International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2643-9670
Vol. 6 Issue 12, December - 2022, Pages: 288-294

Spatio-Temporal Analysis of Crime Hotspots in Lokoja, Kogi State

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Abstract: *Criminal activities have been a major worry in the modern-day society, there has been increase in intolerable levels of delinquency and crime in most developing countries and Lokoja in Kogi State is not left out. This study deals with spatio-temporal analysis of crime hotspots in Lokoja, Kogi State. The data used included crime incidences within Lokoja metropolis for the years 2015, 2016 and 2017, GPS device was used to capture the absolute location of the crime hotspots, and approximately 109 coordinates of crime incidences were collected. The secondary data used included the records of crime from the Police Headquarters, Lokoja. This research work used GIS as a tool to detect areas that have dense clusters of criminalities, the kernel density algorithm was used to calculate the magnitude per unit area from crime point. Buffer of 1km from police station were produced for a better understanding of the distribution of crime pattern, from the map. The results from this research have shown the possibility of utilizing crime maps and analysis generated using Geographic Information System as a tool in policing for crime fighting, control and crime prevention programs. It is recommended that the security operatives i.e. police and communal watch group, should be beefed up in every crime hotspot areas. Kogi state should use this research work as a model for crime management and expand the scope to the remaining part of the state.*

Keywords: Crime, GIS, Spatio-temporal, Buffer, Spatial analysis

1.0 INTRODUCTION

Crime's existence in this world could be traced back to the era of mankind's creation and mankind has continuously devised ways to combat it as much as possible. The occurrences of criminal activities have become usual news in almost all part of the world today. However, there has been great deal of debate among the security experts on the causes of crime (Agada *et al.*, 2022). Any city with high rate of criminal records seems to be unattractive to investment be it local or foreign, and this is the present situations that prevail in most part of Nigeria. (Olajuyigbe *et al.* 2016).

Dambazau (1997) categorized crime into four categories, namely; offence against lawful authorities (escape from custody, corruption and bribery, gambling, perjury, breach of peace), offence against property (theft, burglary, house breaking, and store breaking, armed robbery, receiving stolen properties, unlawful possession of drugs), offences against local act: This also involves fire arms act, traffic offence, narcotic, liquor offence, etc and finally, offence against person (manslaughter, murder, suicide, wounding, assault kidnapping, child stealing, rape etc).

Anderson (2006) classified crime as property crime, violent crime and nuisance/other crimes Ahmadi (2003), on the other hand categorized criminality as economic, social and security crimes. Nuisance crimes according to Anderson (2006), are noise registration of grievances and unconfirmed (suspicions) activities that are not investigated. Violent crimes fall into the category of assaults, fighting, homicides, robberies, sexual assaults and stabbings (Ellis and Walsh, 2000). Property crime on the other hand is broken into two categories which include break and enter (actual and attempted break and enter), and automotive theft, which includes stolen automobiles and items stolen from automobiles (Ellis and Walsh, 2000).

Security crime as recognized by Ahmadi (2003), centers on security against a person, examples include hold up, burglary, shoplifting, robbery and motor theft while economic crime centers on crime that are against money or property or a person. They include auto theft, shoplifting, burglary and fraud. Social crimes are social behavioural deviant acts such as drug and alcoholic habit, pick pocket, robbery and theft from either moving or stationary vehicles.

Groft and La Vingne (2001) observed that, factors which lure potential targets and more so, simple geographic convenience for a potential offender, increases changes of criminality because criminals are humans with intelligence who can migrate around, and can also live in the society just like every one of us.

Between the period of 1989–1996, more than half of the urban settlers recounted being victims at least once of crimes and this is regardless of what part of the world people live in (Ackerman & Murray 2004). Also, high crime rates are not limited to a selected

nation alone, but its occurrence is world over. Eck and Weisburd, (1995) explained that research seeking to understand the geographical variation in the rate of crime has been ongoing for more than a century and half.

