within Lokoja metropolis for the years 2015, 2016 and 2017.

### 3.1.2 Acquisition of Crime Incidence Spatial and Attribute Data

The approximate coordinates of 109 crime incidences were collected using a hand-held GPS. The bulk of the attribute data were extracted from the police crime report. The attribute data collected were used to create the crime geodatabase

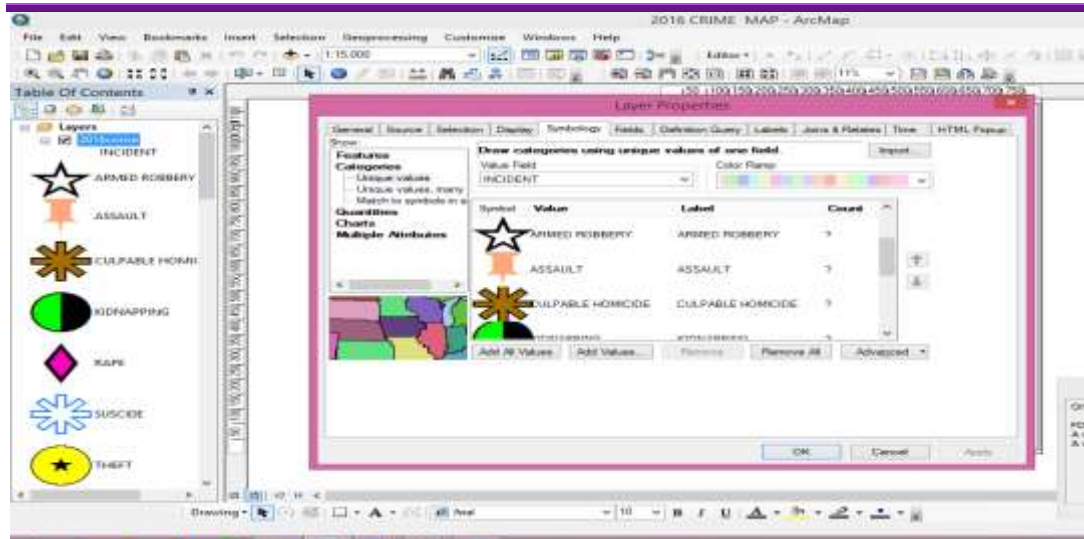
### 3.2 Data Processing

The data acquired from the primary and secondary sources were processed for subsequent use in ArcGIS 10.1 environment. The operations include; Data entry, Data editing, Coordinate system harmonization Address geocoding.

### 3.3 Creating crime incidence maps

Mapping of crime distributed within Lokoja over three years period under study involves displaying the Lokoja street network layers as a background and crime location displayed on top. Crime location layers represent different types of crime happening within that period using different colours and symbols. The process of representing crime types in different symbols and colours is known as reclassification of crime type. Layers were used in the classification of crime for each year while symbols were used for the crime type

Reclassification of crime types was done for the purpose of representing the different types of crime that happened in a particular area at a particular time, therefore allowing analysis to be carried out. This process was done using symbology in layer properties sub menu in ArcGIS as shown in Figure 2.



**Figure 2:** Symbology sub menu in ArcGIS  
**Source:** Author’s Lab Work (2022)

Various maps such as the composite map of all the crimes for the three years, map of most prevalence crime type for each year and each map shows relationship between reported crimes that happened in one area or the other in Lokoja from 2015 to 2017.

### 3.4 Crime Hotspot Analysis

The process of analyzing and identifying hotspot was carried out using Kernel algorithm interpolation method in Arcmap tool box. Microsoft Excel was used for the generation graph to show the frequency of occurrence of various crimes.

## 4.0 Results and Findings

### 4.1 Crime Types and Frequency

In this study, the frequency of each crime was determined from the police crime incidence report over the period of three (3) years; 2015-2017. Nine (9) crime types were identified namely: theft, culpable homicide, kidnapping, assault, rape, suicide, armed robbery, grievous hurt and public disturbance. Table 3 shows their frequency of occurrence.