A lot of researches have been carried out on the use of GIS applications in crime analysis however, such research efforts have been greatly limited in many developing countries such as Nigeria due to technological backwardness (Olajuyigbe et al. 2016). It is against this background that this research attempts a comparative analysis of the crime scenario in Lokoja metropolis of Kogi State, Nigeria, for 2015, 2016 and 2017. This is aimed at mapping and analyzing crime hotspots in Lokoja metropolis with the view of prescribing a permanent solution to its prevalence.

This study covers spatio-temporal analysis of crime hotspot of reported crime data from the police for three years from 2015 to 2017. Crime such as theft, kidnapping, culpable homicide, rape assault, robbery, etc, that occurred in Lokoja metropolis (Natako – Felele through city centre to Ganaja village and Otokiti Village) of Lokoja Local Government Area, in Kogi State, were all mapped and analysed.

It is a known fact that, offenders in most cases know and study their targets or victims for a period of time. As a form of justifying this study, this very nature of criminality makes Geographic Information System (GIS) a useful tool to security personnel which can be used to effectively plan emergency crime response, analyze historical events, determine mitigation priorities and predict future events. GIS can also be used to pass across information to emergency responders upon dispatch or while en - route to an incident to assist in tactical planning and response (Richardson, 2000). Since response abilities rely on a range of data from several agencies and sources, the ability to access and process information quickly while displaying it in a spatial and visual medium allows agencies to allocate resources quickly and more effectively (Olajuyigbe et al. 2016).

2.0 Review of Related Literature

Elis and Liu, (2018) explained that urban areas are acknowledged for enhanced facilities, improved welfare and greater life opportunities. Lots of migration from rural areas end up in the urban because life offer greener pasture to urbanism than in the rural areas. However, all these advantages as seen in the urban have attracted many serious crime issues. Crime is one of the direct problems associated with urbanization in developing countries (Elis and Liu, 2018). Dambazau (2007) has underlined problems such as security and crime in urban areas in developing countries as a phenomenon to be taking seriously when planning a city. Elis and Liu (2018) in their work aimed at understanding the motives behind crime happenings, the major indicators of crimes and the city authority's response and finally the kind of policy that should be developed by security agencies to mitigate crimes. To realize a viable way of curbing crimes, Elis and Liu (2018) after lengthened consultations of literatures on crime indicators inferred that, in any urban society where crime prevails, an unsafe environment is also created. The setback is that their work never gave the Law enforcers locations to focus their energies on. Finally, Elis and Liu (2018) recommended that, the government creates employment chances for vulnerable youths as such cannot make them engage in crime.

Bodunde and Balogun (2019), wrote that contemporary issues of terrorism is creating challenge on Nigeria's security policy such that, there is failure to understand that, current revolutions in terrorists and bandits grand strategy of kidnapping for ransom and suicide bombing have overtaking the place of conventional military warfare. Observations were made concerning the methodology explored in Bodunde and Balogun (2019) and discoveries where made which inferred that, lack of operational mechanisms of combating terrorism and dearth of the technicalities of the moving trend of revolution in military warfare.

Olasanmi, Agbaje and Adeyemi, (2020) have identified that cyberbullying is one of the crimes that has emerged from the modern day technologies. Olasanmi *et al*., (2020) described it as crime that make use technologies to cause harm or intimidate others and it is most prevalent among Nigerian Students because they make use of the social media a lot. The methodology adopted was a sample questionnaire which did analysis both on descriptive and inferential statistics and, inferred that cyberbullied victims often exhibit a variety of negative outcomes especially anger, embarrassment, fear and anxiety. The outcomes of Olasanmi *et al*., (2020) showed that victims may resort into crimes.

Sherman, Gottfredson, MacKenzie, Eck, Reuter, and Shawn (1998), wrote that, not all crime prevention strategies work however, some programs need to be evaluated with enough scientific evidence before conclusions can be drawn. They also agreed that in their work, enough evidence is available, to create provisional lists of what works, what doesn't, and what's promising. Those lists will grow more quickly if countries invest more resources in scientific evaluations to hold all crime prevention programs accountable for their results.

Sherman et al., (1998) also likened the art of crime prevention to that of art of medicine whose effectiveness lies in the coffers of the State and local crime prevention assistance programs. As a way of prevention, special emphasis should be placed on factors that relay to juvenile crime. It was inferred that, crime rate is on increase among the youths (Sherman et al., 1998).

Sherman et al., (1998) summarized the crime mitigation approach as drafted in the law as; (a) reductions in juvenile delinquency; (b) reductions in susceptible risk factors that contribute to juvenile violence; and (c) increase proactive factors that reduce the likelihood of delinquency and criminal behavior.

2.1 Research Direction

This research work would used GIS as a tool to identify areas that contain dense clusters of crimes and the kernel density algorithm as used by Chainey and Ratcliffe, (2005) would be used to calculate a magnitude per unit area from crime point features using a kernel function to fit a smoothly tapered surface.

3.0 METHODOLOGY

3.1 STUDY AREA

Nigeria comprises 36 states and the Federal Capital Territory. Kogi State is one of the states and is in the North Central part of the country and generally referred to as the Confluence State because river Niger and river Benue meets at Lokoja. Lokoja is capital of Lokoja Local Government Area as well as Kogi State situated in the Central region of Nigeria. It is located between latitudes 07º 03' 0" to 07° 05' 5"North of the Equator and longitude 06° 03' 00" to 06° 05' 00"East. It is characterized by rocky and hilly terrain configuration with heights ranging from between 5.860m and 411.480m above mean sea level. The state enjoys both wet and dry seasons with annual rainfall ranging between 804.5mm and1767.1mm having a mean annual temperature of 27°C. Relative humidity is 30% in dry season and 70% in wet seasons. (Joy, 2016).