**Table 3:** Frequency of crimes incidents n Lokoja between 2015 and 2017

S/No.	Crime type	Frequency of occurrence			Total	Percentage (%)
		2015	2016	2017		
1	Theft	9	12	14	35	32.11
2	Culpable Homicide	11	6	7	24	22.02
3	Kidnapping	5	2	2	9	8.26
4	Assault	nil	3	6	9	8.26
5	Rape	6	5	Nil	11	10.09
6	Suicide	3	1	Nil	4	3.67
7	Armed Robbery	3	2	2	7	6.42

8	Grievous hurt	nil	Nil	3	3	2.75
9	Public Disturbance	nil	Nil	7	7	6.42
	Total	37	31	41	109	100

Source: Author’s Lab Work (2022)

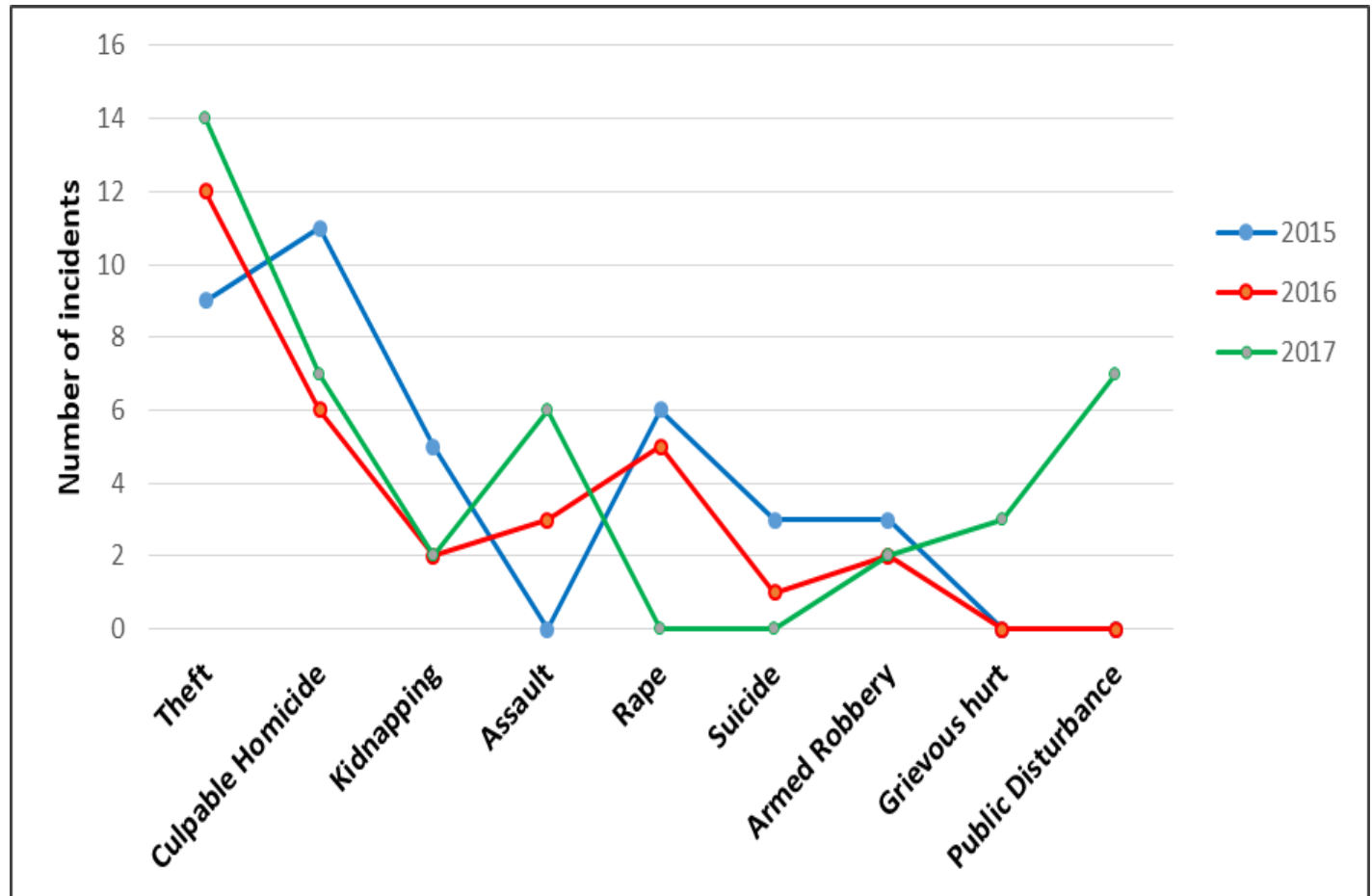


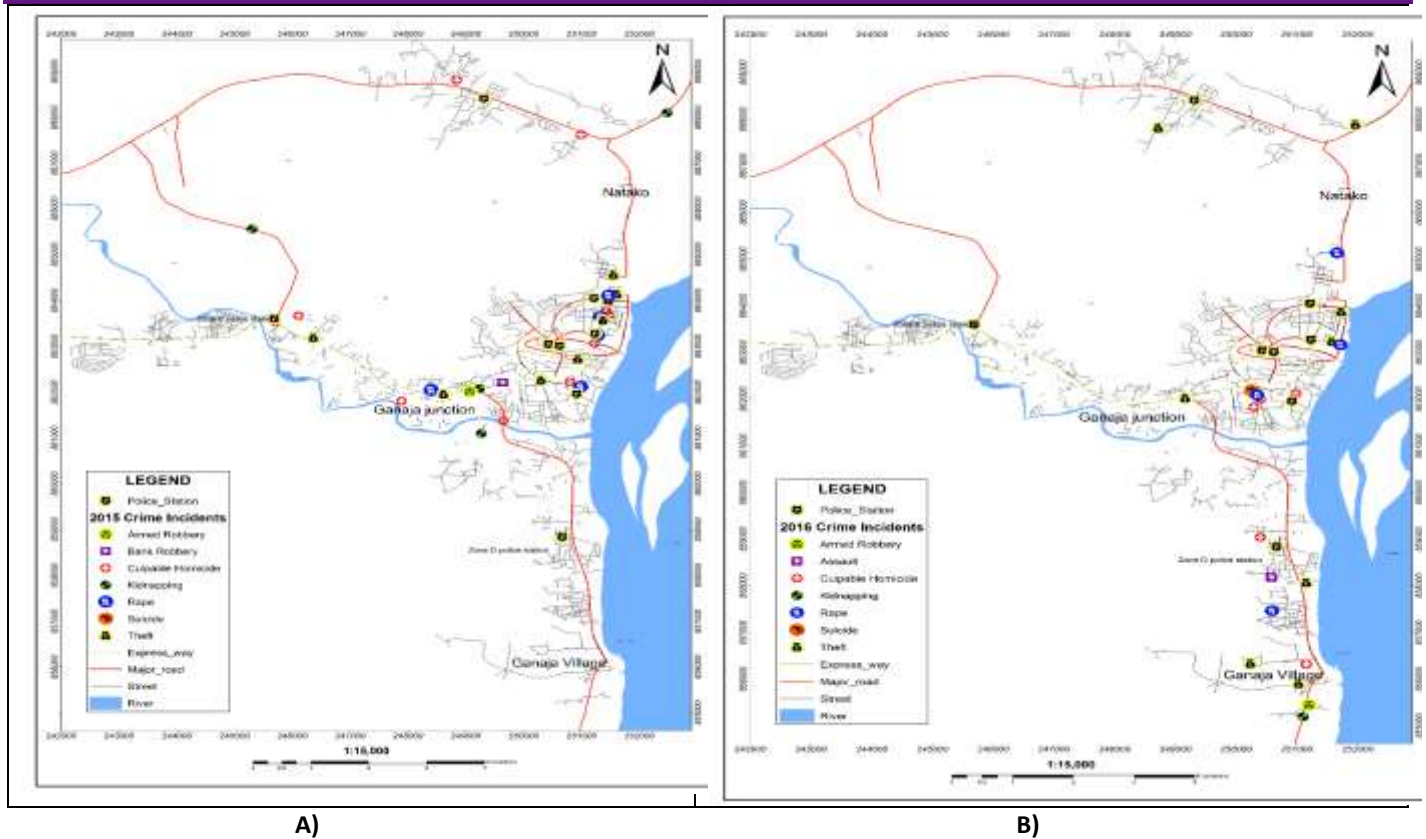
Figure 3: Prevalence of the different crime incidents between 2015 and 2017

Source: Author’s Lab Work (2022).