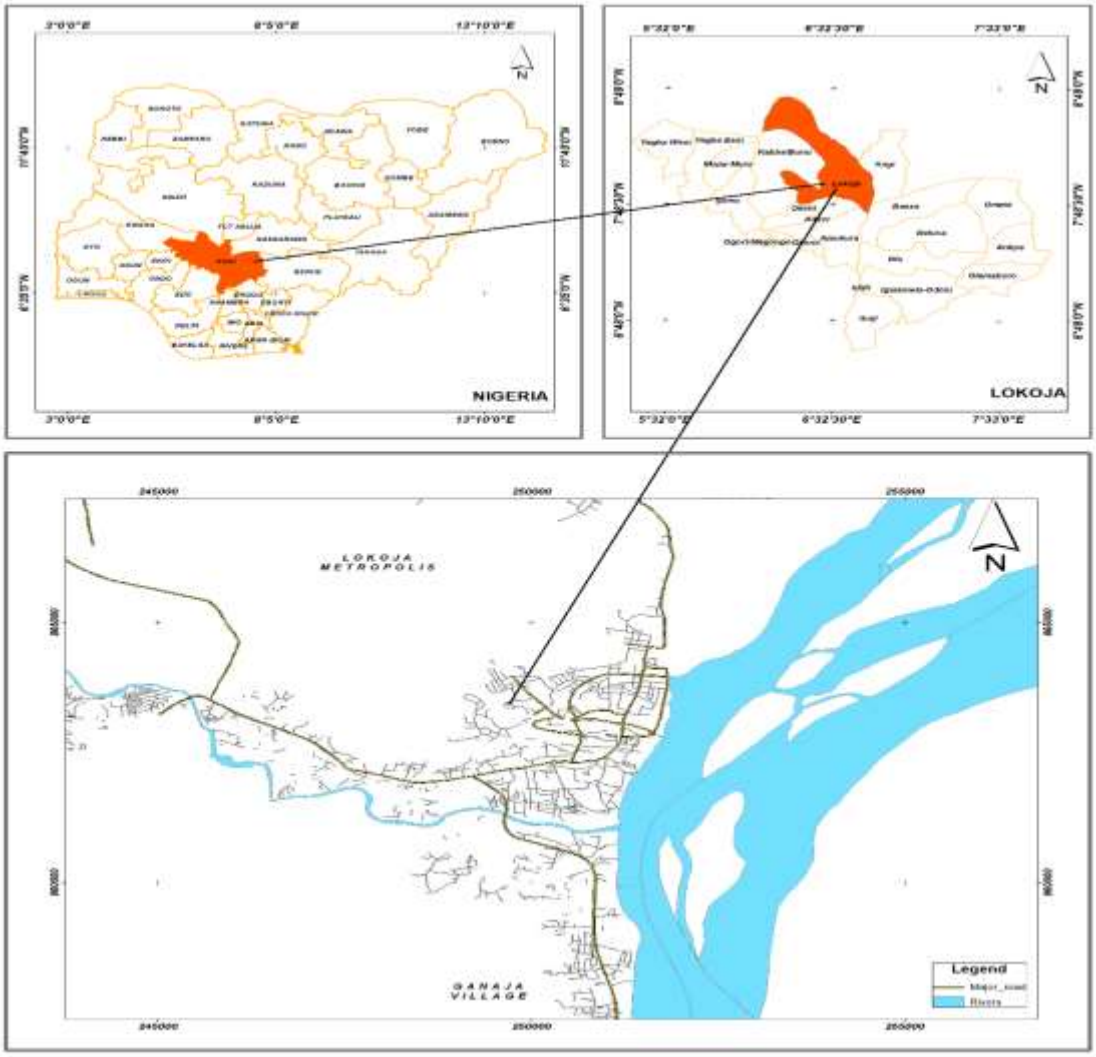

Figure 1: The Study Area. **Source:** Authors Lab work, (2022).

3.1 Acquisition of Crime Incidence Data

The study made use of both primary and secondary data. The secondary 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, while GPS device was used to capture the absolute location of the crime hotspots. 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 in ArcGIS 10.1 environment. The operations include; Data entry, Data editing, Coordinate system harmonization and Address geocoding.

3.2 Creating crime incidence maps

The Mapping of crime scattered within Lokoja for a three year period involves showing the Lokoja street network layers as a background and overlaying the crime location map on top. Crime location layers represent different types of crime happening within that period using different colours and symbols. Reclassification of crime types was done for the purpose of representing what types of crime 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

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

Kernel agorithm interpolation method in Arcmap tool box was used to identify hotspots clusters, crime incidences and frequency of its occurrence was used for the intepolation. Microsoft Excel was used for the generation of bar chart for graphical representation of the frequncy of occurenc of various crimes.

4.0. Results and Analysis

4.1 Result

4.1.1 Results of prevalence of Crime in Lokoja

To analyse frequency of occurrence of a crime type over the period of three years. A chart was produced in Microsoft Excel by plotting the frequency of occurrence of crime against various crime type and the corresponding years.

Table 1.1: Crime classification of 2015 to 2017 incidences in Lokoja (Authors lab work 2018)

S/No	Crime Type	Year/No. of Incidence				
		2015	2016	2017	Total	Percentage (%)
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	

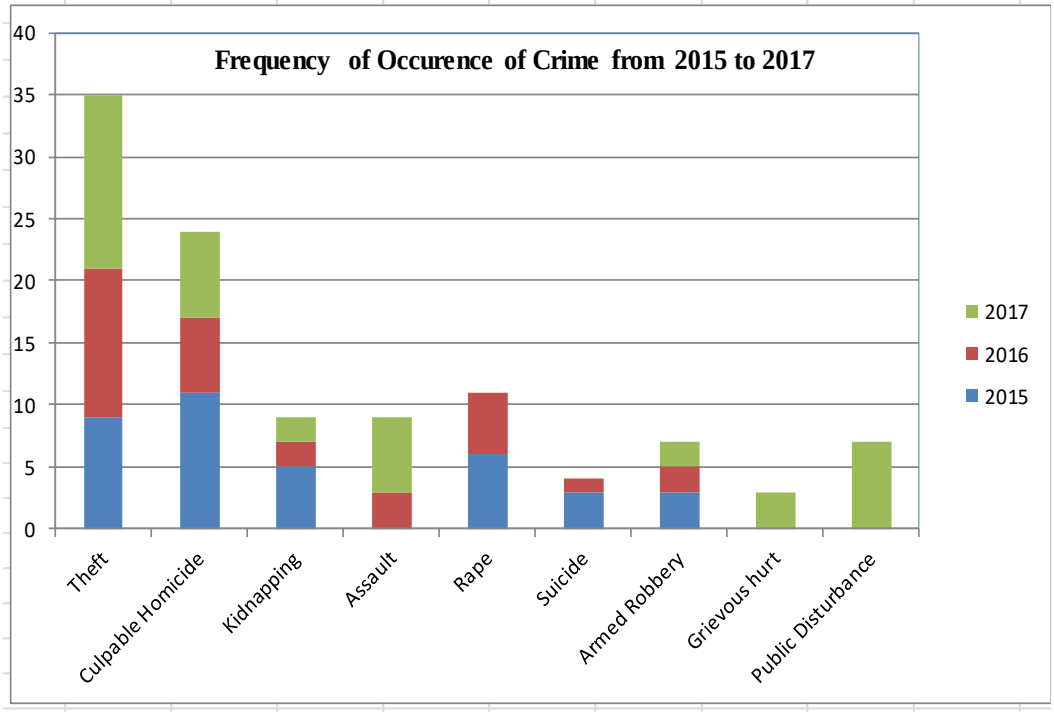

Figure 4: Graph of prevailence of various Crime type over Period of 3 Years.

4.1.2 Result of the Hotspot map

The results from using Kernel algorithm method are displayed in figure 2 and 3.