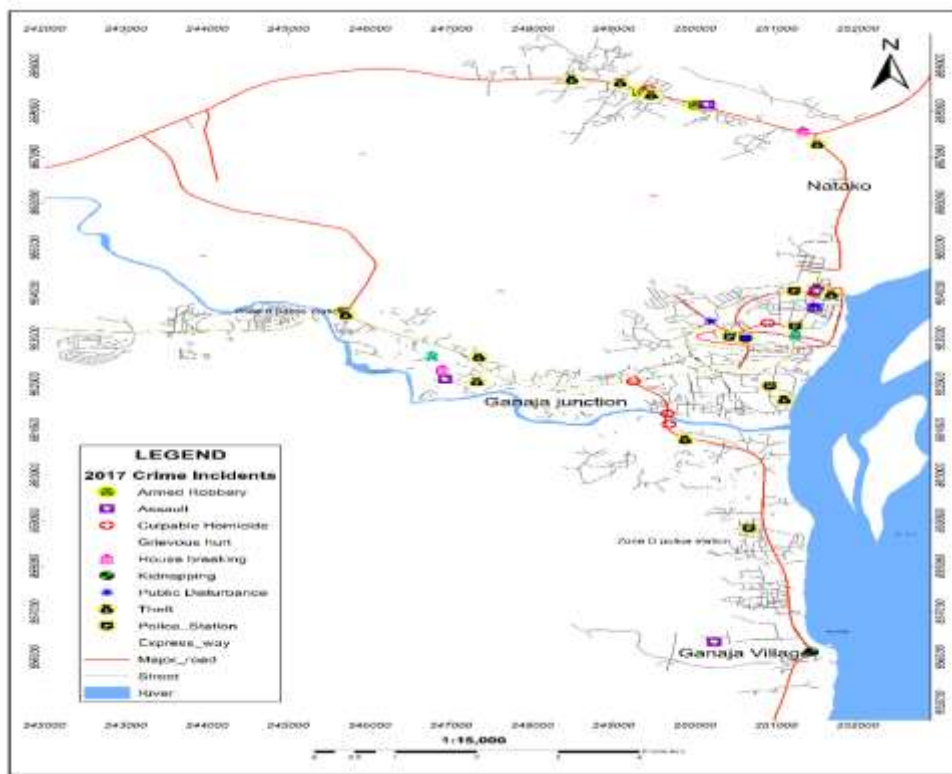
#### 4.2 Crime mapping

Crime maps for the years 2015, 2016 and 2017 were created using ArcGIS 10.1.

Symbology property was used to differentiate the different crime types with their spatial location displayed on each map.



Each map also showed the spatial distribution of all crime incidents within the study area.



**Figure 4:** Crime incidents map of Lokoja metropolis (a) in 2015 (b) in 2016 and (c) in 2017

Source: Author's Lab Work (2022)

Results show that crimes are not clustered in their distribution across the three years.

Lokoja is a linear settlement along a major road and river. Most of the crimes occur along the major road or close to it.

## 5.0 Conclusion

The findings from this study show that the incorporation of GIS in crime mapping and analysis is a much more efficient means of crime pattern analysis than the current manual system of records. This is because of its geographic referencing capabilities. In this study, crime incidence maps were generated for 2015, 2016 and 2017, for the study area to map the crime locations, to identify the hotspots and related information from the crime database.

Finally, the study has demonstrated that geo-information technology can give a greater perspective to crime study, analysis and hands-on decision making to prevent and curb crimes.

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