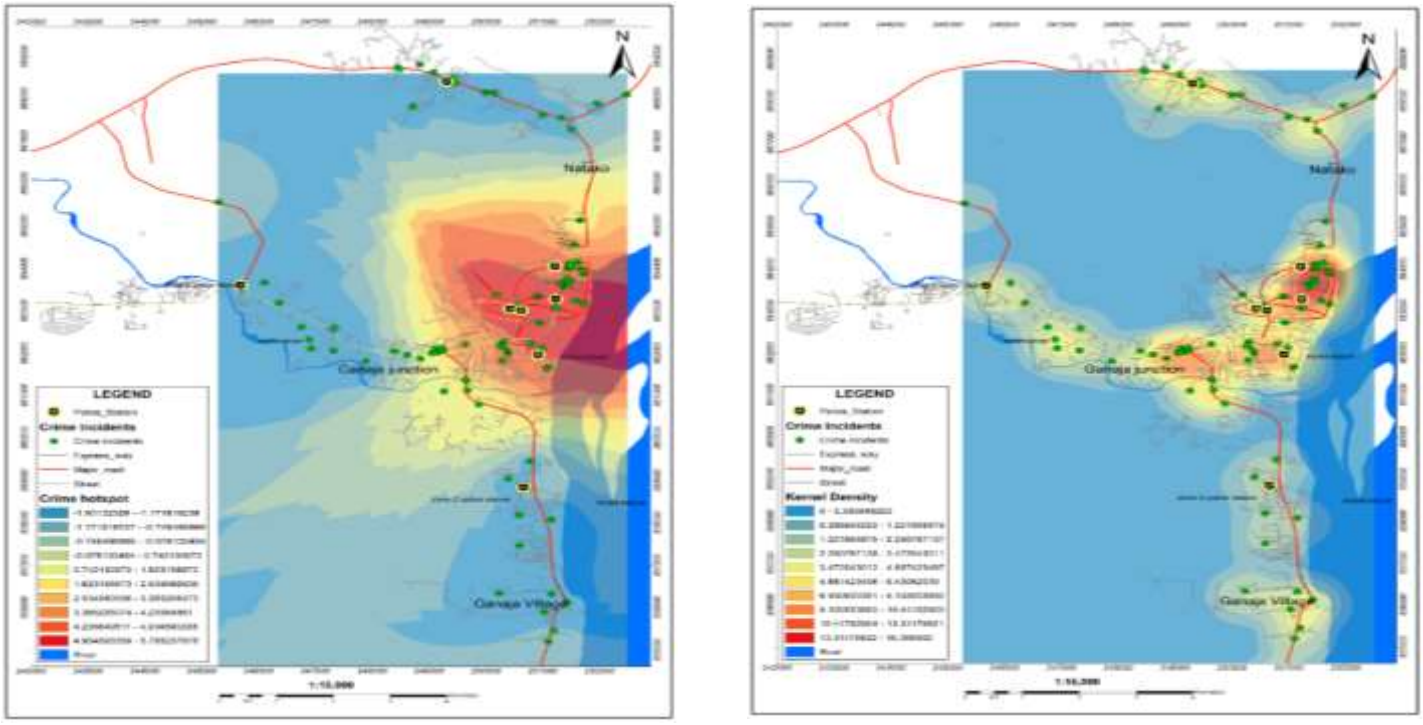

Figure 2: Hotspot map (left) and kernel density map (right) of crime incidents within Lokoja metropolis for 2015 to 2017

Source: Author's Lab Work (2022)

4.1.3 Result of the Spatio-temporal Analysis of crime hotspots

To ascertain the spatio-temporal nature of crime in the study area, the Crime maps of incidenses of each year for the three years (2015 to 2017) on a buffer of 1km from police station were produced

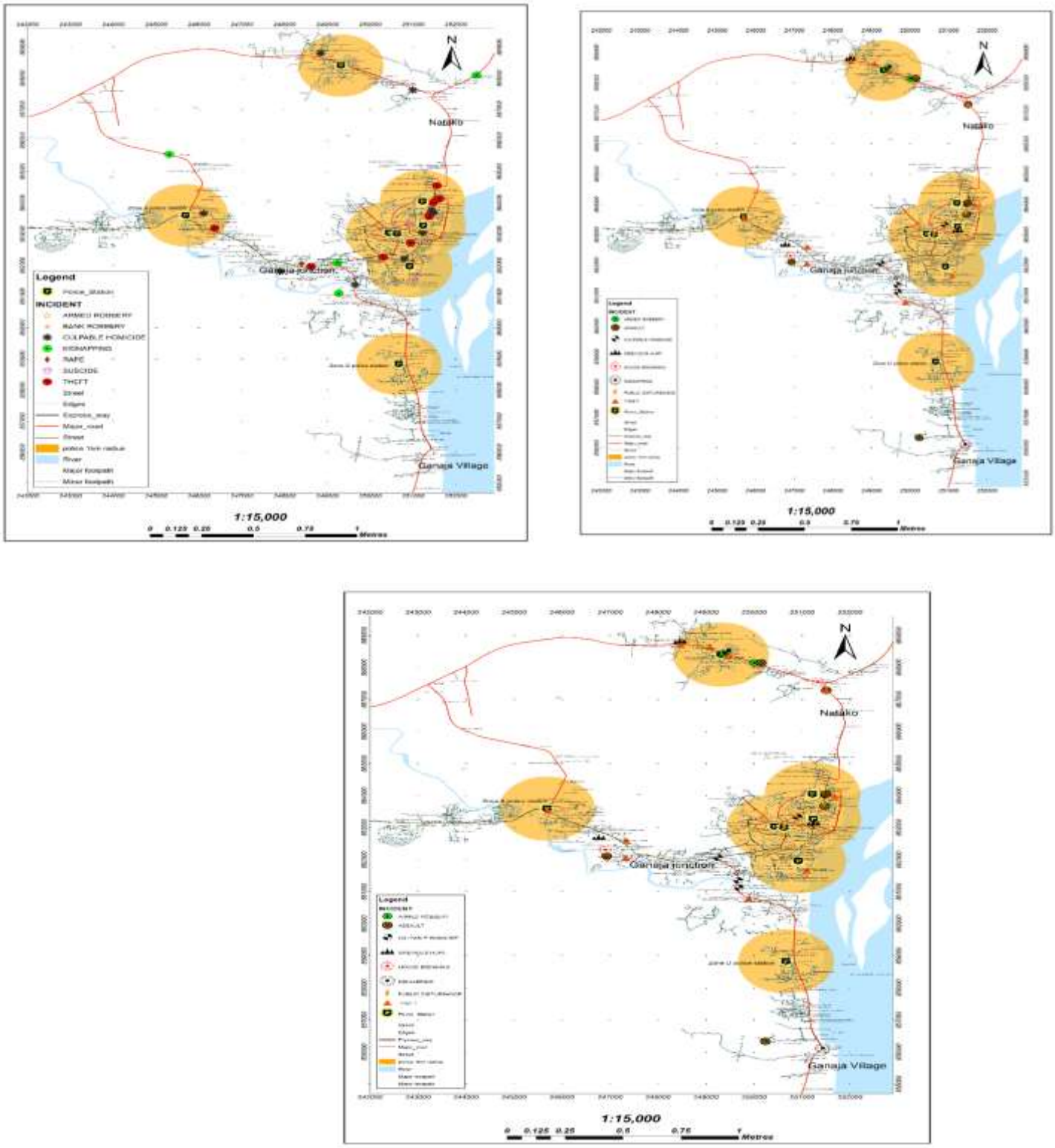

Figure 3: Buffer analysis of police stations for (a) crime incidents in 2015 (b) crime incidents in 2016 and (c) crime incidents in 2017.

4.6 Discussion of Results

From Table 1.1, and Figure 4, there is increase in theft cases between 2015 and 2017 with 2017 having the highest theft, culpable homicide recorded the highest occurrence in 2016, kidnapping reduced from 2015 to 2017, while assault is on the increase from 2015 to 2017. Generally the prevalent crime in Lokoja is the cases of theft which contributes 32.11 percent of the total reported crime committed from 2015 to 2017, culpable homicide followed with 22.02 percent while rape account for 10.09, while kidnapping and assault contributes 8.26 percent each over the period of three years from 2015 to 2017.

In figure 2, areas that contain dense clusters of events (hotspots) were identified. These high concentration areas usually should demand special police attention. Furthermore, the kernel density algorithm calculates a magnitude per unit area from crime point features using a kernel function to fit a smoothly tapered surface.

The result of the kernel density and hotspot analysis shows that there exist three (3) crime hotspots within Lokoja metropolis namely; Paparanda roundabout, Local Government Secretariat junction and Ganaja junction. Ganaja junction is about 1.6 km away from the closest police station. The crime density presents a concentric pattern of crime within the core of the city as compared to the periphery.
From Figure 3a, it is seen that crime incidences are concentrated in the city centre with few crime cases reported at the periphery in 2015. In 2016 (Figure 3b) on the other hand, the crime incidents moved to the periphery as a result of improved policing in the city centre. Ganaja village reported more crimes in 2016, while in 2017 (Figure 3c), Felele community recorded the highest incidences of crime. For a better understanding of the distribution of crime and pattern, from the map, it was observed that the crime were randomly distributed across varying locations over time.

5.0 Conclusion and Recommendation

The three years of reported crime data in the research area has given a glimpse of how the crime being a human phenomenon is not at all random and dispersed evenly over the whole study area but it is clustered for few spots and random in other areas. The results from this research have shown the possibility of utilizing crime maps and analysis generated using Geographic Information System as a tool in policing for crime fighting, control and crime prevention programs. Therefore, it is recommended that the security operatives i.e. police and communal watch group, should be beefed up in the crime hotspot areas. Kogi state should use this research work as a model for crime management and expand the scope to the remaining part of the state.

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